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EFFECT OF TWO PREPARATIONS BASED ON PLANT EXTRACT ON ZOOTECHNIC PARAMETERS AND HEALTH CONDITION OF BROILER CHICKEN
/
EFFET DE DEUX EXTRAITS VEGETAUX SUR LES PARAMETRES ZOOTECHNIQUES ET ETAT DE SANTE DE POULET DE CHAIR

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***Keywords**: broiler, biochemical parameters, zootechnic parameters*

ABSTRACT

In the context of the search for alternatives to antibiotics, several non-therapeutic substitution methods can be envisaged; Including the use of plant extracts, which are increasing by being proposed and studied with the aim of improving the homogeneity and performance of breeding.

The aim of the present study is to evaluate the effect of supplementation in plant extracts of two deferential preparations (Oregano and Garlic), and (mint and eucalyptol) to improve the zootechnical performance and biochemical parameters of the broiler.

The experiment lasted 45 days, it was conducted on a total of 180 chickens divided into three groups. One control group and 2 groups received 2 different treatments. The overall results recorded showed differences in weight gain between the control group and the two experimental groups (1312 vs 2219 gr 1312 vs 2011 gr, 2219 vs 2011 gr) respectively. The mortality rate was higher in the control group compared with the two treated groups (28.33 vs. 0.0%).

The results of the assay of some biochemical parameters (glycemia, cholesterol, triglycerides) appear in direct relation with the supplementation of these vegetable preparations. However, the level of glycemia decreases in group (Oregano and Garlic) compared to the control group (1.83 vs 2.38 g/l) the level of cholesterol (0.79 vs 0.99 g/l) and the triglyceride level (0.70 vs 0.96 g/l). The vegetable preparations used have a positive effect on the zootechnic and biochemical parameters. They even improved the weight of offal (liver and heart).

RESUME

Suite à l'interdiction de l'utilisation des antibiotiques comme facteur de croissance dans l'alimentation des animaux d'élevage et leur impact néfaste sur la santé publique, plusieurs méthodes substitutives non thérapeutiques, dont les extraits de plantes, ont été proposées et étudiées pour l'amélioration des performances de poulet de chair.

L'objectif de la présente étude et d'évaluer l'effet de la supplémentation en extraits de plantes d'*Origan* et d'*Ail* et la menthe avec Ecalyptus pour améliorer les performances zootechniques et les paramètres biochimiques du poulet de chair.

L'expérience a duré 45jours, elle a été menée sur un effectif global de 180 poulets répartis en deux lots. Un lot témoin et 1 lot expérimental (suppliment é en extrait végétal). Les résultats globaux enregistrés ont montré des différences au niveau du gain de poids entre le lot témoin et deux lots expérimentaux (1312 vs 2219 gr 1312 vs 2011 gr, 2219 vs 2011 gr) respectivement. Le pourcentage de mortalités est élève dans le lot témoin par rapport au lot traité (28.33 *vs* 0,0%).

Les résultats du dosage de quelques paramètres biochimiques (glycémie, cholestérol, triglycérides) paraissent en relation directe avec la supplémentions de ces préparations végétales. Toutefois, le taux de la glycémie diminue dans le lot expérimental par rapport au lot témoin (1.83 *vs*2.38 g/l) le taux du cholestérol (0.79 *vs*0.99g/l) et le taux des triglycérides (0.70 *vs* 0.96g/l). Les préparations végétales utilisées ont un effet positif sur les paramètres zoothecniques, biochimiques et l'état de santé de poulet de chair.

INTRODUCTION

Poultry is an economical source of animal protein, particularly for developing countries, which has justified its rapid development worldwide over the last thirty years (*Sanofi, 1999*). In Algeria, poultry farming has expanded and developed dramatically through the various development plans of the Ministry of Agriculture. Production increase is due to the control of farm management, a better nutritional optimization of diets, the use of growth factors and the control of animal health status (*Langhout, 1998*). Diseases affecting poultry farming constitute one of the main constraints to its development and cause enormous economic losses, like increase in the mortality rate and the misuse of antibiotics. Antbiotics have adverse effects on human and animal health (Article 11-2 of Regulation (EC) No 2003/1831), namely the recurrent emergence of public health problems related to antibiotic-resistant bacteria which led the authorities to ban antibiotics as growth factors in animal feed in 1 January 2006 (*Brenes and Roura 2010*).

Thus, several mixtures of Essential Oils (HE) or synthetic compounds (associated or not with other products such as spices), have appeared on the world. The aim of the present study is to evaluate the effect of the use of HE in poultry feed on zootechnical performances and also on the biochemical parameters (glycemia, cholesterol, triglycerides).

MATERIAL AND METHOD

The aim of this study is to determine the effect of two preparations of plant extract on zootechnical parameters and some biochemical parameters in broiler chickens. The study was conducted in the region of BLIDA; is for a period of 45 days, from May 21 to July 06, 2017.

Animals: This study was conducted on 180 mixed ISA CLASSIC strains of mixed sex, with a uniform weight (44 g). The ISA CLASSIC female produces an average of 148 chicks in 64 weeks. Its ability to adapt to any environment makes it an ideal product for both temperate and tropical areas.

Food: The used food is granulated, according to the standard formula most used in farms, it contains different products to meet the needs of animals considering the three phases of breeding (start, growth, finishing).

Drink water was controlled by the municipal health office. It was distributed to the the all groups. For the zootechnical parameters, we have calculated the weight gain, the mortality rate and then for each breeding step.

Biochemical parameters:The aimof the study is to determine the values of some biochemical parameters namely: glycemia, triglycerides, cholesterol. Blood samples were taken at the end of each breeding phase (start 15 day, growth 28 day, finish 45 day), 5 subjects were taken randomly at the end of each phase. Samples were taken by incision of the wing vein, according to the technique described by *Anon (1993).* The collected blood was centrifuged at 4000 rpm for 10 minutes to collect the serum which was immediately frozen in dry 5 ml glass tubes. This serum was used for the analysis of three biochemical parameters.

Statistical analysis:

The results are expressed on average and the standard deviation and to a one-way analysis of variance (statistical software STAT ANOVA STAT version 2017) to determine the effect of the food compliment of two preparations on the all parameters. The significant level is at least 5 %.

A. ZOOTECHNIC PARAMETERS:

1. Average weight gain:

The following table reports the different values of the average weight of the 3 groups A, B, C according to the age and the rearing phase. In the finishing phase, we noticed that the weight of the two groups B (2219 ± 338.02) g and C (2011 ± 201.45) g increases rapidly with a significant difference compared to group A.

RESULTS

Table 1

Weight change in subject weight (g)

Lot	Phase		
	Start (15th day)	Growth (28th day)	Finish (45th day)
A	210±17.32	722±124.92	1312±223.68
B	220±25.29	753±42.95	2219±338.02
C	270±24.49	838±133.06	2011±201.45

Through our observations on the average weekly weight achieved from the first week to the end of breeding, the best weights was in favor of experimental groups C and B. It is established that the weight gain is closely related to the added vegetable food supplements, which match with the results of (*Wang et al. 2009*).

Mortality rate: The animal mortality observed in the first three days is due to stress (transport, handling) during the installation of the chicks, and will not be taken into consideration

The results of the mortality rates recorded for each phase of each batch are presented in Table 2.

Table 2

Mortality recorded for each step (%)

Group	Step		
	Start (15th day)	**Growth (28th day)**	**Finish (28th day)**
A	13.33	33.33	28.33
B	3.33	1.66	0
C	1.66	1.66	0

The mortality rates in lot A (13.33%) during the start-up phase is very significant p-value> 0.0001, compared to the two experimental groups B (3.33%) and C (1.66%).

The mortality rate in the finishing phase and 0% for group B and C so the difference is very significant p-value => 0.0001 compared to the control group.

Yield (Liver and heart):

Liver: The following Table reports the different values of the average weight of the carcasses according to the age and phases of the 3 groups.

Table 3

Weight change in liver weight (g)

Group	Step		
	Start (15th)	**Growth (28 th)**	**Finish (45 th)**
A	9.8±0.83	31.2±2.13	30±3.53
B	10.6±0.8	24±2	49±12.44
C	12.6±2.05	30±10.48	44±5.47

The start phase shows significantly better results between the two groups C and A (p-value = 0.043).

The Growth phase, showed a remarkable acceleration of liver weight (Hernández et al. 2004) and results were significantly better between A, C (p-value = 0.009).

• The liver weight results during the finishing phase are in the standards (33 g) (*Alamargot, 1982*) for lots B and C, p-value = 0.723.

Heart: Table 2 reports the different values of the average heart weight according to the age and phases of the 3 groups.

Table 4

Evolution of the weight of the heart (g)

Group	Step		
	Start (15 th)	**Growth (28th)**	**Finish (45th)**
A	2.2±0.83	2.8±1.16	9.8±0.83
B	2.00±1.54	5±0.0	11.2±2.16
C	1.4±0.48	5.2±0.74	12±2.34

Statistical results show a non-significant difference between (B, C)
(p-value = 0.90). While between A and C, A and B the significant difference (p-value = 0.023) (p-value = 0.032).

Carcass: The following table reports the different values of the average weight of the carcasses according to the age and phases of the 3 groups.

Table 5

Weight change in the weight of the empty carcass (g)

Group	Step		
	Start (15th)	**Growth (28th)**	**Finish (45th)**
A	168±27.74	618.4±112.86	1129±259.76
B	204±20.59	575±26.34	1724.8±319.25
C	218±19.64	646±111.50	1544±103.10

On the other hand, in the finishing phase the carcass weight of batch B marks a maximum value (1724.8 ± 319.25) g and very significant compared to the growth phase (p-value = 0.012).

2-BIOCHEMICAL PARAMETERS: The biochemical parameters determined in this study concerned blood glucose, total cholesterol and triglycerides.

Blood glucose: The different blood glucose values provided by the analysis are displayed in Table 6.

Table 6

Evaluation of blood glucose (g)

Glycemia (g/l)	Step		
	Start (15th)	Growth (2th)	Finish (45th)
A	3.09± 0.43	3.68±2.02	2.38±1.40
B	2.21 ±0.18	1.95±0.13	1.83±0.72
C	2.74 ±0.23	2.03±0.34	2.40±0.84

Cholesterol: The total cholesterol levels recorded during this study are shown in Table 7.

Table 7

Evaluation of total cholesterol (g)

Cholestérol (g/l)	Step		
	Start(15th)	Growth (28th)	Finish (45th)
A	1.55± 0.11	1.05±0.24	0.95±0.13
B	1.30 ±0.16	0.67±0.18	0.79±0.11
C	1.49 ±0.23	0.79±0.19	0.99±0.17

The cholesterol level drops significantly during the growth phase in batch B and C, however, it shows a slight non-significant decrease in the control group.

Triglycerides: Triglyceride (TG) levels are reported in Table 8.

Table 8

Evaluation of triglyceride levels (g / l)

Triglycerides TG (g/l)	PHASE		
	Start (15th)	Growth (28th)	Finish (45th)
A	1.38± 0.22	0.51±0.051	0.96±0.37
B	1.10 ±0.18	0.40±0.058	0.58±0.21
C	1.45 ±0.30	0.36±0.02	0.70±0.22

The triglyceride (TG) level decreases significantly in the growth phase in all groups.

CONCLUSIONS

Herbal dietary supplements are a good alternative to replace growth promoting antibiotics.

On zootechnical parameters, the results obtained in this study showed:

-A good performance of the weight.

- a remarkable reduction in the mortality rate while preserving a good health status of the animals.

a good yield of carcasses and viscera (liver, heart).

On biochemical terms, the analyzed parameters (glycemia, cholesterol, triglycerides) remain in the norms, which proves that the two preparations have a regulating and positive effect on the biochemical metabolism. Also, the study showed the absence of characterizing lesions of coccidiosis in treated lots compared to the control group, which explains the preventive action of the two dietary supplements used. Both preparations can be used in poultry farming as alternatives to antibiotics by minimizing the negative effect on public health.

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PRELIMINARY TESTS FOR THE ASSESSMENT OF SOME COMMERCIAL, LOW COST SENSORS FOR MEASURING THE TEAT-LINER CONTACT PRESSURE / *ÎNCERCĂRI PRELIMINARE PRIVIND UTILIZAREA UNOR SENZORI COMERCIALI PENTRU MĂSURAREA PRESIUNII DE CONTACT MAMELON-MANŞON*

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Keywords: *force sensor, linearity, hysteresis, drift.*

ABSTRACT

The purpose of the paper was to evaluate, under laboratory conditions, different types of flexible force sensors: three force sensitive resistor (FSR) sensors and one capacitive sensor. The FSR sensors were: FSR 400, FSR 402 (Interlink) and A201 FlexiForce (Tekscan); the capacitive sensor was a SingleTact miniature force sensor. A FC-22 compression load cell (Phidgets) was used as a reference.

The linearity, hysteresis and drift were evaluated for each sensor.

The linearity and hysteresis characteristics of the sensors were evaluated in static tests, gradually loading and then unloading the sensors (nine steps, from 1.84 N to 10.67 N and then back to 1.84 N); the output voltage was measured for each load step. Drift tests evaluated the increase of the sensor output signal with time (2500 s), under constant load (9.81 N).

The FC-22 and A201 sensors have displayed perfectly linear characteristic, with r^2=0.999; for the FSR 400 and FSR 402 the output voltage was given by a second order polynomial (r^2=0.998 and r^2=0.999, respectively). For the SingleTact sensor the response was also linear (r^2=0.968).

No hysteresis was recorded for the FC-22 sensor and only minor hysteresis was recorded for the A 201 and SingleTact sensor (average values of -0.96% and -2.4%, respectively). The FSR 400 sensor recorded relatively low values of the hysteresis (-9.6… + 8.0%), while for the FSR 402 sensor the hysteresis was comprised between -25.6 and – 1.65%.

There was no drift recorded for the FC 22; for A 201 sensor the drift was 2.1%, while a significant drift was recorded for the other sensors.

REZUMAT

În cadrul lucrării au fost evaluate, în condiţii de laborator, diferite tipuri de senzori flexibili: senzori de tip FSR (FSR) şi un senzor capacitiv. Senzorii de tip FSR au fost: FSR 400, FSR 402 (Interlink) şi A201 FlexiForce (Tekscan); senzorul capacitiv a fost de tip SingleTact. Ca referinţă s-a utilizat o celulă de forţă de tip FC-22 (Phidgets).

Pentru fiecare senzor au fost evaluate liniaritatea, histerezisul şi deriva în timp a semnalului de ieşire.

Liniaritatea şi histerezisul au fost evaluate în teste statice, pe parcursul cărora senzorii au fost încărcaţi şi apoi descărcaţi (în nouă trepte, de la 1.84 N la 10.67 N şi înapoi la 1.84 N). Deriva semnalului în timp a fost determinată sub sarcină constantă (9.81 N), aplicată timp de 2500 s.

Pentru senzorii FC-22 şi A201 s-au obţinut caracteristici liniare (r^2=0.999);pentru senzorii FSR 400 şi FSR 402 s-a obţinut o caracteristică polinomială de ordinul II (r^2=0.998 şi respectiv r^2=0.999). Caracteristica senzorului SingleTact este de asemenea liniară (r^2=0.968).

Senzorul FC-22 nu a prezentat histerezis. Pentru senzorul FSR 400 histerezisul este relativ redus (-9.6%...+8.0%); pentru senzorul FSR 402 histerezisul a avut valori cuprinse între -25.6% şi – 1.65%.

Senzorii FC 22 nu a prezentat derivă a semnalului de ieşire; pentru senzorul A 201 aceasta a fost de 2.1%, fiind semnificativ mai mare pentru ceilalţi senzori testaţi.

INTRODUCTION

The principle of mechanical milking relies on the pressure difference between the udder and the vacuum applied to the teat. In order to limit the development of congestion and edema and provide relief to the teat from the milking vacuum, the pulsation principle is used (*Mein, Williams, Thiel, 1987*); the ISO 3918: 2007 standard defines pulsation as the cyclic opening and closing of the teatcup liner. Collapse of the teatcup liner beneath the teat is achieved when air at atmospheric pressure is admitted into the pulsation chamber of the teatcup; the liner opens, allowing the extraction of milk, when vacuum is applied to the pulsation chamber.

According to some authors (*Bade et al., 2009*), the pulsation rate and ratio, the vacuum level and the compressive load applied to the teat when the liner collapses are the factors affecting the peak milk flow rate: the flow rate increases when the vacuum applied to the teat end and the duration of the b phase increases; in the meantime, the liner compression should increase in order to relieve tissue congestion due to the higher milking vacuum. *Adley and Butler* (*1994*) stated that inadequate liner collapse could lead to high infection levels. *Mein and Reinemann* (*2009*) also concluded that the liner compression should increase when the milking vacuum is increased, but also mentioned that an increased liner compression has negative effect over the teat-end condition, leading to the development of teat-end hyperkeratosis.

The problem of the liner-teat contact pressure imposes the use of a pressure transducer operating in difficult conditions: round shape of the surface on which the pressure is applied, the existence of shearing forces due to liner movement, limited space provided by the artificial teat. Many researches consider that the maximum contact pressure is applied to the apex of the teat, but it is difficult to mount a pressure sensor in this area, so that the general practice is to place the sensor on the lateral surface of the teat. Mainly two types of devices were considered for measuring the liner-teat contact pressure: load cells and transducers based on a flexible pressure-sensitive layer (FSRs). For the first type of sensor, the load cell is placed inside an artificial teat (covered with latex – *Adley and Butler, 1994* - or even with an excised artificial teat – *Davis et al,. 2001*) and the pressure from the liner-teat interface is applied to the load cell by the means of a circular piston (*Adley and Butler, 1994*) or of different sensor coverings (*Davis et al., 2001*). The friction forces between the piston and its bore affect the compressive load transmitted to the load cell; the relatively significant cost of the load cell is also a disadvantage. For the second type of sensors, while some authors (*Reinemann et al.,1994*) concluded that the use of a flexible pressure-sensitive layer is not an accurate measuring method, others, like *van der Toll et al.* (*2010*), used it in order to measure the pressure at the teat-liner interface and concluded that the horizontal shear forces did not degrade the sensor's pressure readings. This method has some advantages: the sensor is easily applied on the surface of the artificial teat and does not disturb the pressure distribution because it is thin; the sensors are relatively cheap; the signal conditioning circuit is a very simple one.

The purpose of the paper was to evaluate, under laboratory conditions, different types of flexible force sensors: three force sensitive resistor (FSR) sensors and one capacitive sensor. The FSR sensors were: FSR 400, FSR 402 (Interlink) and A201 FlexiForce (Tekscan). The capacitive sensor was a SingleTact miniature force sensor; while the force sensing resistor type sensors (Tekscan and Interlink) were widely investigated, except for the mention made by *Reinvee and Jansen (2014),* no other references were found regarding the miniature capacitive force transducers. A FC-22 compression load cell (Phidgets) was used as a reference.

MATERIAL AND METHOD

A FSR force sensor (sometimes called piezoresistive sensor) consists of two flexible membranes with conductive traces; a carbon-based ink is applied on one of the membranes. In unloaded state the electrical resistance is high (in the range of MΩ); when the two substrates are pressed together (under load), the microscopic protrusions on the FSR ink surface make the electrical link between the conductive traces. At low forces only the tallest protrusions make contact; at higher forces more and more points make contact. The result is that the resistance between the conductive traces is inversely proportional to the applied force.

Different producers make different types of FSR sensors, with different dimensions and using different receipts for the pressure-sensitive ink, resulting in different electrical characteristics of the respective sensors. Figures 1, 2 and 3 present the construction and characteristics of three FSR sensors which were tested.

In order to obtain an output voltage an electronic signal conditioning unit with adjustable gain was used (Fig. 4).

SingleTact is a capacitive miniature force sensor, combined with a proprietary interface board offering a 0 to 2 V analog output. The operating principle is based on the variation of electric capacity of the sensor when the distance between the electrodes is modified. The electrodes are separated by a proprietary compressible dielectric matrix, which acts as a spring. Figure 5 presents the construction and characteristics of the SingleTact pressure sensor.

A FC-22 compression load cell (Phidgets) was used as a reference. The compression cell uses four silicon piezoresistive strain gages and a proprietary electronic interface in order to provide a 0.5 to 4.5V analog output (Fig. 6).

For each sensor the following characteristics were investigated:

- linearity;
- hysteresis,
- drift.

Fig. 1 – The Interlink FSR 402 pressure sensor
diameter of the active area:14.68mm; nominal thickness: 0.46mm.

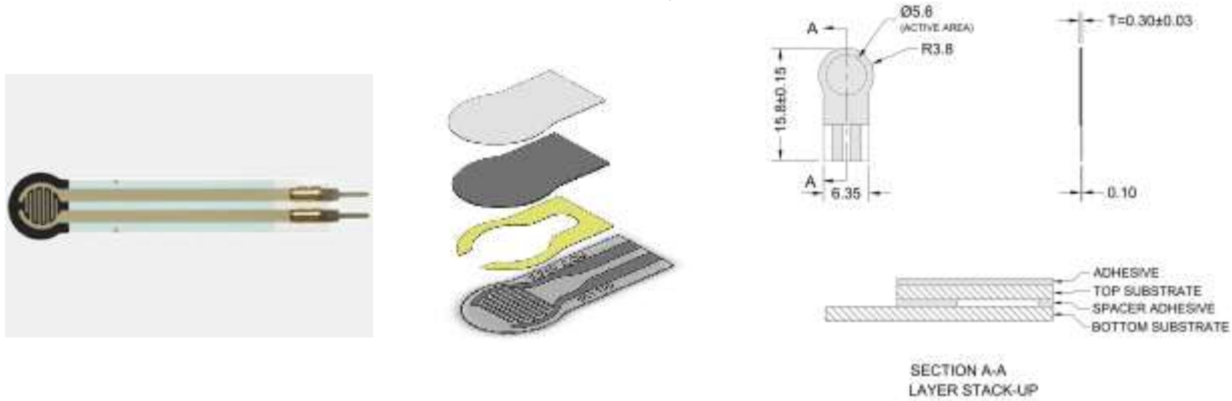

Fig. 2 – The Interlink FSR 400 pressure sensor
diameter of the active area:5.62mm; nominal thickness: 0.30mm.

Fig. 3 – The FlexiForce A201 pressure sensor
- diameter of the sensing area: 9.53 mm
- nominal thickness: 0.203 mm

A specific workbench was used in order to perform the above-mentioned tests; the schematics of the test rig is shown in Figure 7. Each sensor (3) was mounted on a base plate (5) using double adhesive tape; a circular silicone bumper (4) was placed over the sensing area of the transducer in order to distribute force evenly over the entire surface (*Vidal-Verdu, 2011*; *Vecchi et al., 2000*). The sensors were conditioned before the tests; according to the specifications of the producers, the conditioning process was conducted in the following manner:

- the sensor was loaded 110% of the maximum weight;
- the weight was maintained for a few minutes and then removed;

• the process was repeated five times.

Linearity and hysteresis characteristics were evaluated by gradually loading and then unloading the sensors while adding weights on the weighing pan; the sensors were loaded with the following forces: 1.844 N; 2.825 N; 3.806 N; 5.768 N; 6.749 N; 7.730 N; 8.711 N; 10.673 N. The output voltage was measured for each load step.

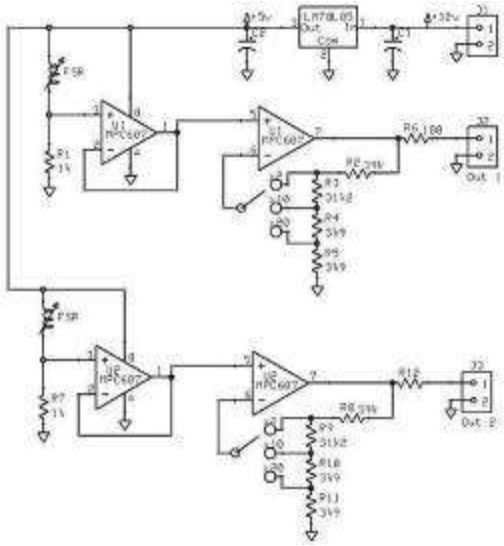

Fig. 4 – Schematics of the signal conditioning unit for the Tekscan and Interlink sensors (two channels)

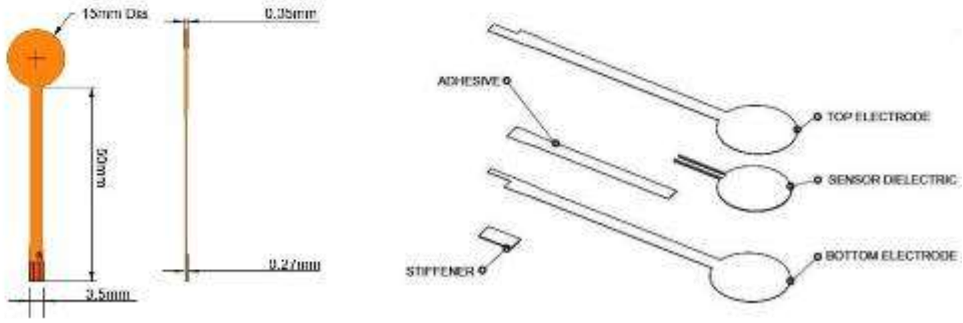

Fig. 5 – The SingleTact pressure sensor

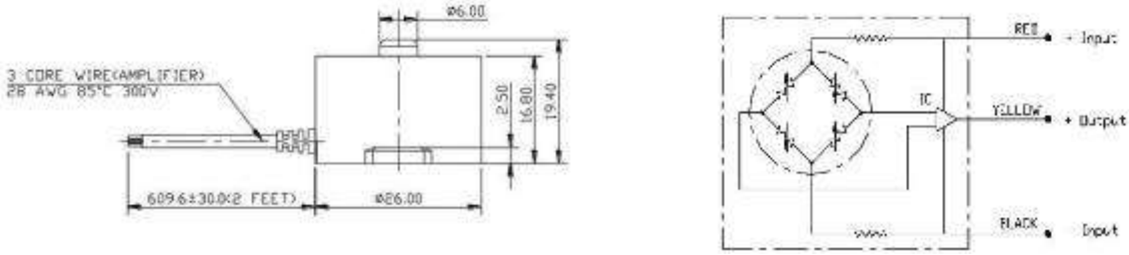

Fig. 6 – The FC-22 load cell

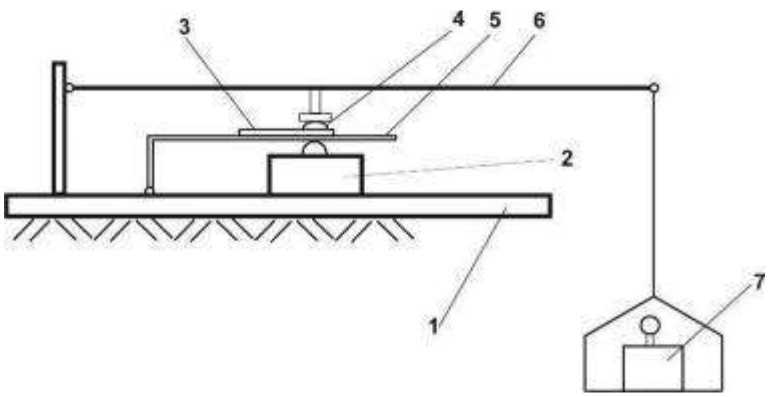

Fig. 7 – Schematics of the test workbench

1-base plate; 2-load cell; 3-force sensor; 4-circular silicone bumper; 5–sensor base plate; 6-lever; 7-weight

Three loading-unloading cycles were performed for each sensor and then the voltage-force regression equations were determined, using the average values of the forces when loading and respectively unloading the sensor. The hysteresis was calculated with the formula (*Komi et al., 2007*):

$$\Delta U_{\%} = \left(1 - \frac{U_{unload}}{U_{load}}\right) \cdot 100 \quad [\%],$$

where U_{load} is the voltage output of the sensor during loading and U_{unload} is the voltage output when unloading the sensor, for the same force. The hysteresis was evaluated over the entire force range and also at 50% of the maximum force (*Razak et al., 2012*).

Drift evaluated the increase of the sensor output with time (2500 s), under constant load (9.81 N); the starting point (when the load was fully applied to the sensor was determined using the changes in the slope of the voltage-force curve (*Komi et al., 2007*)

RESULTS

Linearity and hysteresis

Figure 8 presents the linearity and hysteresis results for the FC-22 sensor; the chart clearly shows a linear voltage-force characteristic of the sensor. The relative standard deviation for the entire data set (eight force levels, three loading-unloading cycles) was 1.47%; the relative standard deviation of the mean was 0.6%. The hysteresis level was comprised between -0.46% and + 0.55%. At 50% of the force range the hysteresis was comprised between 0 and 1.45%, with an average value of 0.446%.

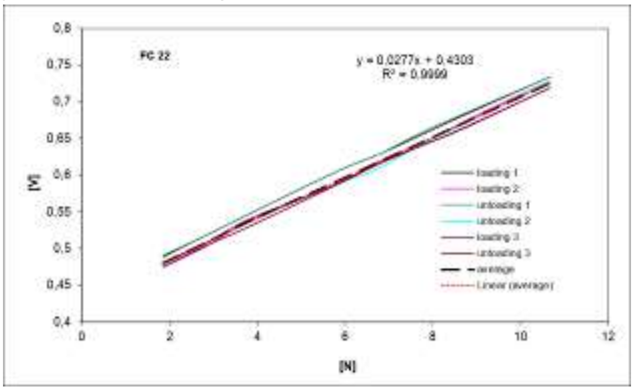

Fig. 8 – Voltage-force characteristic for FC 22

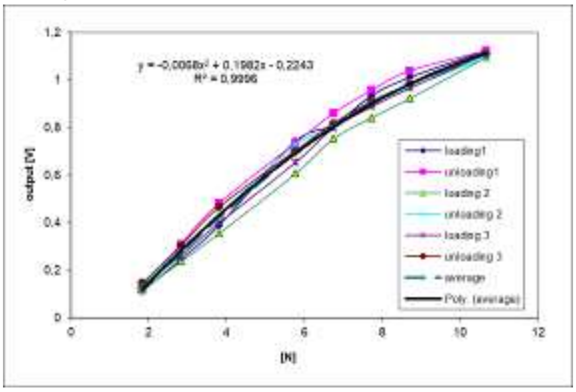

Fig. 9 – Voltage-force characteristic for FSR 402

The voltage-force characteristic of the FSR 402 sensor (Fig. 9) is a second order polynomial; the average value of the relative standard deviation was 6.303%, with a maximum value of 10.546%.

Negative values of the hysteresis were recorded for this sensor: for the same force, the output voltage was higher when the sensor was unloaded and lower when it was loaded; the values were comprised between -1.67% and – 25.6%, with an average value of -11.5%. The lower values of $\Delta U_{\%}$ were recorded for the maximum loading force (10.67 N). At 50% of the force range the hysteresis was comprised between -2.51% and – 6.17%, with an average value of -4.888%.

Figure 10 presents the voltage-force characteristic of the FSR 400 sensor; higher values of the output voltage were recorded for this sensor (in comparison with FSR 402), probably due to the lower diameter of the sensing area, which led to higher values of the contact pressure. The voltage-force characteristic is also a second order polynomial; the average value of the relative standard deviation was 2.258%, with a maximum value of 3.45%. Both positive and negative values of hysteresis were recorded, with variations between -9.58% and +8.08% and an average value of -0.249%. At 50% of the force range the hysteresis was comprised between -2.46% and – 6.96%, with an average value of -1.614%.

The FlexiForce A 201 sensor has a linear voltage-force characteristic, similar to the one provided by the FC-22 transducer. The data relative standard deviation was comprised between 0.99 and 5.67%, with an average value (for the entire data set) of 2.454% and a relative standard deviation of the mean of 1.002%. Both positive and negative values of hysteresis were recorded, with variations between -11,1% and +8.23% and an average value of -0.96%. At 50% of the force range the hysteresis was comprised between -1.02% and 2.06%, with an average value of 0.347%.

Figure 12 presents the voltage-force characteristic of the SingleTact sensor; the trendline shows a linear characteristic, but with a lower value of r^2 (0.9668, compared with 0.9999 for FC-22 and A 201). The relative standard deviation was comprised between 0.889 and 4.94%, with a mean value of 2.587%.

The sensor displayed negative hysteresis, with values comprised between -10.78% and 0%; the average value of hysteresis was -2.399%. At 50% of the force range the hysteresis was comprised between -1.57% and – 4.46%, with an average value of -3.489%.

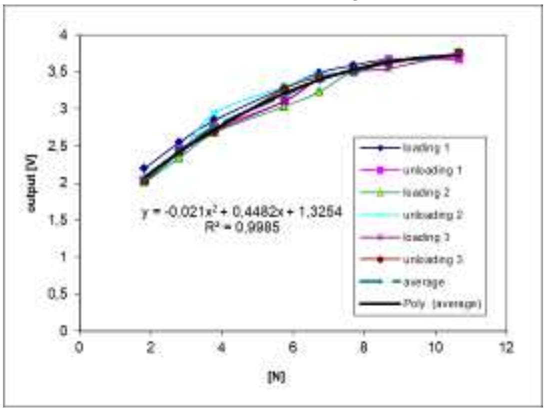

Fig. 10 – Voltage-force characteristic for FSR 400

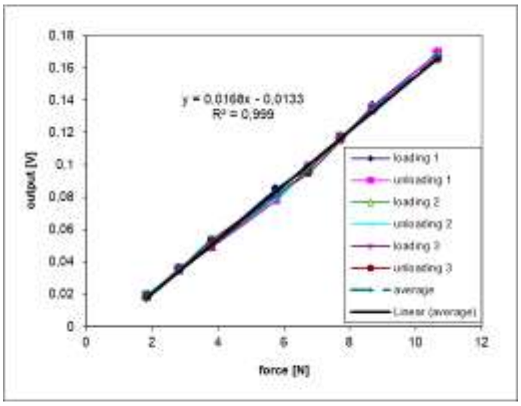

Fig. 11 – Voltage-force characteristic for A 201

The results concerning the linearity of some sensors are in accordance with the findings of other authors: a series of tests performed by *Vecchi et al. (2000)* also confirmed the linear characteristic for FlexiForce type sensor and a second order polynomial for the Interlink FSR sensor. *Lebossé et al. (2011)* also concluded that the Tekscan Flexiforce sensors are characterized by a better linearity than the Interlink FSR sensors.

Most of the authors show that, for the FSR type sensors, repeatability is one of the major issues and the average relative standard deviation of the data set could be used in order to evaluate this parameter; table 1 summarizes the results concerning this parameter.

Table 1

Average relative standard deviation of the data set [%]

Sensor	FC 22	FSR 402	FSR 400	A 201	SingleTact
Relative standard deviation	1.47	6.303	2.258	2.454	2.587

Signal drift

Figure 13 displays the centralized results concerning the signal drift.

The output signal of the FSR 402 sensor has increased with 52.5% during the 2500 s of the test (from 0.6543 V to 0.9961 V); the most significant increase (32%) was registered during the first 15 s (from 0.6543 V to 0.8643 V). In the first second of the test the signal has increased by 19.4%.

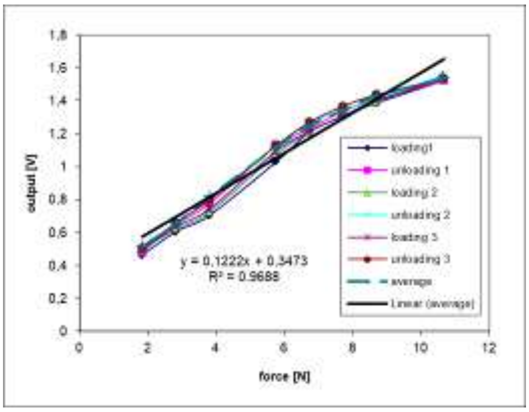

Fig. 12 – Voltage-force characteristic for SingleTact sensor

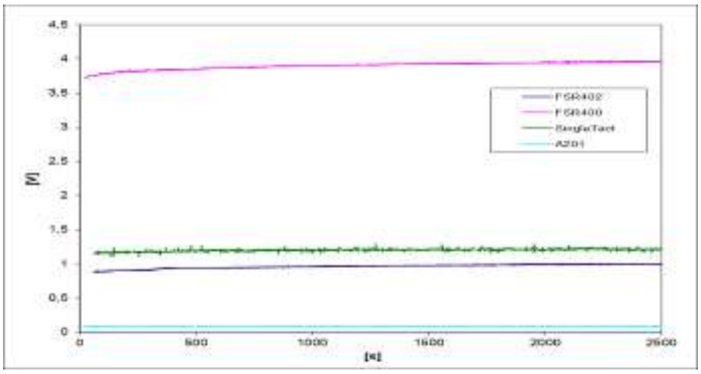

Fig. 13 – Centralized data for signal drift

For the FSR 400 sensor the output signal has increased by 7.43% during the entire duration of the test (2500 s), from 3.682 V to 3.955 V; in the first 15 s of the test the signal has increased with 0.79%. There were 3-5 s time intervals during which the signal level has remained constant, then increasing by 0.2-0.3 %; during the last 1000 s of the test the signal increased by 0.87%.

The signal drift for the FlexiForce A 201 sensor was 2.1% during the entire duration of the test (2500 s). At the beginning of the test the signal level has remained constant for 16 s (0.234 V).

For the Singletact sensor the output signal has increased by 12.1% during the drift test (2500 s); during the first 5 s the output voltage has increased by 4.0% and by 2.2% in the first second.

No drift was recorded for the FC-22 load cell, the output signal being constant for the entire duration of the test.*Vecchi et al. (2000)* also recorded signal drift for the FlexiForce and FSR sensors when a constant load test was performed; in series of tests Vidal-Verdú et al. (2011) reported a drift of up to 10.7% of the full scale output in 1974 s (worst case), while *Reinvee and Jansen (2014)* mention a value of the drift of 4.1% (in a period of 1200 s) for the Tekscan Flexiforce sensors and 7.1% for the Interlink FSR.

CONCLUSIONS

Two basic types of force sensors were tested in this series of experiments: force sensing resistor type and capacitive type sensors.

Table 2 summarizes some of the more significant results of the tests.

Table 2

Summary of the most significant results

Sensor type	Characteristic		
	Linearity (regression equation, r^2)	**Hysterezis, % (average, at 50% load)**	**Drift, % (over 2500 s)**
FSR 402	$y = -0.0068x^2 + 0.1982x - 0.2243$ r^2=0.9996	-4.888	52.5
FSR 400	$y = -0.0021x^2 + 0.4482x + 1.3254$ r^2=0.9985	-1.614	7.43
A 201	$y = 0.0168x - 0.0133$ r^2=0.999	0.347	2.1
SingleTact	$y = 0.1222x + 0.3473$ r^2=0.9688	4.489	12.1
FC 22	$y = 0.0277x + 0.4303$ r^2=0.9999	0.466	0

The data in Table 2 suggests that the FC 22 load cell would be the best choice; the results from Table 1, referring to repeatability, would also confirm this selection. Unfortunately, because of its dimensions, this sensor cannot be mounted inside an artificial teat in order to evaluate the teat-liner contact pressure.

According to the experimental results, the FSR-type sensors would be the next logical choice because they are cheap and involve low cost electronics.

The Interlink FSR 402 is the most inappropriate choice, because of the non-linear characteristic and high levels of relative standard deviation, hysteresis and drift. Moreover, applying it on the curved surface of the artificial teat would cause its bending and probably the alteration of the output signal.

Better results were recorded for the Interlink FSR 400 sensor, although its output voltage-load characteristic is also non-linear; this problem could be addressed by the appropriate design of the signall conditioning unit. It should be noted that the Interlink sensors are the cheapest of all the tested sensors.

The Flexiforce sensor achieved better results in comparison with the Interlink sensors: linear characteristic and the lowest values of the relative standard deviation, hysteresis and drift. In fact, it is considered that the Tekscan Flexiforce sensor can overcome some of the common problems of the FSR sensors, especially in terms of linearity, repeatability and time drift, while the Interlink FSRs are more robust (*Reinvee and Jansen, 2014*).

The SingleTact capacitive sensor provides also a linear output signal-force characteristic, but presents a relatively high hysteresis at 50% load and significant drift. Moreover, the conditioning circuit of the capacitive sensor is complex and subject to noise due to connecting cables, as seen in Figure 13.

The Tekscan Flexiforce sensor seems to be the best choice in order to measure the teat-liner contact pressure. Nevertheless, it should be noted that there are not two identical sensors, so that each one must be calibrated before use and that additional tests should be performed in order to study the effect of sensor bending when applying it on the exterior surface of the artificial teat.

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COMPARATIVE ANALYSIS OF PNEUMATIC WATER AERATION SYSTEMS / *ANALIZA COMPARATIVĂ A SISTEMELOR DE AERARE PNEUMATICĂ A APEI*

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Keywords: *Water aeration, fine air bubbles generators*

ABSTRACT

The paper presents a comparative analysis of two pneumatic aeration systems, namely:

a) Porous diffuser aeration systems constructed of elastic membranes.

b) Fine air bubble generators made of orifices with orifices.

For each installation, the constructive solution and the experimental results obtained are presented. It reveals the advantages of fine bubble generators compared to porous diffusers.

REZUMAT

În lucrare se prezintă o analiză comparativă a două instalații de aerare pneumatică, și anume:

a) Instalații de aerare cu difuzoare poroase construite din membrane elastice.

b) Generatoare de bule fine de aer construite din plăci cu orificii.

Pentru fiecare instalație se prezintă soluția constructivă și rezultatele experimentale obținute. Se relevă avantajele generatoarelor de bule fine în comparație cu difuzorii poroși.

INTRODUCTION

Aeration of water leads to increased dissolved oxygen in water.

Aeration is necessary to improve water quality to avoid oxygen deficiency in systems where there is biochemical oxygen demand over water self-sufficiency to remove toxic gases that can be found in water and wastewater treatment.

The main purpose of water aeration, regardless of the industry and the reason it is used, is to increase or maintain an optimal level of dissolved oxygen in a mass of water.

The oxygen required for the aeration process is taken from the atmospheric air and introduced into the water. In order for this aeration to be effective, uniform air dispersal must be ensured throughout the mass of water in a tank or basin; the air must be spread evenly so as to ensure the oxygen demand.

In order to achieve the dispersion of air in water, the following devices are used: porous diffusers made of ceramic materials, sintered glass, rigid porous plastics, metal plates or other materials in which very fine orifices are created, elastomeric membranes. Currently, the use of fine bubble generators built by unconventional technologies: laser processing, electroerosion, microcracking (*Besnea, 2017*) are investigated.

Of the energy consumption of a water treatment plant one part, about 50% is used for aeration of water. Aeration is currently performed with porous diffusers made of ceramic or glass; it does not emit bubbles of equal size and emit non-uniformly on the surface of the diffusers. In the laboratories of the Politehnica University of Bucharest were designed and built fine bubble generators (FBG) in which the plate with orifices is made by electroerosion (Ø <0.5 mm). In this case, the orifices are equal and evenly distributed in the xOy plane.

The size of the air bubble produced by the fine pores is influenced by the air flow, the porosity of the diffuser, the viscosity of the fluid in which it is emitted. Fine bubbles are obtained by passing an air stream through submerged porous plates.

MATERIAL AND METHOD

Pneumatic systems for water aeration

There is a constructive solution that consists of the placement of some pierced pipes, located on the basin base; is a "coarse" water aeration method with many problems in operation, so it will not be analyzed.

For each category, the following are presented:

- System architecture;
- System performance.

In order to make a comparative study of the three categories, the following will be kept constant:
- the hydrostatic load H = 500 mm H_2O;
- the air flow rate: $\dot{V} = 0.6 \ m^3 / h$;
- water temperature: t = 24°C;
- atmospheric pressure: p = 101325 N / m^2;
- the size of the orifices is approximately equal to 0.1 ÷ 0.2 mm.

a. Porous diffusers made of ceramic materials or elastic membranes

These devices can be made of plastic, elastic, ceramic and have different shapes and sizes, such as: circular plates, rectangular plates, tubes, panels, domes, elastic membranes.

The materials from which the elastic membranes are made are: rubber, latex, membranes E.P.D.M (Ethylene - Propylene - Dien - Monomer) *(Tănase, 2017)*. E.P.D.M membrane porous diffusers have a high aging duration, are resistant to ozone, and the diffusers body is made of shock-resistant plastics. For elastic membrane diffusers, the orifices will close if the air stops. It does not require maintenance because, during operation, membrane vibrations lead to self-cleaning of the active surface.

Presentation of the porous diffuser with elastic membrane E.P.D.M.

The porous diffuser is made up of three elements:

1) An inwardly threaded ring that secures the elastic membrane to the diffusers body;

2) Elastic membrane made of E.P.D.M., having many orifices for injecting air into water (Figure 1);

3) Porous diffuser body made of plastic which at the bottom has an opening through which compressed air enters (Figure 2).

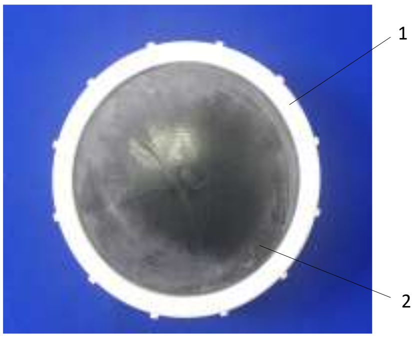


Fig. 1 - Overview of the porous diffuser

1 - elastic membrane fixing ring; 2 - the elastic membrane

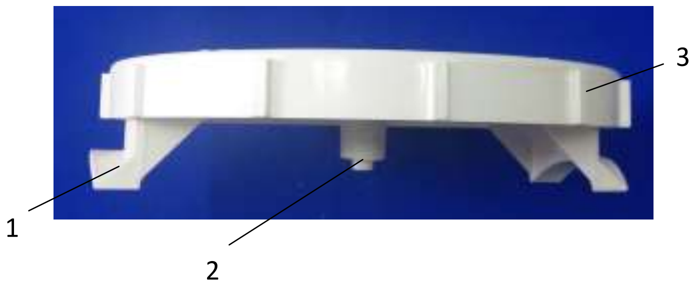


Fig. 2 - Side view of the porous diffuser

1 - body of the porous diffuser; 2 - compressed air inlet connection; 3 - elastic membrane fixing ring

The porous diffuser sets on the base of the water basin through four supports integral with the porous diffuser body.

b. Fine bubble generators made of plates with orifices

It is known from the literature *(Cusma, 2017; Tănase, 2017)* that with the reduction of the air bubble diameter, the oxygen transfer rate to the water is higher; the diameter of the air bubble is a function of the orifices diameter in the perforated plate of the FBG.

Gas bubbles immersed in water may come from:

• atmospheric air (21% O_2 + 79% N_2);
• atmospheric air + oxygen in the cylinder;
• air with low nitrogen content (oxygen concentrators);
These gas bubbles can be classified as follows (Figure 3):

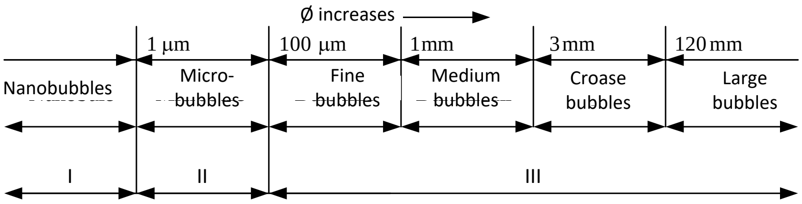


Fig. 3 - Classification of gas bubbles according to their diameter (Ø)
I - the area where the gas bubbles can be observed under the microscope;
II - the area where gas bubbles can be observed with difficulty;
III - the area where gas bubbles can be observed with the naked eye.

The paper presents a fine bubbles air generator, in which the plate has 152 orifices with d_0 = 10 µm. As a result of the research in the field of micro technologies, air bubbles can be called "micro bubbles".

The construction of the fine bubble generator

In order to obtain fine bubbles, the diameter of the orifices must be as small as possible (d_0 <1 mm) and the distribution of the orifices in the plate should be uniform.

The bubble generator has a dispersion element, a rectangular metal plate.

The plate thickness s = 2 mm has 152 orifices of diameter d_0 =0.1 mm and the distance between the orifices is d = 2 mm. Thus, the two conditions were met *(Cusma, 2017; Pătulea, 2012)*.

$$\frac{s}{d_0} > 3 \rightarrow \frac{2}{0.1} = 20 \tag{1}$$

$$\frac{d}{d_0} > 8 \rightarrow \frac{2}{0.1} = 20 \tag{2}$$

Figure 4 shows a plan view of the FBG of rectangular shape.

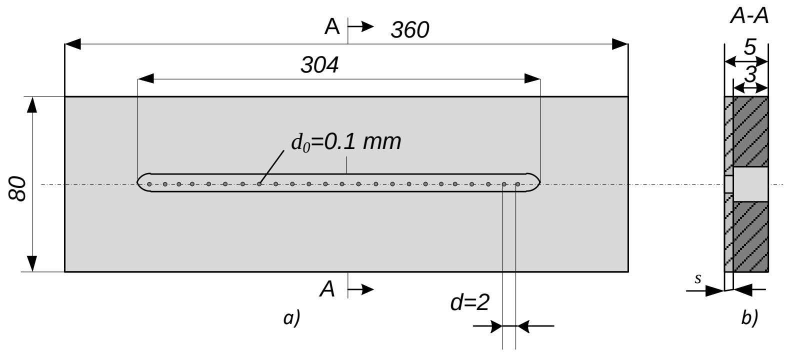


Fig. 4 - Perforated plate of the FBG
a) plan view; b) cross-section

Figure 5 shows the constructive solution of the fine bubble generator to be used in experimental researches. The orifices in the perforated plate were made by micro drilling machine KERN Micro. This machine has an accuracy of ± 0.5 µm and can process parts with a height of 220 mm and a diameter of 350 mm.

In order to achieve this FBG, which is an original constructive solution, it took a theoretical and experimental work revealed by *(Constantin et all, 2015; Călușaru et al, 2012, Băran et al, 2010)*.

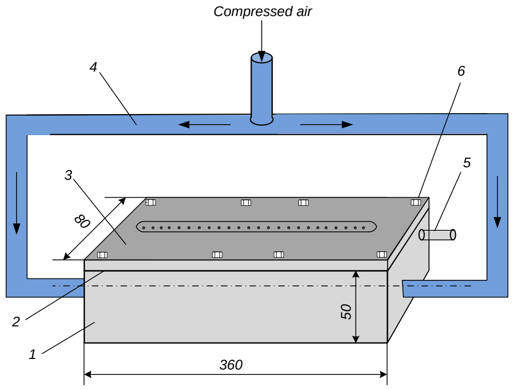


Fig. 5 - Air fine bubble generator
1 - compressed air tank; 2 - sealing gasket; 3 - the orifice plate;
4 - Ø 18 mm pipe with compressed air; 5 - connection for the measurement of the air pressure in the tank;
6 - perforated plate fastening screws

The equation of the oxygen transfer rate in water is *(Cusma, 2017)*.

$$\frac{dC}{d\tau} = a \cdot k_L \left(C_s - C\right) \tag{3}$$

where:
C - the dissolved oxygen concentration at time τ;
ak_L - volumetric mass transfer coefficient;
C_s - the concentration of oxygen in water at saturation.
The values of ak_L and C_s are constant in time.
If limit conditions $C = C_0$ are imposed for $\tau = 0$, equation (3) can be integrated:

$$\int_C^{C_s} \frac{dC}{C_s - C} = \int_0^{\tau} a \cdot k_L \, d\tau \quad . \tag{4}$$

$$ln\left(C_s - C\right) = a \cdot k_L \cdot \tau + 0 + ct \,. \tag{5}$$

It results:

$$C = C_s - \left(C_s - C_0\right) \cdot e^{-a \cdot k_L \cdot \tau} \,, \tag{6}$$

$$\tau = 0 \tag{7}$$

Equation (6) can be numerically integrated if there are known:
C_0 - the initial concentration of dissolved O_2 in water;
Cs - saturation concentration of dissolved O_2 in water for a given water temperature;
ak_L - the volumetric transfer coefficient of the oxygen [s^{-1}] or [min^{-1}] determined by one of the chemical or electrical methods.
The values of C = f (τ) are calculated based on a computation program.

RESULTS

The objectives of experimental researches are:

A. Determination of the pressure loss (for different airflows) that occurs when the compressed air passes through the "dry" elastic membrane (ie located outdoors)

Subsequently, the pressure losses for the "wet" membrane (the membrane inserted into the water tank).

B. Experimental determination of the increase in dissolved oxygen concentration in the operation of the porous diffuser.

a. Porous diffuser built with elastic membrane E.P.D.M.

Figure 6 shows the scheme of the experimental installation; after commissioning the compressor the air flow rate and the pressure *(Tănase, 2017)* were measured at the entrance at the porous diffuser. In this case, there was no water in the tank, so the pressure loss for the "dry membrane" is established.

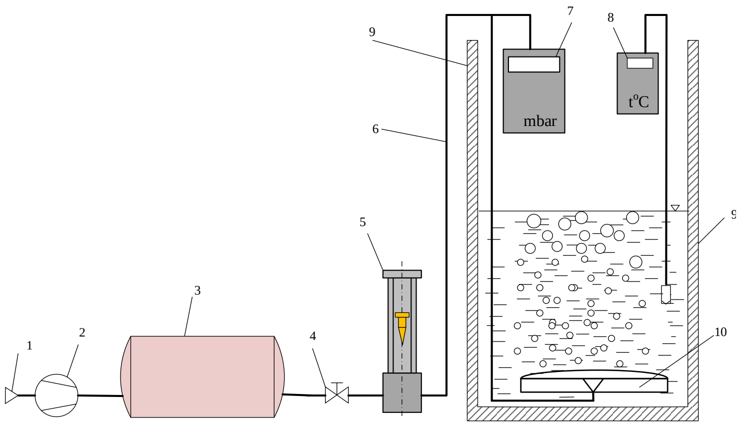


Fig. 6 - Measuring scheme for the operation of the porous diffuser with elastic membrane

1 - air filter; 2 - electro compressor; 3 - air tank; 4 - pressure reducer; 5 - rotameter; 6 - compressed air pipe; 7 - digital indication manometer; 8 - digital thermometer; 9 - water tank; 10 - porous diffuser

For different flows rate resulted the pressure losses Δp, shown in Table 1. Thereafter, water was introduced into the tank (H = 500 mmH_2O) and the pressure drops for the "wet" membrane was measured; the air flow rate remained the same and the experimental results are shown in Table 1.

Table 1

Air pressure losses through the elastic membrane porous diffuser

No.	"dry" membrane		"wet" membrane	
	$\dot{V}\,[dm^3/h]$	Ap [mbar]	$\dot{V}\,[dm^3/h]$	Δp [mbar]
1	400	1.47	400	57.5
2	600	2.11	600	61.1
3	800	2.70	800	62.40
4	1000	3.79	1000	64,50
5	1200	4.92	1200	66.30
6	1400	5.86	1400	68.20
7	1600	7.58	1600	71.80

Based on the table were drawn curves $\Delta p = f(\dot{V})$ for the two cases were plotted.

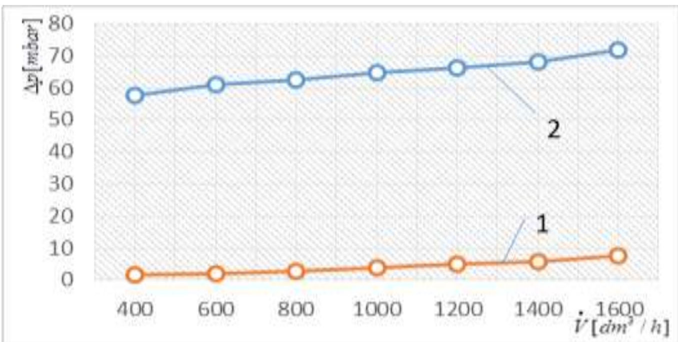
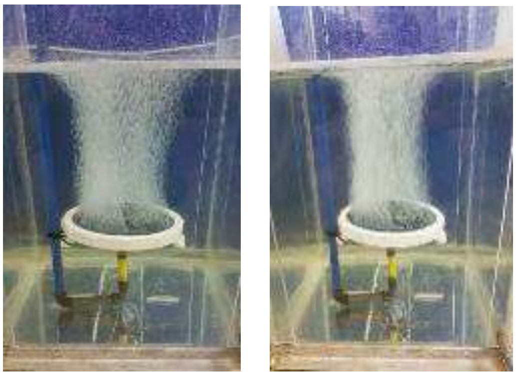


Fig. 7 - Graphical representation of the function $\Delta p = f(\dot{V})$

1- for „dry" membrane; 2- for „wet" membrane

Figure 8 shows the operation of the porous diffuser, the elastic membrane having orifices of Ø 229 μm.



a) b)

Fig. 8 - Column of air bubbles generated by the porous diffuser

a) $\dot{V} = 1400\,dm^3 / h$; *b)* $\dot{V} = 1600\,dm^3 / h$

For the determination of the increase in the dissolved oxygen concentration in water the following shall be measured:

• Water temperature t = 22.5 °C and from *(Călușaru, 2014)* it results the saturation concentration C_s = 8.6 mg/dm^3.

• Initial concentration of dissolved oxygen in water C_0 = 5.10 mg/dm^3.

• The time is noted at which the experience begins and from 15 ' to 15' the concentration of dissolved oxygen in water is measured by the electrical method.

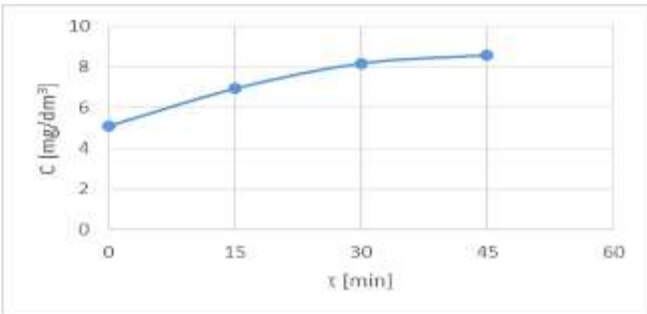


Fig. 9 - Graphical representation of $C_{O_2} = f(\tau)$

The obtained results are similar to that reported in the literature *(Călușaru, 2014; Băran et al, 2011; Pătulea et al, 2012)*.

b. Fine bubble generator built from plate with orifices

The outline of the experimental installation for air-to-air air intake is shown in Figure 10. The purpose of the research is to validate the theoretical results obtained previously.

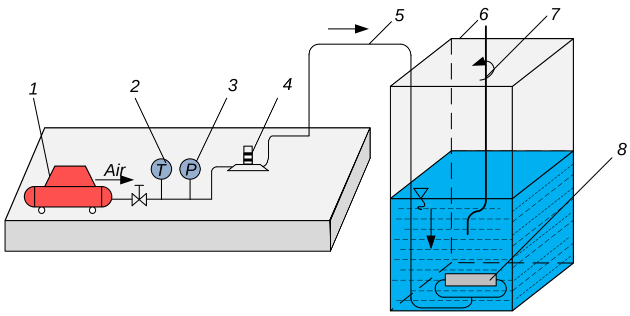


Fig. 10 - Sketch of the experimental installation for the injection of atmospheric air into water

1 - air compressor; 2 - thermometer; 3 - manometer; 4 - rotameter; 5 – fine bubbles generator feed pipe; 6 - parallelepiped water tank; 7 – oxygenometer probe; 8 - fine bubbles generator with 152 orifices Ø 0.1 mm

During experimental researches, the following values will be maintained: gas pressure at the entrance to FBG, the gas flow rate, hydrostatic load. At 15 minutes the air supply of the FBG is interrupted and oxygen sensor (7) is inserted; the signal taken from the probe is processed in the microcomputer and digitally displayed on the microcomputer screen (*Călușaru, 2014).*

The FBG of rectangular shape with 152 Ø 0.1 mm orifices is shown in Figure 11.

Fig. 11 - FBG with 152 orifices Ø 0.1mm in operation

The fine bubble generator is provided with a perforated plate with Ø 0.1 mm drilled orifices. A program has been carried out for the determination of the increase in dissolved oxygen concentration in water in time. Based on the results the curve 1 in Figure 12 was plotted.

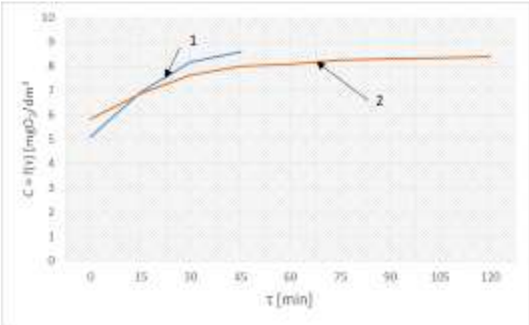


Fig. 12 - $C_{0_2} = f(\tau)$ **for atmospheric air**

1- curve drawn based on experimental data for porous diffuser; 2- curve plotted based on the experimental data in the case of the fine bubble generator

Curve 1 was plotted for the variation in oxygen concentration for porous diffusers. After conducting the experimental researches with the FBG, the curve 2 in Figure 12 was plotted. The obtained results are similar to other papers in the literature *(Tănase et al, 2014, Oprina et al 2009)*.

CONCLUSIONS

1. Porous diffusers with EPDM membranes have a long service life, are shock-resistant, maintenance-free.

2. Elastic membrane porous diffusers have a simple construction, increased operational reliability.

3. Perforated membrane orifices have a diameter of about 0.21 mm, which ensures dispersion of fine bubble air (Ø ≈ 1 mm).

4. Loss of air pressure through the elastic membrane porous diffuser is 2 to 10 mmH_2O higher compared to the FBG with perforated plate by electroerosion.

5. Disadvantages of porous diffusers are:

- emit bubbles of different sizes;
- does not ensure a uniform dispersion of the air in a volume of water.

6. Designing a fine bubble generator, where the perforated plate has Ø 100 μm orifices, is a first in the field of water aeration;

7. The smaller the diameter of the air bubble dip in the water, the longer the ak_L will increase, so it will increase the oxygen transfer rate to the water;

8. In the paper the theoretical and experimental results for fine bubble generators are compared, the perforated plate has orifices Ø <0.5 mm and it is shown that the most efficient generator is the one with the smaller orifices diameter;

9. Advantages of using FBG are:

• A uniform dispersion of air bubbles in the water is ensured;

• The size of the bubbles dispersed in the water mass is the same;

• The air pressure drop across the FBG passage is lower than the porous diffusers;

• The loss of pressure in a porous diffuser is 0.61 mH_2O (Table 1), and at a FBG is 0.02 mH_2O as a result, the energy consumed for compressing the air is much lower in the case of the FBG;

• The theoretical and experimental research presented above leads to a very good coincidence, which reveals the correctness of these researches.

ACKNOWLEDGMENT

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IMPROVEMENT OF MEASURING DEVICES OF SEEDING MACHINERY / СОВЕРШЕНСТВОВАНИЕ ДОЗИРУЮЩИХ УСТРОЙСТВ ПОСЕВНЫХ МАШИН

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Key words: *measuring devices, seeding machines, pneumatic dispenser*

ABSTRACT

The design of the improved measuring devices of pneumatic seeding machines as exemplified by the pneumatic dispenser of seeding machine УПС-8 is suggested. The differential characteristics of the improved design is the application of new dispenser disc and seed dropper of excessive seeds. The results of investigation of seed sowing using the suggested design are presented.

РЕЗЮМЕ

Предложена конструкция модернизированных дозирующих устройств пневматических посевных машин, на примере пневматического высевающего аппарата сеялки УПС-8. Отличительными особенностями усовершенствованной конструкции является использование нового высевающего диска и сбрасывателя лишних семян. Приведены результаты исследований качества посева семян с использование предлагаемой конструкции.

INTRODUCTION

Modern social economic situation in the world predetermines the necessity of the accelerated development of the national agricultural production (*Anokhina et al, 2016; Kushnarev L.I., 2015).* It is of great importance in relation to the world food crisis, calling for the solution of problems of the country food security (*Lachuga et al, 2009*). Machinery and engineering resources of agro complex in modern agriculture are used deficiently and to implement them in the service of intensive agricultural production is the task of high priority (*Emelyanov et al, 2016; Kostikov et al, 2016*).

In the growing of the agricultural crops, the seeding machine occupies an important place, and especially, the pneumatic seeding machines of precision seeding, because it is impossible to harvest high yield without high-quality seeding. Dispensers of pneumatic seeding machines of precision seeding were developed and improved in several directions (*Kanunnikov et al, 2013*):

- Improvement of seed selection by dispenser (disc) – form, profile of vacuum opening, vacuum;
- Creation of seeds active layer (usage of agitators directly near disc);
- Creation of condition for single seed selection (seed droppers of different forms);
- Creation of conditions for reduction of seeding machine readjustment period and labour facilitation (application of different disc plates);
- Improvement of seed flow process from tanker (tanker form, application of different agitators);
- Providing the guaranteed release of dispensers (cells cleaning), seed ejector blades, etc.

To increase the quality of seed dispensing process by seeding mechanism, one can examine two ways of improvement: seed disc modernization and application of new seed dropper of excessive seeds.

Modernization of seeding disc (Fig. 1) consists in mounting on disc 1 from the side of vacuum chamber jumper 4, which is fixed to the disc in slot 3 and gets through centers of vacuum openings 2 (*Kalashnikova et al, 2013*). More than that jumper has lugs 5, which get into vacuum openings, into their by the depth equal to half of the disc thickness.

This improvement allows decreasing of vacuum openings obstruction whereby increasing one-grain seeding quality. Besides, the suggested engineering design is simple in production and can be used for modernization of already existed seeding machines (particularly, seeding machines UPS-8 (universal pneumatic seeding machine).

The main idea of new seed dropper (Fig. 2) consists in the following: on rod 1, on one end, there is handle 2 with spring 3, and on the other end clamp 4 with elastic gripper in the form of brush 5 is fixed (*Kalashnikova et al, 2013*).

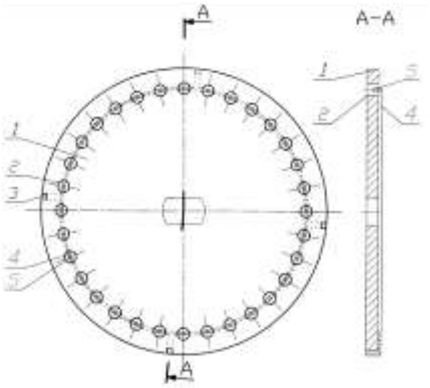

Fig. 1 - Suggested seed disc with mounted jumper
1-seeding disc; 2- vacuum opening; 3-slot; 4-jumper; 5-lug on jumper

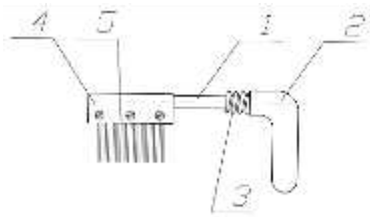

Fig. 2 - Overview of excessive seeds dropper
1-rod; 2-handle; 3-spring; 4-clamp; 5-brush

The suggested engineering design provides precision one-grain seeding and change of setting angle of elastic gripper of dropper allows sowing of seeds of different fractions, and so expands opportunities of application of seeding mechanism. More than that there is a possibility to adjust the seeding mechanism without its dismount easily and quickly (*Chernoivanov et al, 2012; Sorokin et al, 2016*).

The suggested improvements of seed disc and dropper design were tested in the laboratory and field conditions.

MATERIAL AND METHOD

The experimental method consists in changing and control three factors (Table 1). Indicators of basic level of the factors of peripheral speed of cells correspond to seeding machine motion with speed 9 km/h, vacuum value in vacuum chamber – to average value of control limits of vacuum value according to the operations manual of seeding machine UPS-8 (universal pneumatic seeding machine). Single seed feeding by seed disc cell M (pc.) was considered as optimization parameters, at that, $M \rightarrow 1$ and zero delivery of seeds by cell p_0 (pc.), at that $p_0 \rightarrow 0$.

Laboratory tests were done on Orel State Agrarian University experimental base on the self-engineered installation (Fig. 3a), that allows recording of seed sowing with detection of double sowing and sowing gate-passes in different modes of seeding mechanism. The installation consists of the following engineering elements: seeding mechanism 1 of seeding machine UPS-8 (universal pneumatic seeding machine), electromotor 2 for seed disc drive, vacuum meter 3 of company «Westfalia» for vacuum control in seed chamber, piezoelectric sensor 4 (piezoelectric sensor of grain losses – PSGL-1), strain-gauge station A17-T 5 with sampling frequency 25000 Hz operating in the mode of oscillograph, notebook 6 for recording and notation of the data obtained.

Table 1

Basic factors and levels of their variations

Factor name	designation	Factors levels			Variability interval
		Minimum (-1)	Basic (0)	maximum (+1)	
Cells peripheral speed of seed disc [m/s]	X_1	0.29	0.33	0.37	0.04
Vacuum value in vacuum chamber [kPa]	X_2	5	5,5	6	0,5
Position of excessive seeds dropper	X_3	5	6	7	1

RESULTS

As the result of the experimental data processing it was proved that one-grain feeding by the seed disc cell *M*, is in the limits of $1 \le M \le 1{,}025$pc, at that $M \to 1$, and zero seed delivery by cell is $p_0 \le 0{,}02$ pc.

1-serial seeding mechanisms, 2- experimental seeding mechanism

a) b)

Fig. 3 – General view of installation for tests in laboratory conditions (a) a seeding machine with experimental seeding section (b)

Field tests were carried out at the Shatilovskaya agricultural experimental station in the Novodereven'kovsky district of the Orel region (Russia) at the experimental plots with usage of serial seeding machine UPS-8 (universal pneumatic seeding machine) with mounted experimental seeding mechanism (Figure 3b).

Analysis of the field tests results shows that the suggested mechanism fulfils the majority of standard terms of reference and technical specifications, thereat, serial mechanism does not correspond to some impose requirements on stability and evenness of seeding and also on plant distribution.

Figure 5 presents the curves of variation of interval distribution between plants in drill rows of corn seeds testify that the suggested mechanism has better seeds distribution than serial one (25.8 % and 19.3 % of plants in the preset interval correspondingly). This is explained in the way that the single selection quality of the suggested mechanism is higher.

Low location of the point in the limit of 0-5 sm on the variation curve of plant distribution of the suggested mechanism testifies that double feedings are practically absent, but curve approximation to zero in the limit of 25-30 sm testifies refers to low level of grain losses in seeding. It proves that the suggested seeding mechanism provides the best quality of one-grain seed dispensing.

Thus, the obtained results of the field tests proved validity of theoretical and laboratory experimental research on improvement of technological process of one-grain seeding and created with this research seeding mechanism corresponds to modern requirements specified to seeding machines and provides highly productive corn seeding for ultimate plant population.

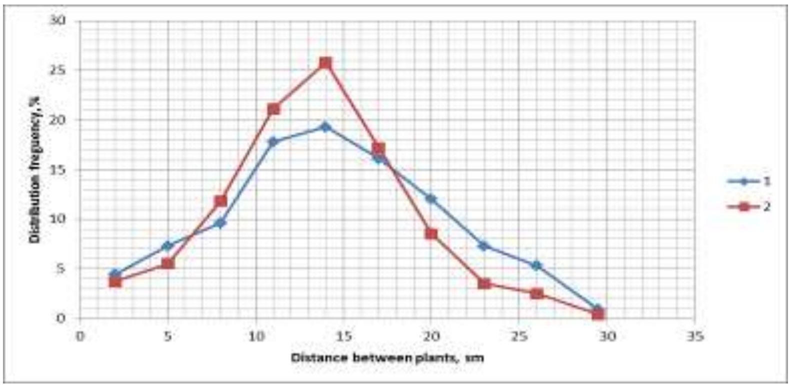

Fig. 4 - Variation curve of interval distribution between plants in drill rows of corn seeding done by seeding mechanisms: serial (curve 1); developed (curve 2)

CONCLUSIONS

The suggested designs of the seeding mechanism elements provide quality improvement of seed dispensing by pneumatic seeding machines of precision seeding being applied to newly develop seeding machines as well as to already exist and operate in agriculture. It results in obtaining some extra profit with minimum expenditures for machines reequipment.

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SONIC GENERATOR DRIVEN BY WIND VIBRATING MECHANISM
/
GÉNÉRATEUR SONIQUE ACTIONNÉ PAR UNE ÉOLIENNE VIBRANTE

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Keywords: *Sonics, Vibrant wind machine, Resonance, Self-vibration, Sonic network*

ABSTRACT

The study of the dynamics of wind turbines deals, among other aspects, on the harmful effects of vibration either on the fatigue of materials, the rotor aeroelastic instability, noise or other vibrational phenomena.

However, oscillatory movements can be beneficial for the processing and transport of mechanical energy. Indeed, an aeraulic mechanism working in special conditions (for example, by self-vibration or resonance) can be used to extract the wind energy. Afterwards, this mechanical energy can be communicated to a sonic generator through a resonant line. This arrangement can be seen as a new type of wind turbine that is fundamentally different from the vertical axis wind turbine (VAWT) or the horizontal axis wind turbine (HAWT) called vibrant wind engine (VWE).The theory of VWE will be discussed and few vibrant mechanisms will be presented and commented.

RÉSUMÉ

L'étude de la dynamique des éoliennes porte, entre autre, sur les effets nocifs des vibrations que ce soit la fatigue des matériaux, l'instabilité aéroélastique du rotor, le bruit ou autres phénomènes.

Toutefois, les mouvements oscillatoires peuvent être utilisés pour la transformation et le transport de l'énergie mécanique. En effet, un mécanisme aéraulique fonctionnant dans des conditions particulières (par exemple, à la résonance ou en auto vibration) peut être utilisé comme extracteur de l'énergie du vent. Ensuite, cette énergie peut être transmise à une génératrice électrique à travers une ligne résonnante. Cet arrangement, qu'on appelle machine éolienne vibrante (MEV), peut être vu comme un nouveau type d'éolienne qui est fondamentalement différente des éoliennes à axe horizontal (HAWT) ou vertical (VAWT). La théorie de MEV sera discutée et quelques mécanismes aérauliques vibrants seront présentés et commentés.

INTRODUCTION

Classes of components of a wind turbine

A wind turbine is made to extract mechanical energy from the wind and turn it into other forms of energy suited to the various applications such as mechanical energy (rotational, translation or roto-translation), electric power, thermal energy, etc. Figure 1 shows the main component classes of a generic wind turbine where: S, the energy source (wind), E, the extractor of wind energy, T, transmission and transformer of energy, M, modulators of energy and C, the consumers (electric networks, isolated users, etc.).

The wind turbine is a turbine powered by S, a current of air, generally, the natural wind. Unlike hydraulic turbomachinery who are driven by a jet of fluid through a pipe under almost constant pressure (because of the extent of the accumulation lakes), the wind turbine uses a drowned jet whose characteristics are generally random. This has implications for construction, control and operation of a wind turbine, consequences which are absent in the case of hydraulic generators. Indeed, the use of confined liquid jet allows the command of the input power by manipulation of simple valves, which modulate the admission of the liquid to the turbine blades. Thus, the predictability and ease of modulation of the input flow allow the realization of a stable movement of the rotor of the generator and so it ensures an electric wave of quality. On the other hand, the wind being not harnessed, the wind turbines have to deal with an input power variation between approximately known limits by statistical measures of a site over large periods of time (*Ilinca et. al., 2003*).

The system E has a multitude of possibilities to make the capture (*Spera D. A, 1994; Hau E., 2006; Saulnier and Reid, 2009; Olives et. al., 2013*). Currently on the market are mainly two solutions: wind turbine with horizontal axis *(HAWT)* and, in a smaller segment of market, the wind turbine with vertical axis *(VAWT)* (*Paraschivoiu I., 2002; Patel M.R., 2006*). This trend is due to the ability of the turbine to extract energy from the wind. Indeed, from this point of view, the horizontal axis turbine with 3 blades presents the greatest performance, with a power factor $c_p = 45\%$, not far of Betz index ($c_p = 59\%$), while the wind turbine vertical axis with c_p= 30% is next (*Patel M., R. 2006*). However, HAWT must be fitted with the devices orientation against the wind on the difference of *VAWT* which is omnidirectional (*Martel and Dery, 2005*). Just by looking quickly at these two types of wind turbines, we deduce that the capture of the energy is based on specific body: the blade.

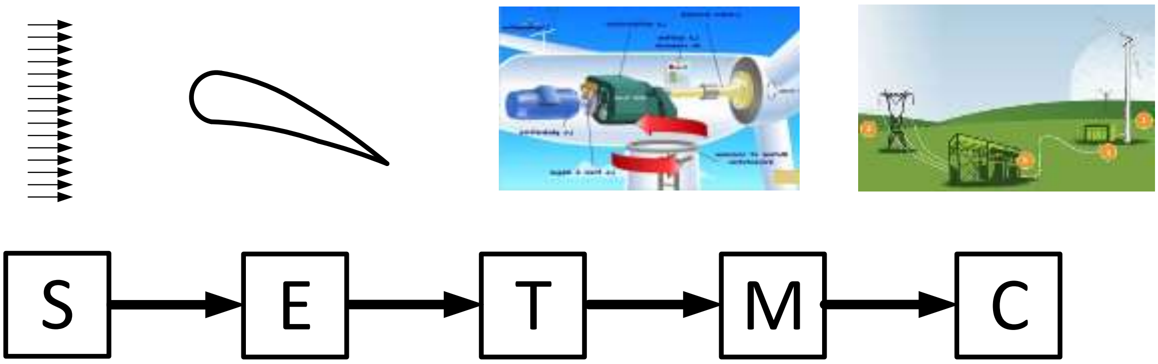

Fig. 1 – Classes of components of a wind turbine

Transmission T is the subsystem that is most diversified. It may have the form of a simple shaft or up to a quite sophisticated mechanism with multiple degrees of mobility. This part also includes the various generators and transformers of energy: mechanic, hydraulic, electric, pneumatic, sonic, etc.

Modulators M regulate and direct the flow of energy: adjustment of the voltage, intensity or the phase of the current (electric or sonic), the distribution of the fluid, clutch, declutch, braking of the shafts, etc. Also note that to ensure the stability of the wave (electrical, sonic, or other) should be used mechanical or electrical devices that can be costly, bulky, inefficient, energy consumer, difficult to operate, etc. (*Labonville R., 2008*).

Finally, consumers C absorb the energy provided by the chain, and turn it in other energy or mechanical work.

Researchers, inventors, companies and hobbyists have invested many efforts in this area on several directions, as for example:

- the conditioning of air stream by capture and duct (*Allaei and Andreopoulos, 2014; Grant and Kelly, 2004)*;

- the introduction of new systems to capture the movement of the wind (*Festo, 2014, Stinson E., 2015*);

- the invention of some systems of transformation of mechanical energy into other forms of energy (*Patel M. R., 2006*).

The conditioning of the air is necessary since wind is a field of low energy density in comparison, for example, to a liquid medium. The idea is to harness the current with a static device, and directs it through a tapering passageway that passively and naturally accelerates its flow.

In the following lines, we will get mainly of a new extraction system of wind energy as well as with the transformation of this energy into vibrational energy.

MATERIAL AND METHOD

The theory of self-vibrations produced by fluid flow around à body

Be an airfoil whose chord is tilted at an angle α from the horizontal and who is under the influence of an horizontal airflow of speed $\bar{v}$ (Figure 2 a). The resultant of the forces of pressure applied on the profile has two components which can be determined, by testing in a wind tunnel, and who present themselves as curves given by the functions (*Den Hartog J. P., 1934; Voinea et. al., 1989, Paraschivoiu I., 2002*):

$P = P(\alpha) \quad T = T(\alpha)$

These forces are called the lift, P, respectively the drag, T and act as forces applied to the profile (*Paraschivoiu I., 2002; Patel M. R., 2006; Spera D. A., 1994*).

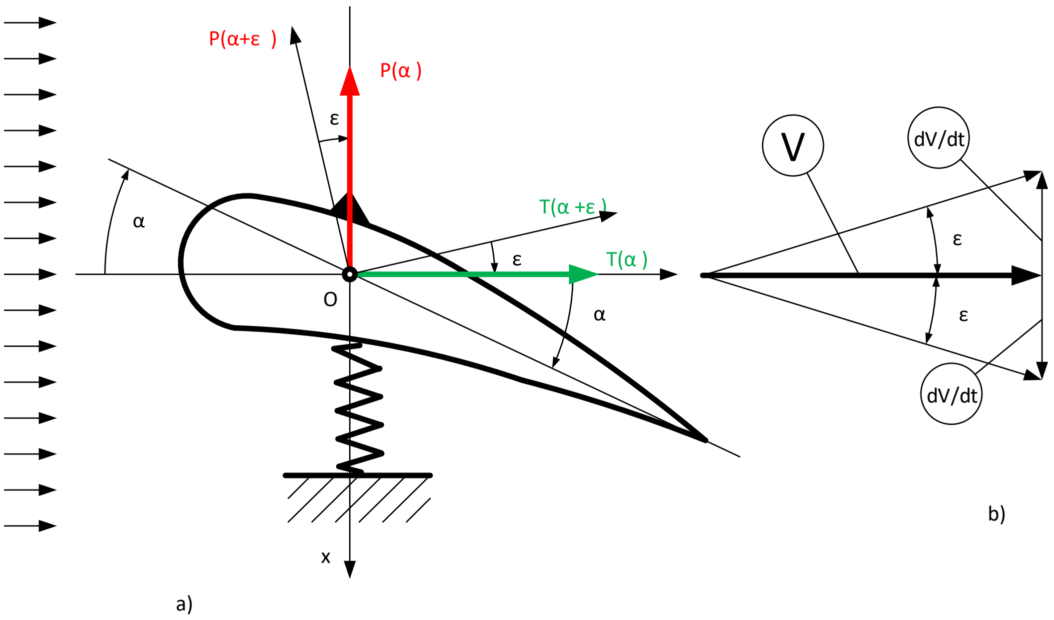

Fig. 2 – Self-vibrations induced by fluid flowing around a body

We study the motion of the profile on the vertical direction, denoted with x, and considered to be positive downward. If at some moment, the airfoil is under the action of an elastic force kx, the equation of motion is of the form,

$$-kx - F = m \cdot \ddot{x} \tag{1}$$

The force F is equal to the projection, on the axis Ox, of the resultant of the forces of drag and lift.

If the profile is at rest, this resultant is given only by the lift force $P(\alpha)$ but, if the profile is moving in the positive direction of the vertical axis Ox with a speed $\dot{x} \ll v$ then, the relative speed of the air regarding the airfoil, makes an angle ε (figure 2b) given by the relationships,

$$\tan\varepsilon = \frac{\dot{x}}{v} \approx \sin\varepsilon = \varepsilon \approx \frac{\dot{x}}{v} \quad \text{et} \quad \cos\varepsilon \approx 1$$

Under these conditions, the drag and lift have the expressions:

$P = P(\alpha + \varepsilon) \quad T = T(\alpha + \varepsilon)$

and the projections of these forces on the axis Ox will be the force $-F$ where,

$$F = P(\alpha + \varepsilon) \cdot \cos\varepsilon + T(\alpha + \varepsilon) \cdot \sin\epsilon = P(\alpha + \varepsilon) + T(\alpha + \varepsilon) \cdot \varepsilon$$

Since ε is small, we can develop in Taylor series and retain only the linear terms, and with

$$P(\alpha + \varepsilon) = P(\alpha) + \frac{\partial P(\alpha)}{\partial \alpha}\varepsilon \quad \text{et} \quad T(\alpha + \varepsilon) = T(\alpha) + \frac{\partial T(\alpha)}{\partial \alpha}\varepsilon$$

we get

$$F = P(\alpha + \varepsilon) + T(\alpha + \varepsilon) \cdot \varepsilon = P(\alpha) + \frac{\partial P(\alpha)}{\partial \alpha}\varepsilon + \left[T(\alpha) + \frac{\partial T(\alpha)}{\partial \alpha}\varepsilon\right]\varepsilon$$

Neglecting the terms in ε^2 finally, there are the expression of the aerodynamic force acting on the direction $-Ox$,

$$F = P(\alpha) + \left[T(\alpha) + \frac{\partial P(\alpha)}{\partial \alpha}\right]\varepsilon$$

Then the movement equation (1) becomes,

$$-kx - P(\alpha) + \left[T(\alpha) + \frac{\partial P(\alpha)}{\partial \alpha}\right] \cdot \frac{\dot{x}}{v} = m \cdot \ddot{x}$$

or in a canonical form,

$$\ddot{x} - \frac{\left[T(\alpha) + \frac{\partial P(\alpha)}{\partial \alpha}\right]}{mv} \cdot \dot{x} + \frac{k}{m}x = -\frac{P(\alpha)}{m} \tag{2}$$

It recognizes here the equation that describes a damped vibratory movement,

$$\ddot{x} + \frac{c}{m} \cdot \dot{x} + \frac{k}{m} \cdot x = F$$

with the damping factor $c = -\frac{\left[T(\alpha) + \frac{\partial P(\alpha)}{\partial \alpha}\right]}{v}$.

Based on the damping factor the movement can be classified in:

- damped vibration, if $T(\alpha) + \frac{\partial P(\alpha)}{\partial \alpha} < 0$;
- harmonic vibration, if $T(\alpha) + \frac{\partial P(\alpha)}{\partial \alpha} = 0$;
- self-vibration, if $T(\alpha) + \frac{\partial P(\alpha)}{\partial \alpha} > 0$.

Since the drag $T(\alpha)$ is always positive, we see that the motion can be unstable if, on a portion of the curve, $P = P(\alpha)$, we have $T(\alpha) + \frac{\partial P(\alpha)}{\partial \alpha} > 0$.

The solution of the equation in the case of the self-vibrations is:

$$x = A \cdot e^{\frac{\left[T(\alpha) + \frac{\partial P(\alpha)}{\partial \alpha}\right]}{2mv} \cdot t} \cdot \cos[\sqrt{\left(\frac{k}{m}\right)^2 - \left(\frac{\left[T(\alpha) + \frac{\partial P(\alpha)}{\partial \alpha}\right]}{2mv}\right)^2}) \cdot t - \varphi] \quad (3)$$

Energetically, multiplying the equation (2) by $m\dot{x}$ we obtain,

$$m\ddot{x}\dot{x} - \frac{\left[T(\alpha) + \frac{\partial P(\alpha)}{\partial \alpha}\right]}{v} \cdot \dot{x}^2 + kx\dot{x} = -P(\alpha)\dot{x} \Leftrightarrow \frac{d}{dt}\left(\frac{m\dot{x}^2}{2} + \frac{kx^2}{2}\right) = \frac{\left[T(\alpha) + \frac{\partial P(\alpha)}{\partial \alpha}\right]}{v} \cdot \dot{x}^2 - P(\alpha)\dot{x}$$

But, with $E = \frac{m\dot{x}^2}{2}$ and $U = \frac{kx^2}{2}$, respectively the kinetic and potential energies, it results that:

$$\frac{d}{dt}(E + U) = \frac{\left[T(\alpha) + \frac{\partial P(\alpha)}{\partial \alpha}\right]}{v} \cdot \dot{x}^2 - P(\alpha)\dot{x}$$

Because the right member of the equation can be positive, we conclude that the total energy of the system ($E + U$) may be increasing with time, and, furthermore, this growth is exponential.

In conclusion, in this section, we see from the equation (3) that the amplitude grows exponentially with time (unlike the case of resonance where the increase is linear) which makes that the self-vibrations are a very effective mean of extraction of the energy from the wind.

This brings us to look at a way to take advantage of this phenomenon by using this installation as an extractor of energy instead of the rotating blade.

In the next paragraph, we will show some possible patterns of vibrant wind turbines.

Ideas on exploitation: the vibrant wind engine (VWE)

The above considerations invite us to think that instead of capturing energy via circular continuous motion of a propeller (like in HAWT or VAWT), the aerodynamic effect of instability that produces self-vibrations can be exploited. This vibrant motion has been considered as the worst case by the engineers who actively tried to design their devices to be far from these domains of operation (and, is to say, for a good reason). But, what can be seen as a danger for some, for others can be an opportunity.

In order to do this, several steps must be overcome, namely:

- to ensure a linear displacement of the aerodynamic profile;
- to find a mechanism that will allow to modify easily the profile inclination during the operation;
- to design a mechanism for the transformation of oscillatory motion in continuous rotary motion.

The very first idea to guarantee a linear displacement of the profile is to guide the motion with a translational joint. However, in practice this is a bad idea because the translational guide has severe inconveniences (clearings, premature wear, noise, etc.). Instead, we will be looking for a mechanism with rotational joints only (Figures 3, 4, and 5 show some possibilities).

Thus, in the Figure 3, the linkage AC, pinned at A, provides a linear motion of the profile as long as the displacement is small compared to the length AC.

To modify the inclination of the aerodynamic profile we need to stop the movement of the blade.

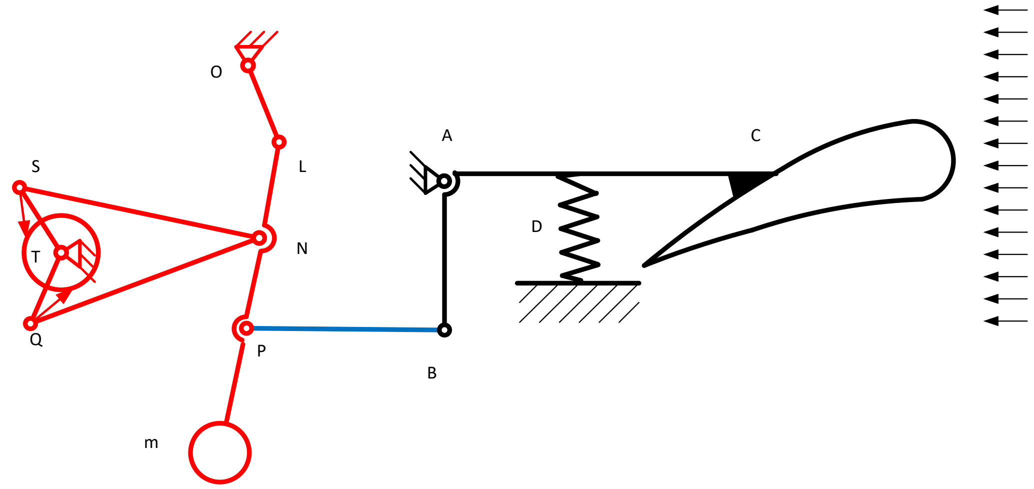

Fig. 3 – VWT with direct action on CCC

Figure 4 shows a solution using a Sarrut mechanism (*Cornellier C., 2017*). The Sarrut mechanism, built of the linkages AD, CD, KE, FE and AK, allows a translation vertical motion on AK platform, although all the elements moves rotationally.

To modify the inclination of the aerodynamic profile, the stop of the motion of the blade is needed.

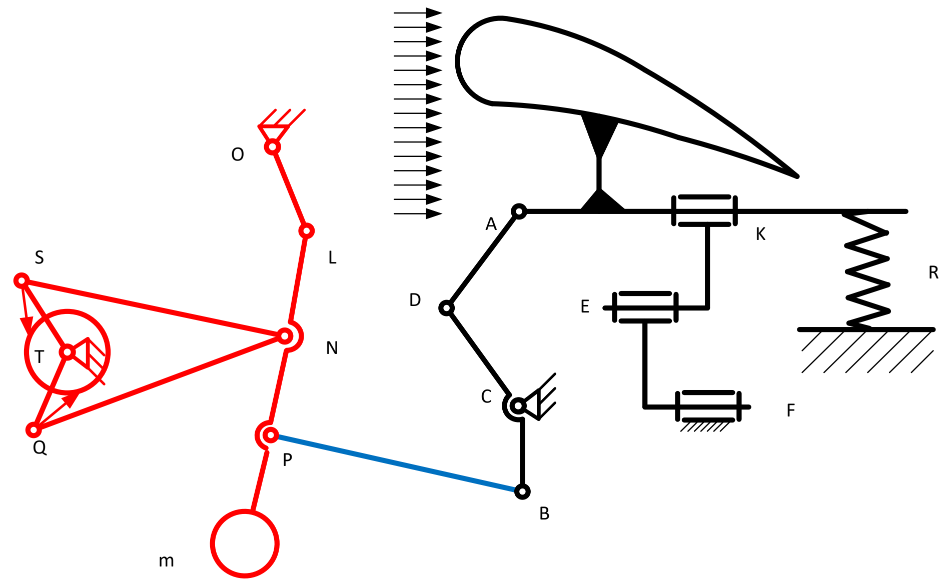

Fig. 4 – VWT with Sarrut mechanism action on CCC

Figure 5 exploits the properties of a Tchebytchev four-bar linkage $AHDC$, whose connecting rod is DG and the following relationships are true:

$HA = HD = HG = 2.5 \cdot CD$

$AC = 2 \cdot CD$

Under these conditions, the point G traces a straight line segment (*Artobolevski I., 1975-1978*). We builds on the segments GH and AH, the parallelograms $GHEL$, respectively, $AHEB$. It can easily be seen that the segment LG has a vertical displacement no matters what is the inclination of the fixed segment AB (which occasionally can be vertical). So, this segment can be used for the active displacement of the aerodynamic profile, glued at.

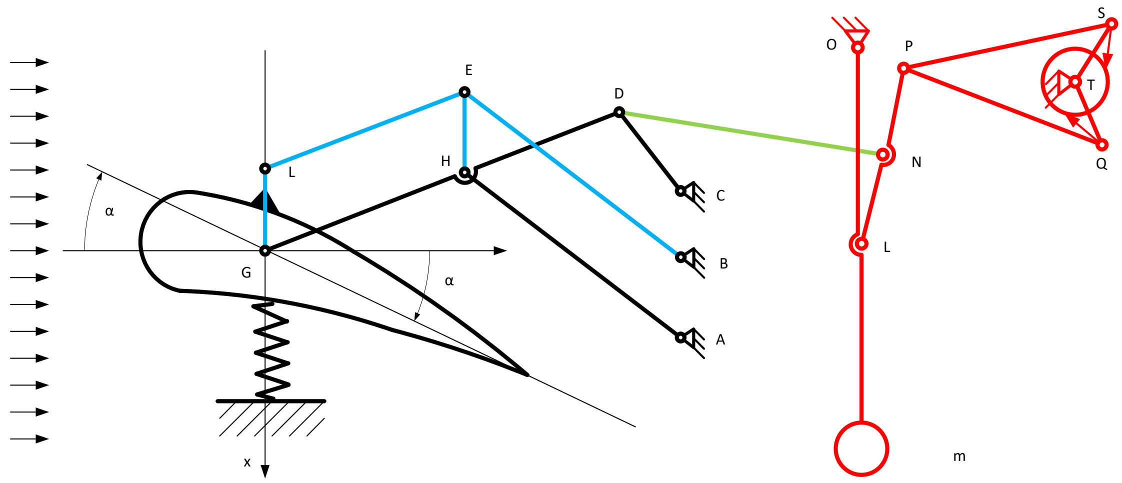

Fig. 5 – VWT with Tchebytchev mechanism action on CCC

Moreover, by modifying the angle of AB, the angle α of the profile is automatically modified with the same value and this operation can be executed while the mechanism is still in motion.

Now, for the conversion of oscillatory motion of the body PB, on Figures 3 and 4, or link ND, on Figure 5, we have some feasible solutions.

For example, one can imagine the connected rod, attached to a piston of a sonic generator such that a sonic network will transport and transform the motion until the end of the transformation chain. That means than the wind engine is entirely vibrant (*Constantinescu G., 1985; Abaitancei et. al., 2010, Denes-Pop I., 2015; Mailloux M., 2017; Marcu and Ciupan, 2016; Petric A. A., 2011; Pop I. I., 2006; Popescu G., 2016; Radu S. I., 2012*).

Another possibility is to employ a Constantinescu's torque converter of two degree of mobility (the mechanism whose joints are O, L, N, S, T, Q) (*Constantinescu G. 1985; Ene M., 2013; Mailloux M., 2017*). The oscillatory motion in the point P excites this mechanism. The exit shaft T, can be rigidly connected with the rotor of a sonic generator thus, a sonic network will continue the rest of the transformations.

In this paper, it was not mentioned the issue of the omnidirectionality of the wing engine who is a common problem with HAWT and can be solved in the same way. Additionally, the INVELOX technology (*Allaei D., Andreopoulos Y., 2014*) or the concept of ducted wind turbine (*Grant and Kelly, 2004*) can be profitably integrated in the design of VWM.

Finally, a combination of sonic and electric systems can be necessary for some applications. This is a problem pertaining of the electricians and the solutions are numerous (*Félice and Révilla, 2009; Husain I., 2003; Lautier et. al., 2007*).

CONCLUSIONS

This paper offers a contribution to the study of a vibrant wind device, a new concept of in the field of wind machinery. Our contribution are resumed in the following:

- the signalisation of the phenomenon of self-vibration and the possibility of application in the practice of the wind machinery, like an extractor of wind energy;
- the device of many mechanisms to be employed for wind harvest energy, like Sarrut mechanism, Tchebytchev mechanism, etc.;
- introducing a mechanism for the treatment of the movement, after his extraction, with the mean of Constantinescu's Torque Convertor;

The concept of VWM needs further theoretically investigations, laboratory experiments and prototype design in order to validate his viability.

ACKNOWLEDGEMENT

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VERTICAL WIND TURBINE WITH SONIC GENERATOR / ÉOLIENNE À AXE VERTICAL AVEC GÉNÉRATRICE SONIQUE

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Keywords: *Sonicity, Vertical wind turbine, Truncated Darrieus wind turbine, Sonic network*

ABSTRACT

Wind energy seems to be by now one of the most promising source of renewable energy with near zero air pollution. To convert wind energy into electrical or mechanical energy, two types of wind turbines operate mainly in the market: the Horizontal-Axis Wind Turbine (HAWT) and Vertical-Axis Wind Turbine (VAWT). This article presents the results of the researches on the special type of the VAWT namely the truncated Darrieus turbine (named Dermond wind turbine) and also one new type of transmission and transformation of the energy by the way of sonic network.

The motivation of this innovative wind turbine comes from some specifications like the adaptation to mountain, northern environments and remote areas, easy installation and maintenance, very simple and reliable mechanics, the fact that this turbine is always oriented toward the wind. The prototype of a 100 kW Dermond wind turbine was installed on the experimental Donald Murphy Center, the property of the University of Québec in Abitibi-Témiscamingue in Rouyn-Noranda, Canada. The story of this adventure and the main conclusions will be reported.

The other points of the paper deals with the sonicisation of the prototype of Dermond wind turbine. Sonicisation, like electrification, means the utilisation of the sonic network for the transformation and transportation of the mechanical energy by stress waves in the fluid tubes. The ideas originate in the Constantinescu's Theory of Wave Transmission who introduces the concept of sonics in the beginning of the twentieth century. A dynamic model of the sonic split transmission will be presented and commented.

RÉSUMÉ

L'énergie éolienne semble être la source la plus prometteuse d'énergie renouvelable avec presque zéro pollution de l'air. Afin de convertir l'énergie du vent en énergie électrique ou mécanique, deux types d'éoliennes se trouvent sur le marché : l'éolienne à axe horizontal (HAWT) et à axe vertical (VAWT). Cet article présente les résultats des recherches d'un type spécial d'éolienne VAWT, à savoir, l'éolienne Darrieus tronquées (nommée aussi éolienne Dermond) et aussi sur une nouvelle transmission et transformation de l'énergie avec le réseau sonique.

La motivation de cette éolienne innovante vient de ses caractéristiques spéciales comme l'adaptation aux environnements isolés, montagneux et nordiques, l'installation et la maintenance facile, la mécanique très simple et robuste, le fait que la turbine est toujours orientée contre le vent. Le prototype d'une éolienne Dermond de 100 kW a été installée sur le Centre expérimental Donald Murphy, une propriété de l'Université du Québec en Abitibi-Témiscamingue à Rouyn-Noranda, Canada. L'histoire de cette aventure et les conclusions principales seront racontées.

Un autre point traité dans l'article concerne la sonicisation du prototype de l'éolienne Dermond. La sonicisation, toute comme l'électrification, suppose l'utilisation du réseau sonique pour la transformation et le transport de l'énergie mécanique par des ondes de pression dans des tubes remplis de fluide. Ces idées ont leur origine dans la Théorie de la transmission par ondes du savant Constantinescu qui introduisit le concept de la sonicité au début du vingtième siècle. Finalement, un modèle dynamique d'une transmission sonique de l'éolienne sera présenté.

INTRODUCTION

The wind turbine to axis horizontal versus vertical axis wind

A wind turbine is a turbine which extract mechanical energy from the wind and turn it into other forms of energy needed for various applications (mechanical energy (rotational, translational or roto-translational), electrical power, thermal energy, etc.) (*Jaffe and Taylor, 2018*). There are a multitude of ways to do this extraction (*Spera D.A., 1994; Hau E. 2006; Saulnier and Reid, 2009; Olivès et. al., 2013)* but currently the practice has validated two solutions: horizontal axis wind turbine (HAWT), which is in a dominant position in the market and, in a smaller market segment, the vertical axis wind turbine of type Darrieus (VAWT) (*Paraschivoiu I. 2002; Patel M. R. 2006*). This asymmetric diffusion is due to the ability of the turbine to extract energy from the wind. Indeed, from this point of view, the horizontal axis with maximum three wind turbine blades, present the greatest performance with a coefficient of power cp = 45 percent close of Betz index (cp max = 59%). While closely watching the wind turbine vertical axis with cp = 30% *(Patel M., R. 2006*). However, HAWT must be fitted with the devices orientation against the wind on the difference of VAWT which is omnidirectional (*Martel and Dery, 2005*).

Experimental Donald Murphy Center of the University of Quebec in Abitibi-Témiscamingue in Rouyn-Noranda, Canada

The testing site is located on the property of UQAT in Rouyn Noranda, Canada on the Cap d'Ours, a mound adjacent to the University. The choice of this location is not random. We were looking for a place, not very windy (*Ilinca et. al., 2003*) close to a University to verify a complex system capable of integrating several technologies: wind power intermittent system batteries, electro-generateur Diesel, solar cells, batteries, hydrogen, etc. This system was to be multi-functional and usable to be connected to large electric networks, independent networks or as independent source.

Donald Murphy Center is designed to provide access to several teams to experience their ideas: academic researchers in mechanical engineering, electrical engineering, undergraduate, masters, doctorate and post doctorate students, independent inventors, independent businesses, etc. From this point of view the experiemental Center is an industrial incubator.

MATERIAL AND METHOD

Dermond wind turbine

Dermond wind turbine installed at the centre of experimentation is a wind turbine (VAWT) vertical axis with a power of 100 kW, consisting of a rotor, Darrieus type (*Darrieus G. J. M. 2018; Félice and Révilla, 2009; Fox et al., 2009*) with the rotor truncated, a generator and a support structure (Figure 1).

The rotor consists of three blades that have a troposkienne form (*Kouakou and La Roche-Carrier 2011*). The area covered by the rotor is defined as the projection on a vertical plane of the surface generated by the blades in motion. The ends of the blades describe two circles, the lower circle and the upper circle. The area covered by the rotor of the Dermond turbine is approximately calculated by the relationship $A = 2 \cdot H \cdot D/3$ with $H = 11.764\ m$ and $D = 17.108\ m$ that yields to $A = 134\ m^2$. H is noted as the distance measured vertically between the lower and the upper circle and D is the width of the area swept by the rotor, measured at the equator. The specific capacity (which is the ratio of the installed power and the area swept by the rotor) of this wind turbine is of $100/134 = 0.745\ kw/m^2$.

Between the blades (the rotor) and the generator is mounted a differential multiplier type zone Sumitomo of transmission ratio of $10/1$.

The type generator ABB is also used as the engine for starting the machine. The stop of the turbine is done with brakes mounted on the axis between the blades and the reducer in order not to solicit the multiplier/reducer (*Lautier et. al., 2007*).

The structure that supports the turbine is a vertical tower built in steel tubes. The tower is anchored by 6 stays. The cables are fixed below the lower circle leaving the turbine somehow at cantilever. The total height of the tower is $H_t = 36{,}561\ m$ (measured between the base of the structure and the upper part of the blades).

This structure has several advantages from the point of view of the facility in remote areas as for example:

- being omnidirectional;
- the simplicity of the mechanical point of view;
- installation and maintenance simplified;
- a system adapted to the northern climate;
- the assurance of a safety and reliable work.

Being omnidirectional means the operation of the turbine is independent of the direction of the wind, so it doesn't need a device orientation against the wind (like a weather vane, for example). As a result, electricity production will not be affected by the malfunction of a such component. This feature can be critical when the wind turbine will be installed in remote areas or on sites where the wind direction is changing. In addition, Dermond wind turbine consumes no energy to perform the maneuver of orientation as is the case for the classic HAWT.

Mechanical simplicity makes reference to the construction of the rotor and blades. The components of the rotor are related to the hub and is over-constrained construction made of standard industrial modules. No system for the modification of the blades is required. Mechanical simplicity translates into reliability and ease of assembly and maintenance.

It is noted that many parts may already be assembled in the workshop before moving on the site which facilitates the operation. Reasonable capacity cranes are used for the erection of the mast and the assembly of the rotor. This is obviously an advantage for construction in remote areas since the large lifting equipment are few. All mechanical systems are accessible via a scale makes it easier to maintain. It is possible within a shift to remove, reinstall the main mechanical components of the power train and replace them. This is a significant advantage for facilities in remote areas because the downtime of the turbine for major maintenance are significantly reduced. A remote control of the wind turbine is also available, facilitating maintenance for the identification of the causes or the detection of the early signs of failure.

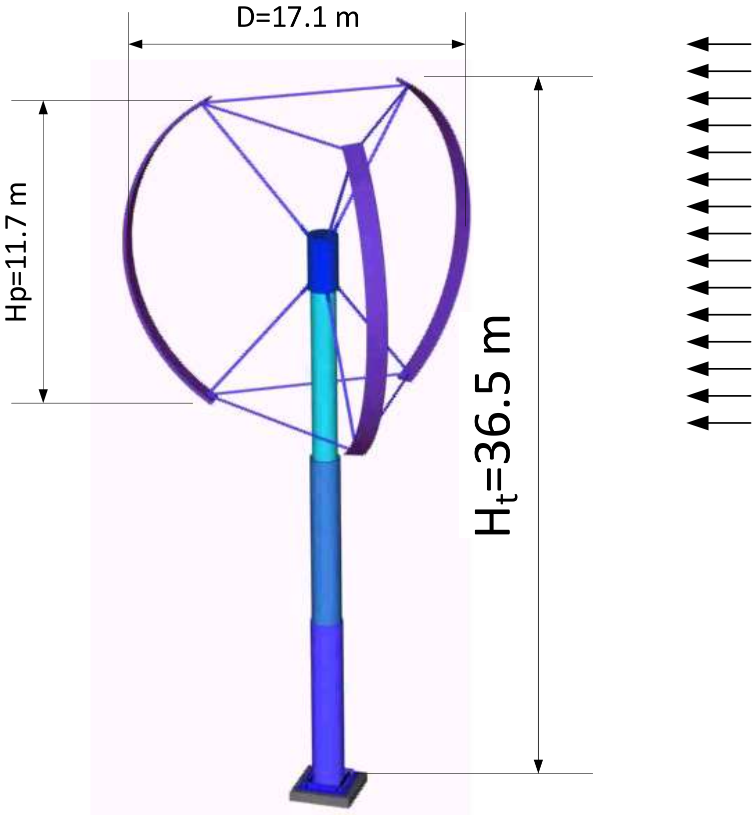


Fig.1 - The 100 kW scheme of the prototype installed in Rouyn Noranda, Québec

Dermond turbine has blades covered with a glaciophobe paint particularly suited to the icing and adapted to the northern climate conditions. The lubrication used in the power train is synthetic and does not heat. The brakes have a watertight sheath which allows to use a braking booster with minimum energy consumption.

The solution adopted for the structure including the hyperstatic geometry of the rotor allows the reduction of the risk of sudden failure of the book. Thus, if one of the elements of attachment gives, the wind will start to vibrate but no catastrophic failure occur. Also, the braking systems are redundant: an electric braking system and two independent mechanical brakes of the power train. The tower is strutted by 6 stays so that if a stay wire breaks, there is not a major failure of the whole.

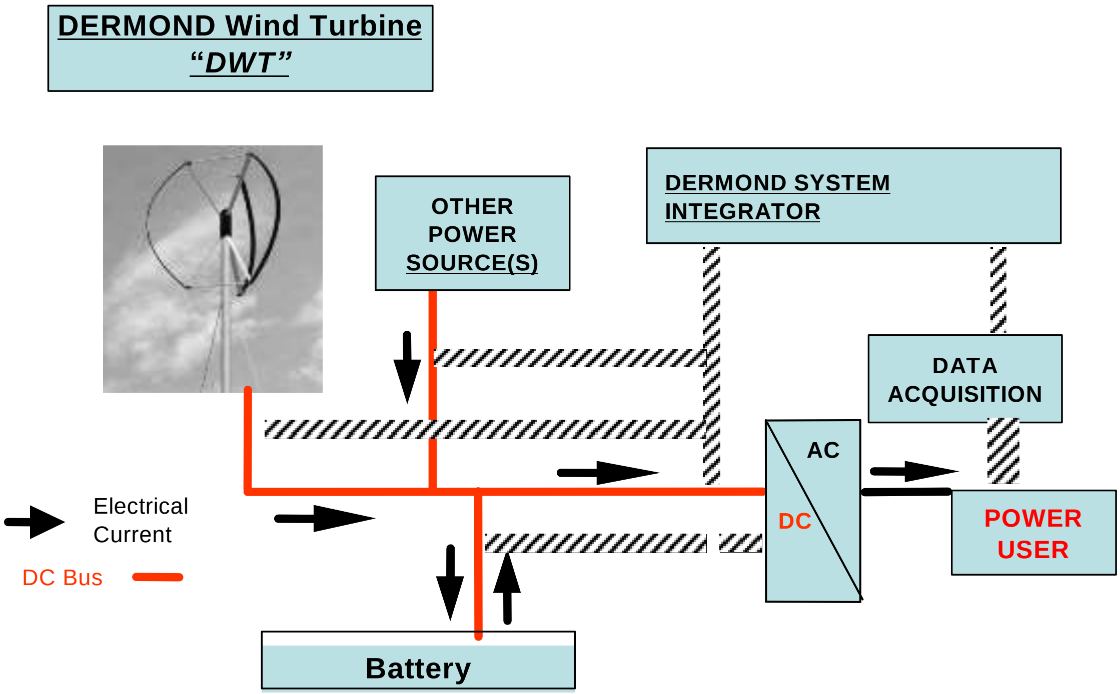


Fig. 2 – Integration diagram of the system of the management of energy

Operation of this prototype facility has allowed so far to confirm the ability of the system to a winter temperature minus $40^o C$. The data collected with this prototype have confirmed that the potential of the technology offered a clear economic advantage for wind turbines from hundreds of kilowatts for electrical networks powered by groups diesel generators and that This technology is able to compete with the large current wind turbines on the major networks.

The energy management system shown in Figure 2 offers the electricity producer the ability to integrate other sources of production or storage of energy, thus offering additional gains to the owner of the electric independent networks. Coupling with existing power plants (diesel, solar, batteries, hydrogen, etc.) is possible too.

The sonicisation of wind turbines

The sonicisation is a devised term that means the application of advances in the theory of the sonics in practice. It's like mechanization, electrification and computerization, etc. The term comes from the word *sonics*, introduced by its inventor, scientist George Constantinesco (*Constantinescu G., 1922, 1985*). The sonics is the science that deals with the study of the transmission of power by mechanical waves in solid or liquid media (*Abaitancei et. al., 2010; Denes-Pop I. 2015; Pop I. I. 2006; Popescu G., 2016; Radu S. I., 2012; Petric A. A., 2011*). With the sonic currents in fluids we can talk about sonic networks and we can design the same features that can be built in the alternative electric circuits: motors (synchronous, asynchronous, single-phase and polyphase, etc.), generators, transformers, etc.

The Sonic transmission, solve the problem of actuation of machines in the sense that we can operate each machine, with an independent sonic engine, engines linked to a central facility where energy is produced by generators with the help of any other mechanical power. The Sonic transmission tubes are less dangerous than the electrical conduit and control devices, valves of start or stop sonic engine are less expensive. Engines cost almost half or one third of the costs of the electric motors of the same power. The weight of the engine is less in the same proportion so that the distribution of sonic energy can compete successfully against the electricity for short distances (*Constantinescu G., 1922, 1985*).

A field of application of sonic transmission can be proposed for the construction of wind turbines and in the following we will describe this sonic device that increases the efficiency of the turbine.

Figure 3a shows the diagram of a transmission gear wheels with two degrees of mobility. The first degree is provided by the rotor of the wind turbine and the second is represented by the sonic generator, GS, in tandem with MS sonic motor. The motion is transmitted by a direct route through the shafts 1 and 6 and by a wheel track side by following the chain $2-3-GS-MS-4-5-6$. The side track is to inject energy into the GS generator that will send it by the MS engine to wheel 4. It's a fitting similar to the Ward-Leonard transmission in electrical engineering.

Thus, it can be changed the angular speed regardless of the angular speed ω_1. We call this mechanism a split transmission and its role is to provide the turbine with a variable speed system that enables to change the angular speed of the output shaft, 7, based on the angular velocity of the rotor of the wind turbine, 1.

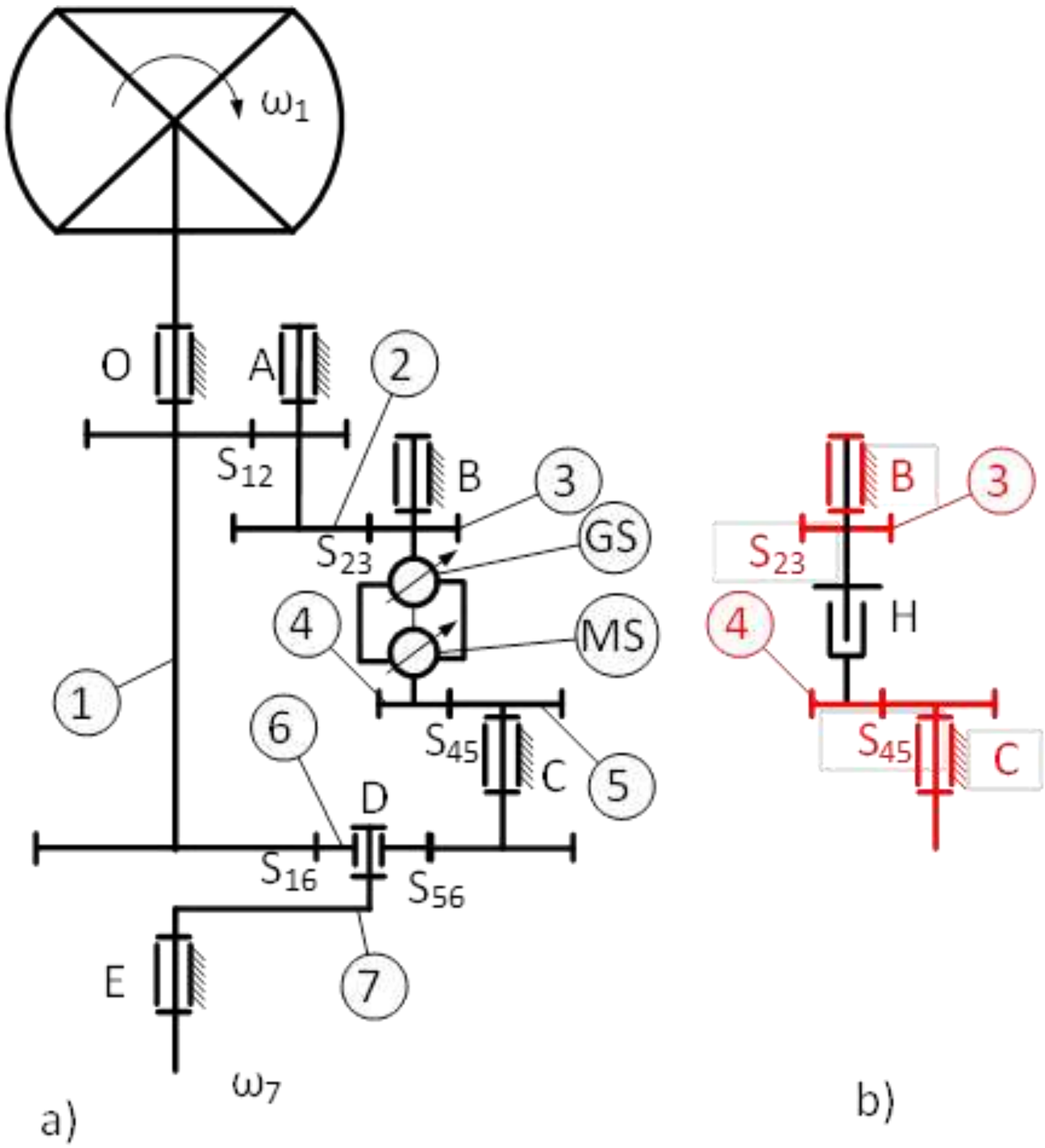


Fig. 3 – Sonics transmission for the VAWT Dermond

This is necessary in order to run the rotor at a speed which ensures maximum performance (*Mantriota G., 2017; Rossetti and Macor, 2013; Labonville R., 2008*) and ensures that the rotor does not turn in synchronous with mode the grid (*Brendann et al., 2009; Lautier et. al., 2005*). Also that it is circulation of power between the elements of the transmission.

For structomatic analysis of the mechanism (*Simionescu et. al., 1996; Pelecudi et. al., 1982; Ene M. 2013*) we will consider the sonic link between the items 3 and 4 as being an active rotational one (labeled with H on the Figure 3 b). Reviewing the number of moving elements $\{1, 2, 3, 4, 5, 6, 7\}$ (so m=7), the number of superior links $\{S_{12} \equiv F, S_{23} \equiv G, S_{45} \equiv J, S_{56} \equiv K, S_{16} \equiv L\}$ (so $s = 5$), as well as the number of lower pairs $\{O, A, B, C, D,\ E, H\}$ (so $i = 7$). This gives us the degree of mobility:

$M = 3 \cdot m - 2 \cdot i - s = 3 \cdot 7 - 2 \cdot 7 - 5 = 2$

This result corresponds to reality, so the calculations are right.

Considerations above deduces:

- the array of kinematic linkages:
$\{0(O,A,B,C,D,E)V, 1(O,L,F,)III, 2(A,F,G)III, 3(B,G,H)III, 4(H,J)II, 5(C,J,K)III, 6(D,K,L)III, 7(D,E)II\}$
- the list of kinematic elements:
$\{F(1,2)RT, G(2,3)RT, J(4,3)RT, K(5,6)RT, L(6,1)RT\}$
- the table of lower pairs:
$\{O(0,1)R(active), A(0,2)R, B(0,3)R, C(0,5)R, D(6,7)R, E(0,7)R, H(3,4)R(active)\}$

With these relations, we have produced the general graph of the kinematical chain of the transmission, represented on Figure 4. This pattern, in turn, will be used for the construction of the diagram graph of the fundamental chain associated with the same mechanism. To do this, higher pairs were replaced (between the teeth of the gear wheels in mesh), which practically is done by removing the elements that form the higher pair and joining them with a fictional element with two lower links to its ends. After the fundamental chain, the diagram presented in Figure 5a is obtained.

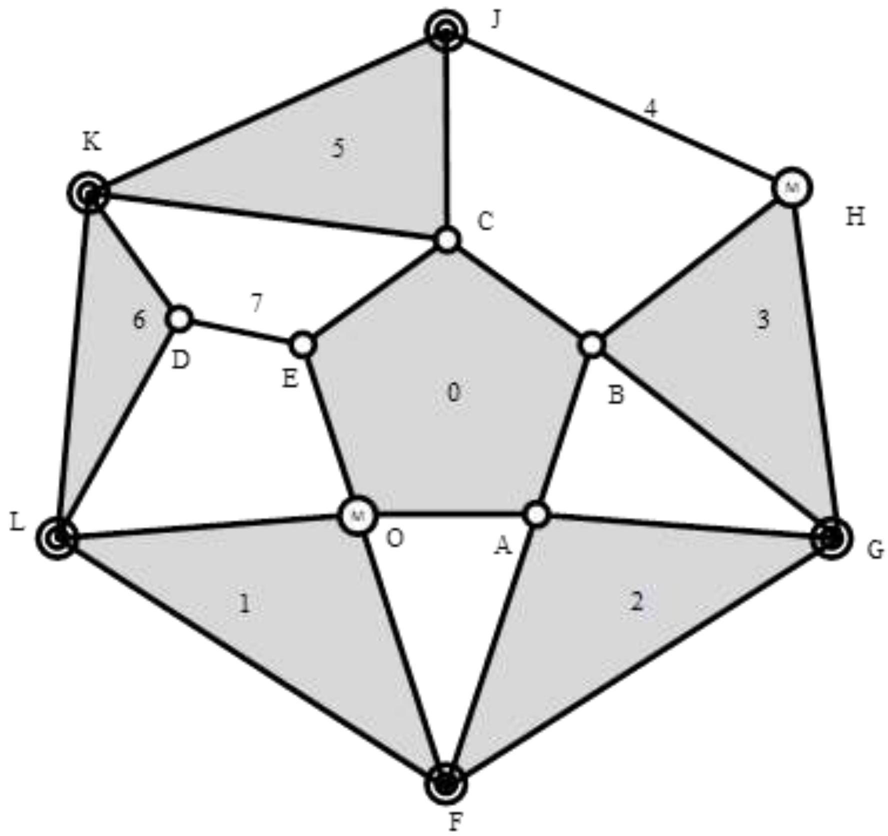


Fig. 4 – General chains associated with the sonic transmission of the VAWT Dermond

From this graph, we perform the partition in structomats (*Ene M., 2016*) and we get the block diagram shown in Figure 5b and the structomatic relation given in Figure 5c. These relationships facilitate us the analytical kinematics of the mechanism to determine the transmission functions of the mechanism. Analysis calculations are done structomat by structomat in the direction indicated by the structomatic relationship. Finally, the transmission functions of position, velocity and acceleration will be useful to the integration of the equation of motion that represents the response of the system. Forces occur in active joints respectively in the joints O and H.

In this case, the work of determination of the transmission functions, which is a time-consuming operation in general, is lightened since we have deal, mostly, with gear wheels with the motion of rotation (except for items 6 and 7).

The equation of motion of the wind turbine with the mechanism of sonic transmission written in matrix form (*Ene M., 2013; Mailloux M., 2017*) is:

$$V^T M V\ddot{q} + V^T M A E\dot{q} = V^T F \qquad (1)$$

In this equation

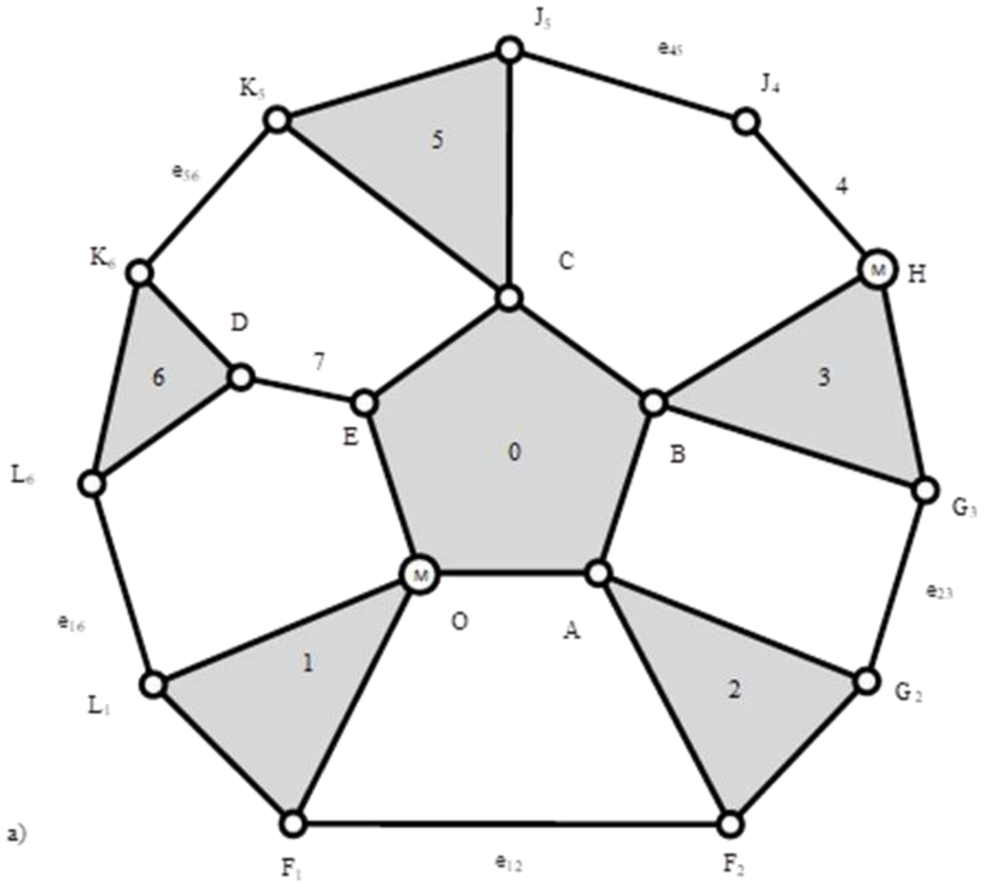
- V^T – is the transmission matrix of velocity;
- M – is the matrix of inertia of the mechanism (diagonal matrix);
- A – is the transmission matrix of acceleration;
- E - is a matrix which contains the generalized velocities;
- F – is the vector of the generalized forces;
- $\dot{q}, \ddot{q}$ – matrices of the generalized velocities and the generalized accelerations, respectively.

The generalized coordinates position elements 1 and 4 (in the active connections).

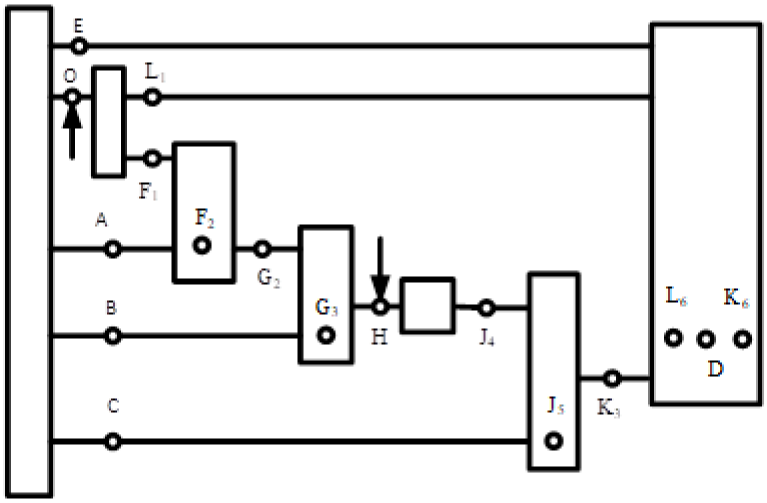
To solve the system of equations, we use the Adams-Moulton predictor-correction scheme for the integration of the equations of motion and coupled with the fourth-order Runge-Kutta method for the first approximations:

$$y_{n+1}^p = y_n + \frac{h}{24}(55 \cdot f_n - 59 \cdot f_{n-1} + 37 \cdot f_{n-2} - 9 \cdot f_{n-3}) \qquad (2)$$

$$y_{n+1} = y_n + \frac{h}{24}(9 \cdot f_{n+1}^p + 19 \cdot f_n = 5 \cdot f_{n-1} + f_{n-2}) \qquad (3)$$



b)



c) $Z(0)+ME(1)+pD(2,e_{12})+pD(3,e_{23})+ME(3)+pD(5,e_{45})+pTR(6,7,e_{16},e_{56})$

Fig. 5 – Structomatics analysis of split transmission for the VAWT Dermond

The method of multiple step of Adams-Moulton is prioritized since it has an accuracy comparable to that of Runge-Kutta but requires less evaluations of the equations of motion. The equations of motion are transformed into a system of differential equations of the first order in the form $y = f(t, q, \dot{q})$. For each step, it is necessary to update the values of the transmission matrices of velocity and acceleration.

The presented split transmission has two degree of mobility, $M = 2$. It may very well introduce a mechanism of three mobility. In this way, by a good choice of geometrical parameters, and mass gives a mechanism which can accumulate kinetic energy in the phases of powerful wind and who can give it up after the gust. This third degree of mobility can arise, for example, in the form of torque converter an invented devised by George Constantinesco. These parts will reduce the consumption of energy from the electric solution and at the same time give an electric wave of superior quality.

CONCLUSIONS

The article provide an overview on the researches made for many years in the laboratory on the experimental Donald Murphy Center for Wind Turbine of the University of Quebec in Abitibi-Témiscamingue in Rouyn Noranda, Canada and the large possibilities offered by this unit for researchers, students, inventors, people and others organizations.

The DWT developed by Dermond, the truncated Darrieus vertical axis wind turbine, who is the heart of the site, is a wind turbine whose mechanical simplicity, easy fabrication and installation allows the competitiveness in the market of the production of electricity in the isolated areas, mountain regions and northern environment of Canada. The results obtained on the prototype are meeting its performances targets.

A sonics transmission for the DWT was presented and analysed. The sonicisation principles of the machines shows that wind turbine industry has a great interest in the massive utilisation of the sonic components for his installations for the robust development of this still emerging business.

ACKNOWLEDGEMENT

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The article is dedicated to the memory of a remarkable man, a true engineer, Jacquelin Déry, one of the pioneers of the promotion of the VAWT in Canada an especially in the Abitibi region and to the memory of Donald Murphy one lover of this county and a great visionary.

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DESIGN OF THE CONSTANTINESCO TORQUE CONVERTER USED AS A MECHANICAL TRANSMISSION FOR AGRICULTURAL TRACTORS
/
DIMENSIONNEMENT DU CONVERTISSEUR DE COUPLE DE CONSTANTINESCO UTILISÉ COMME TRANSMISSION MÉCANIQUE DES TRACTEURS AGRICOLES

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Keywords: *Constantinesco torque converter, Continuously variable transmission, Dynamics, Structomatics*

ABSTRACT
The Constantinesco torque converter (CTC) is a continuously variable mechanical transmission and was introduced by the eminent engineer George Constantinesco during the first half of the twentieth century. This article provides a brief historical overview of the development of the CTC as well as its general functioning principle. A procedure for the integration of the equations of motion of the CTC using the structomatic approach is proposed for the purpose of its sizing. The general dynamic behaviour of the CTC is investigated. The results emphasize the potential of incorporating the CTC into agriculture.

RÉSUMÉ
Le convertisseur de couple de Constantinesco (CCC) est une transmission mécanique à ratios variables proposée par l'éminent ingénieur George Constantinesco durant la première moitié du vingtième siècle. Cet article présente un aperçu historique du développement du CCC ainsi que son principe général de fonctionnement. Une procédure pour l'intégration des équations de mouvement du CCC utilisant les principes de la structomatique des mécanismes est proposée dans le but de procéder à son dimensionnement. Le comportement dynamique général du convertisseur de couple de Constantinesco est investigué. Les résultats mettent l'emphase sur le potentiel d'incorporer le CCC dans le domaine agricole.

INTRODUCTION
Agricultural tractors are frequently used in agriculture to tow equipment such as manure spreaders, trailed sprayers and harvesting equipment or to support certain agricultural implements such as forks or front-wheel-drive rollers and plows at the front or dethatchers at the back. These machines are characterized by a high inertia (empty weight of several tonnes) and thus requires considerable power when they start to move from rest. Several decades ago, the current manufacturers (John Deere, CNH Industrial, Kubota, etc.) have introduced continuously variable transmissions (CVT) to adapt the torque developed to the wheels according to the speed of the tractor, and this, to deal with wide scenarios of solicitation. The proposed transmission models (Fendt Vario, Cnh, ZF, Valtra, etc.) usually include two main parts: the first is hydraulic and the second is mechanical. The use of an epicyclic train is the basis for the operation of these transmissions.

This paper investigates an alternative to the actual CVTs. The Constantinesco torque converter (CTC), which was proposed by the eminent engineer George Constantinesco in the first half of the twentieth century, is a purely mechanical CVT consisting only of links. One of the particularities of this torque converter is that it omits the use of gear trains, clutches, differentials and other components frequently encountered in mechanical systems thus reducing the weight as well as the maintenance time of conventional gearboxes.

During the 1924 Wembley and 1926 Paris exhibitions, the CTC attracted attention not only for its ingenuity and the energy savings it advocated but also for the scientific advances it brought. At these exhibitions, the CTC was mounted on a vehicle (Constantinesco model) and, during the public displays, had shown positive results and it even ensued from discussions with General Motors. Several details concerning the interest and development of the CTC can be consulted in the book written by (*Constantinesco, I., 1994*).

To explain the general operating principle of the Constantinesco torque converter, the model of Fig.1 is used. This model can be modified, for example, by substituting the mass at the end of the pendulum *3* by a flywheel replacing the element 4. Other models are presented in Constantinesco's patents or in his treatise on Sonics (*Constantinescu et al., 1985*). However, he recommended that the configuration of Figure 1 was the most stable.

Briefly, the CTC consists of three subsystems: motor (crank 1 and connecting rod 2), accumulator (double pendulum 3 and 4) and rectification (elements 5, 6, 7 and 8). The motor subsystem induces harmonic motion to the joint C which leads to an oscillating motion of the accumulator subsystem. The rectification subsystem converts the reciprocating motion of the joint D into a unique direction of rotation due to the one way bearings that are mounted on the output shaft H. Constantinesco had named this subsystem mechanical diode by analogy with electricity. The originality of the CTC comes from the fact that the pendulum 3, element of greater inertia, is able to store the mechanical energy developed by the motor at A when the resistance at the output shaft H can not be overcome or simply varied. Thus, after a certain accumulation time, the CTC is able to ensure the motion at the output shaft while using a motor of lower rated power. In addition, the system equipped with the CTC does not stop or block when the resistance increases suddenly and drastically at the output shaft. Constantinesco exposed more details about the functioning of his invention in his paper of 1926 (*Constantinesco, G., 1926*). A notable paper of the early twentieth century is the one of (*Jack R.K., 1927*). *McNeil I. (1982*) also treated of the functioning principles of the CTC in his work.

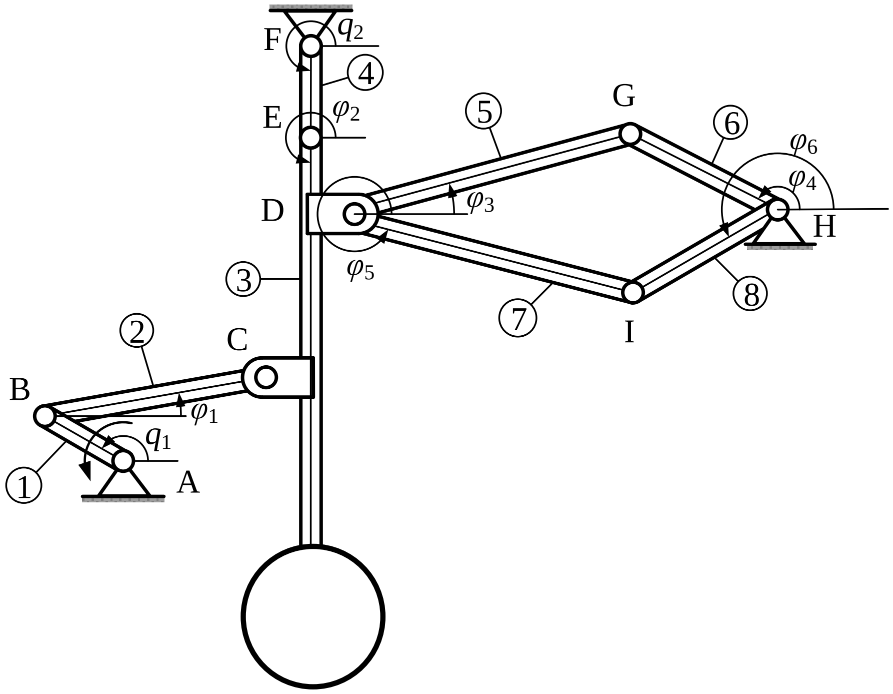


Fig. 1 – Theoritical model of the Constantinesco torque converter

The Constantinesco torque converter has two degrees of mobility whose generalized coordinates are q_1 and q_2 in Figure 1, but is actuated by a single motor located in *A*. For their part, the angles φ_i are the dependent coordinates. The second degree of mobility is relative to its ability to accumulate mechanical energy. Its dynamic behavior is sensitive to the variation of several parameters, mainly the inertia of the pendulum *3*, the lever arm between the joint *D* and the mass of the pendulum *3*, the location of the fixed joints *F* and *H* and the radius of the crank *1*. The study of the stability of the CTC is a subject that can not be neglected. Moreover, a dynamic model of the CTC has been proposed by (*Ion-Guta I., 2016*) based on the Lagrange multiplier method. He also discusses stability by presenting Bode diagrams when the motor speed is constant and the output resistance profile is predetermined.

In the next sections, the dynamic model will be constructed from Lagrange's equations. The numerical procedure for the integration of equations of motion will be presented. The distinctiveness of this procedure is related to the use of the notions of structomatics of mechanisms to compute the transmission matrices. Subsequently, the dynamic results of some simulations will be discussed.

MATERIALS AND METHODS

The design of any system goes through its dynamic analysis. This allows first to deduce the kinematic parameters of all the elements and to know the reactions acting on each of the joints. Ultimately, from these reactions, the stresses soliciting each of the elements are deduced and we can proceed to the sizing. The equations of motion are also prerequisites to the study of the dynamic stability of the system in question.

In this paper, the motion of the Constantinesco torque converter will be studied in the situation where the angular velocity of the motor of Figure 1 is constant. Thus, it is the driving torque required to ensure that this motion law is respected that is calculated. This approach is called inverse dynamics.

Before discussing, in the next section, the dynamic behaviour of the CTC, let us introduce the dynamic procedure put forward to integrate the equations of motion of any linkage mechanisms. It comes down to the following steps:

1) Deduce the sequence of transmission of motion of the mechanism by using the principles of structomatics of mechanisms;
2) Calculate the transmission matrices of velocity and acceleration from the kinematic models of the structomats;
3) Calculate the vector of generalized forces;
4) Integrate the equations of motion with a pre-established numerical method;
5) Save the results.

The sequence of transmission of motion is essential to implement the proposed dynamic procedure. In fact, the general principle of the formation of mechanisms states that any mechanism can be partitioned into a succession of unique groupings (structomats) connected in series or in parallel (*Duca and Simionescu, 1973*). In this way, instead of studying the mechanism as a whole from the outset, it is split into several groupings which have the same dynamic behaviour as the starting mechanism. Each of these unique groupings or structomats is associated with a kinematic and kinetostatic model that can be implemented on a computer software such as Matlab in order to build a library. This library can be easily reused to study a wide range of mechanisms. Since the kinematics of the mechanisms is nonlinear, partitioning the mechanism into a succession of structomats makes it possible to simultaneously solve a smaller number of nonlinear equations.

Regarding the Constantinesco torque converter, its movement is dictated by the connection between two driving elements R (elements 1 and 4) and three dyads RRR formed of the pairs of elements 2 and 3, 5 and 6 as well as 7 and 8. In the notation used, R means a rotary joint. This subdivision is shown in Figure 2a. The sequence of transmission of motion is illustrated using the block diagram of Figure 2b.

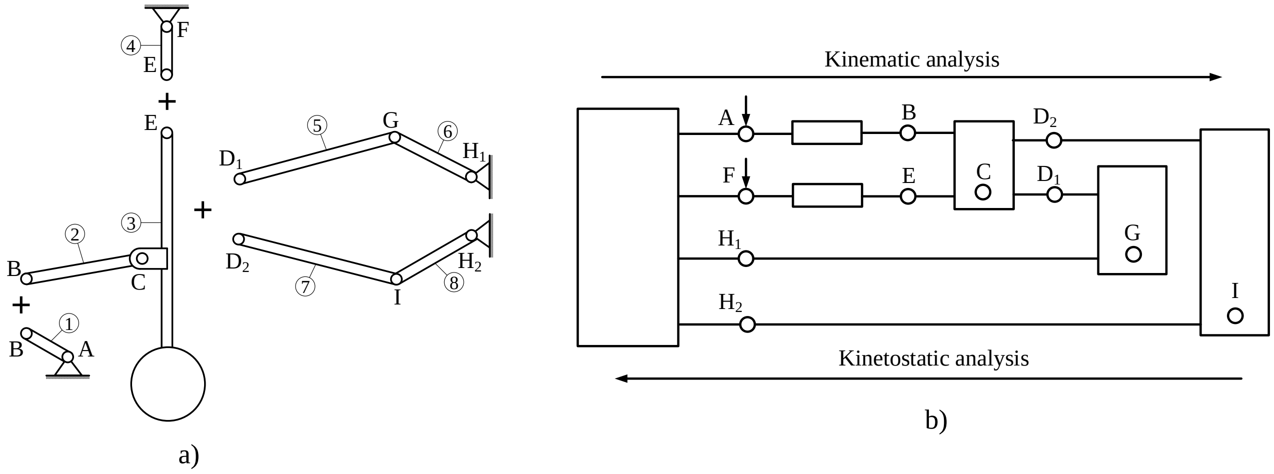
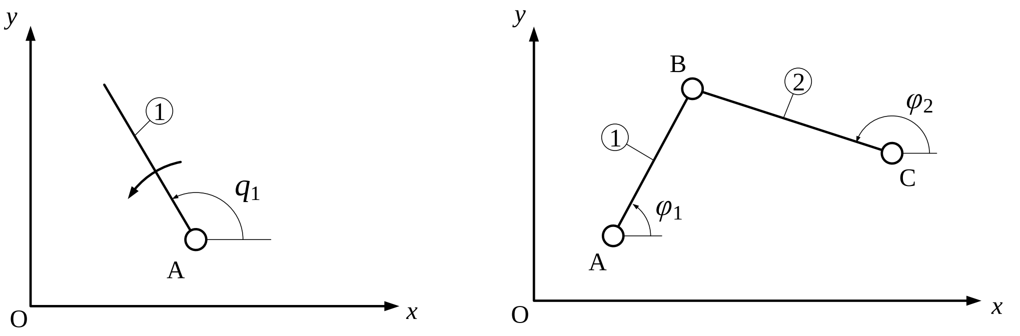


Fig. 2 – a) Highlighting the structomats constituting the CTC; b) Block diagram of the CTC

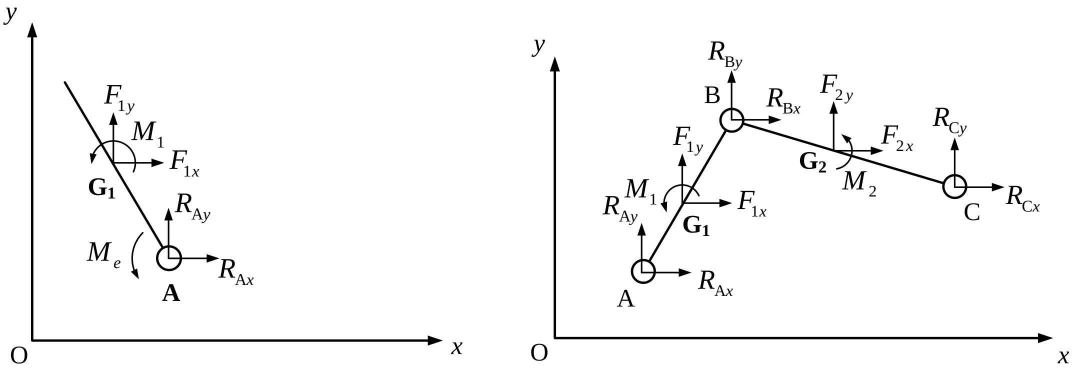
The kinematic and kinetostatic models of the driving element R and the dyad RRR are shown in Figure 3 and Figure 4 respectively. As an example of kinematic modelling, *Moise et. al. (2017)* presented the detailed procedure related to the kinematics of the driving hexade. To perform the kinematic analysis, the subroutines associated with the structomats are called in the order prescribed by the block diagram, that is to say from the zeropole to the final structomats while the kinetostatic runs in the opposite direction. The zeropole is the base or chassis and is always the first structomat to appear in the sequence of transmission of motion.

The driving element R of Figure 3a is an active structomat whose kinematic parameters of joint A and element 1 are imposed and thus known. The kinematic model of the driving element R makes it possible to calculate the kinematic parameters of any points of interest such as the center of gravity or other joints connected to the element 1. The dyad RRR of Figure 3b is a passive structomat where, in order to be able to calculate the kinematic parameters of its elements and joints, those of joints A and C must be previously calculated.



a) b)

Fig. 3 – a) Kinematic model of the driving element R b) Kinematic model of the dyad RRR



a) b)

Fig. 4 – a) Kinetostatic model of the driving element R ; b) Kinetostatic model of the dyad RRR

In Figure 3, the angles q_1, φ_1 and φ_2 are shown for reference purposes and are used to build the subroutines in Matlab. When the whole mechanism is studied, we relate those reference angles to the angles describing its real motion. The following paragraphs describe, in a general way, the proposed numerical procedure to write the equations of motion of a mechanism with *M* degrees of mobility.

Analytically, the dependent coordinates φ_i of a mechanism can be written as a function of the *M* generalized coordinates that are describing its entire motion:

$$\varphi_i = \varphi_i\left(q_1, q_2, ..., q_M\right) \tag{1}$$

Derivation of equation (1) as a function of time, the expressions of the dependant velocities as well as the dependent accelerations can be written as:

$$\dot{\varphi}_i = \sum_{j=1}^{M} \frac{\partial \varphi_i}{\partial q_j} \cdot \dot{q}_j \tag{2}$$

$$\ddot{\varphi}_i = \sum_{j=1}^{M} \frac{\partial \varphi_i}{\partial q_j} \cdot \ddot{q}_j + \sum_{j=1}^{M} \sum_{k=1}^{M} \frac{\partial^2 \varphi_i}{\partial q_j \partial q_k} \cdot \dot{q}_j \dot{q}_k \tag{3}$$

where $\partial\varphi_i/\partial q_j$ et $\partial^2\varphi_i/\partial q_j^2$ are respectively the transmission functions of velocity and acceleration. These functions are also called influence coefficients in the literature. These transmission functions are essential for writing the equations of motion in a matrix formulation. Extracting the analytical expressions of these transmission functions can be mathematically cumbersome. This is why a numerical approach is recommended.

To illustrate the importance of using the kinematic models of the structomats, we start by writing down the equations of position of the dyad RRR of Figure 3b:

$$\begin{aligned} x_A + AB\cos\varphi_1 - BC\cos\varphi_2 - x_C = 0 \\ y_A + AB\sin\varphi_1 - BC\sin\varphi_2 - y_C = 0 \end{aligned} \tag{4}$$

which is a nonlinear system of equations that is solved with a iterative method such as the one of Newton-Raphson. In this way, before going forward with the velocity calculation, the angles φ_1 and φ_2 are calculated. Deriving the system of equations of position (4) as a function of time, we obtain the linear system of equations of velocity:

$$\begin{aligned} \dot{x}_A - AB\sin\varphi_1\cdot\dot{\varphi}_1 + BC\sin\varphi_2\cdot\dot{\varphi}_2 - \dot{x}_C = 0 \\ \dot{y}_A + AB\cos\varphi_1\cdot\dot{\varphi}_1 - BC\cos\varphi_2\cdot\dot{\varphi}_2 - \dot{y}_C = 0 \end{aligned} \tag{5}$$

By imposing successively in (5) that all the generalized velocities are zero except for $\dot{q}_j = 1$, the expression (2) of the dependent velocities are simplified to $\dot{\varphi}_1 = \partial\varphi_1/\partial q_j$ and $\dot{\varphi}_2 = \partial\varphi_2/\partial q_j$. The only resulting unknowns of the system of equations of velocity (5) are therefore these same transmission functions.

The transmission functions of acceleration are calculated from the system of linear equations of acceleration obtained by deriving the system (5) as a function of time and by replacing the dependent accelerations by their expression given in (3).

$$\begin{aligned} \ddot{x}_A - AB\sin\varphi_1\cdot\ddot{\varphi}_1 - AB\cos\varphi_1\cdot\dot{\varphi}_1^2 + BC\sin\varphi_2\cdot\ddot{\varphi}_2 + BC\cos\varphi_2\cdot\dot{\varphi}_2^2 - \ddot{x}_C = 0 \\ \ddot{y}_A + AB\cos\varphi_1\cdot\ddot{\varphi}_1 - AB\sin\varphi_1\cdot\dot{\varphi}_1^2 - BC\cos\varphi_2\cdot\ddot{\varphi}_2 + BC\sin\varphi_2\cdot\dot{\varphi}_2^2 - \ddot{y}_C = 0 \end{aligned} \tag{6}$$

Considering that all generalized accelerations are zero, the transmission functions of acceleration $\partial^2\varphi_i/\partial q_j^2$ are obtained first when the set of generalized velocities are zero except for $\dot{q}_j = 1$ and the mixed transmission functions of acceleration $\partial^2\varphi_i/\partial q_i\partial q_j$ are deduced afterwards when the pair $\dot{q}_i$ and $\dot{q}_j$ of generalized velocities have simultaneously a unit value when the others are zero. In summary, the transmission functions are calculated by performing the kinematic analysis of the mechanism for particular values of the generalized velocities. An example of kinematic analysis using the structomatic approach is given by *Mailloux et. al. (2017).*

This calculation of the transmission functions is relative to a geometrical approach carried out from the closing equations on the contour of the open kinematic chains that are the structomats. To make the bond between structomat and transmission functions, the dyad of Figure 3b has been used, but this approach can be applied to any type of structomats.

From a dynamic point of view, we are interested by the Lagrange's approach. In this way, the expression of the kinetic energy is needed to develop the equations of motion. Details on the development of equations of motion by using the following method can be found in the work of (*Manolescu and Dranga, 1975*) and (*Ene M., 2013*).

In this context, the kinematic parameters of the centers of gravity of each of the elements of the mechanism are included in the elementary transmission vector of position:

$$\mathbf{P}_i = \begin{bmatrix} x_{G_i} & y_{G_i} & \varphi_i \end{bmatrix}^T \tag{7}$$

where G_i is the center of gravity of the *i*-th element of the mechanism.

When the vector (7) is derived as a function of time, it yields to the components of the velocity vector at the center of gravity as well as the angular velocity of the element:

$$\mathbf{v}_i = \frac{d\mathbf{P}_i}{dt} = \begin{bmatrix} v_{ix} & v_{iy} & \omega_i \end{bmatrix}^T = \mathbf{V}_i\cdot\dot{\mathbf{q}} = \begin{bmatrix} \frac{\partial x_{G_i}}{\partial q_1} & \frac{\partial x_{G_i}}{\partial q_2} & \cdots & \frac{\partial x_{G_i}}{\partial q_M} \\ \frac{\partial y_{G_i}}{\partial q_1} & \frac{\partial y_{G_i}}{\partial q_2} & \cdots & \frac{\partial y_{G_i}}{\partial q_M} \\ \frac{\partial \varphi_i}{\partial q_1} & \frac{\partial \varphi_i}{\partial q_2} & \cdots & \frac{\partial \varphi_i}{\partial q_M} \end{bmatrix}\cdot\begin{bmatrix} \dot{q}_1 \\ \dot{q}_2 \\ \vdots \\ \dot{q}_M \end{bmatrix} \tag{8}$$

where $\mathbf{V}_i$ is the elementary transmission matrix of velocity which contains the transmission functions of velocity $\partial\varphi_i/\partial q_j$.

For a mechanism consisting of *m* moving elements, the transmission matrix of velocity takes the form:

$$\mathbf{V} = \begin{bmatrix} \mathbf{V}_1^T & \mathbf{V}_2^T & \cdots & \mathbf{V}_m^T \end{bmatrix}^T \tag{9}$$

so that the kinetic energy of the entire mechanism can be written in matrix form as follows:

$$T = \frac{1}{2}\dot{\mathbf{q}}^T \mathbf{V}^T \mathbf{M} \mathbf{V} \dot{\mathbf{q}} \tag{10}$$

where $\mathbf{M} = diag\left(\mathbf{M}_1 \quad \mathbf{M}_2 \quad \cdots \quad \mathbf{M}_m\right)$ is the matrix of inertia that incorporates mass m_i and the moment of inertia J_{G_i} of each elements :

$$\mathbf{M}_i = \begin{bmatrix} m_i & 0 & 0 \\ 0 & m_i & 0 \\ 0 & 0 & J_{G_i} \end{bmatrix} \tag{11}$$

The components of the acceleration at the center of gravity of the *i*-th element correspond to the second derivative of the elementary position vector (7) :

$$\mathbf{a}_i = \begin{bmatrix} a_{ix} & a_{iy} & \alpha_i \end{bmatrix}^T = \frac{d^2\mathbf{P}_i}{dt^2} = \mathbf{V}_i \cdot \ddot{\mathbf{q}} + \frac{d\mathbf{V}_i}{dt} \cdot \dot{\mathbf{q}} = \mathbf{V}_i \cdot \ddot{\mathbf{q}} + \mathbf{A}_i \cdot \mathbf{E} \cdot \dot{\mathbf{q}} \tag{12}$$

where the generalized acceleration vector is $\ddot{\mathbf{q}} = \begin{bmatrix} \ddot{q}_1 & \ddot{q}_2 & \cdots & \ddot{q}_M \end{bmatrix}^T$ and $\mathbf{A}_i = \begin{bmatrix} \mathbf{A}_i^1 & \mathbf{A}_i^2 & \cdots & \mathbf{A}_i^M \end{bmatrix}$ is the elementary transmission matrix of acceleration with :

$$\mathbf{A}_i^j = \begin{bmatrix} \dfrac{\partial^2 x_{G_i}}{\partial q_j \partial q_1} & \dfrac{\partial^2 x_{G_i}}{\partial q_j \partial q_2} & \cdots & \dfrac{\partial^2 x_{G_i}}{\partial q_j \partial q_M} \\ \dfrac{\partial^2 y_{G_i}}{\partial q_j \partial q_1} & \dfrac{\partial^2 y_{G_i}}{\partial q_j \partial q_2} & \cdots & \dfrac{\partial^2 y_{G_i}}{\partial q_j \partial q_M} \\ \dfrac{\partial^2 \varphi_i}{\partial q_j \partial q_1} & \dfrac{\partial^2 \varphi_i}{\partial q_j \partial q_2} & \cdots & \dfrac{\partial^2 \varphi_i}{\partial q_j \partial q_M} \end{bmatrix} \tag{13}$$

The matrix $\mathbf{E}$ encloses M times the vector of generalized velocities on its diagonal.

As for the transmission matrix of velocity (9), the transmission matrix of acceleration comprises all the elementary transmission matrices of acceleration such that:

$$\mathbf{A} = \begin{bmatrix} \mathbf{A}_1^T & \mathbf{A}_2^T & \cdots & \mathbf{A}_m^T \end{bmatrix}^T \tag{14}$$

The kinematic parameters of the center of gravity of each of the elements are obtained by using the kinematic model of the driving element following the kinematic analysis of each of the structomats. As it was the case for the transmission functions of velocity and acceleration, the partial derivatives included in the transmission matrices of velocity **V** and of acceleration **A** are obtained by imposing particular values on generalized velocities and accelerations. For instance, imposing only $\dot{q}_j = 1$ when the other generalized velocities are zero, the components v_{ix} and v_{iy} of the center of gravity of the *i*-th element correspond to the partial derivatives $\partial x_{G_i} / \partial q_j$ and $\partial y_{G_i} / \partial q_j$ respectively.

A peculiarity of the proposed procedure originate from the fact that the equations of motion are written in matrix form as follows:

$$\mathbf{V}^T \mathbf{M} \mathbf{V} \, \ddot{\mathbf{q}} + \mathbf{V}^T \mathbf{M} \mathbf{A} \mathbf{E} \, \dot{\mathbf{q}} = \mathbf{V}^T \mathbf{F} \tag{15}$$

obtained by inserting the expression (9) of the kinetic energy of the mechanism into the Lagrange equations:

$$\frac{d}{dt}\left(\frac{\partial T}{\partial \dot{q}_j}\right) - \frac{\partial T}{\partial q_j} = Q_j, \qquad j = 1, 2, \ldots, M \tag{16}$$

The vector $\mathbf{F} = \begin{bmatrix} \mathbf{F}_1^T & \mathbf{F}_2^T & \cdots & \mathbf{F}_m^T \end{bmatrix}$ is that of the generalized forces where the elementary force vector of the *i*-th element of the mechanism includes the external forces soliciting it such that:

$$\mathbf{F}_i = \begin{bmatrix} F_{ix} & F_{iy} & M_i \end{bmatrix}^T \tag{17}$$

where the weight of the element is considered as an external force and is included in the component F_{iy}.

The numerical method used for the integration of the equations of motion is the fourth order predictor-corrector method of Adams-Moulton coupled with the one of fourth order Runge-Kutta for the first approximations:

$$\begin{aligned} y_{n+1}^p &= y_n + \frac{h}{24}\left(55 f_n - 59 f_{n-1} + 37 f_{n-2} - 9 f_{n-3}\right) \\ y_{n+1} &= y_n + \frac{h}{24}\left(9 f_{n+1}^p + 19 f_n - 5 f_{n-1} + f_{n-2}\right) \end{aligned} \tag{18}$$

Adams-Moulton's multiple step method is prioritized because it has a precision comparable to that of Runge-Kutta but requires only two evaluations of the equations of motion at each instant compared to four for the latter. To be able to be implemented, the equations of motion (15) are transformed into a system of first-order differential equations in the form of $\dot{\mathbf{y}} = \mathbf{f}\left(t, \mathbf{q}, \dot{\mathbf{q}}\right)$. For each steps, it is necessary to update the values of the transmission matrices.

A special feature related to the inverse dynamics of a mechanism is that, by imposing a constant angular velocity $\dot{q}_1$, the angular displacement follows $q_1 = \left(q_1\right)_0 + \dot{q}_1 t$ whereas the angular acceleration $\ddot{q}_1$ is zero. Here, $\left(q_1\right)_0$ is an initial condition. In this case, it is the motor torque M_1 which corresponds to the unknown so that $M-1$ equations of motions of (15) are solved with the numerical method (18) before substituting the kinematic parameters obtained in the remaining equation of motion to deduce the resulting motor torque.

When all the kinematic parameters of the joints and the elements of a mechanism are known, the kinetostatic models of the structomats can be used to deduce the reactions at the joints. Those of the driving element R and the dyad RRR of the Constantinesco torque converter are shown in Fig. 4.

Then, the stresses are calculated in order to proceed to the selection of the engine(s), the material of the elements, the bearings, etc. Wear and fatigue analyses can also be conducted.

RESULTS

This article presents a preliminary study of the dynamic behaviour of the Constantinesco torque converter of Fig. 1. Thus, the constructive data used for the dynamic study are not those that advocate an optimal configuration, that is to say the one where the efficiency is maximized.

Table 1 groups together the lengths of each of the elements as well as their mass used for the simulations. Each of the elements are considered to be thin rods where the center of gravity is located at their midpoint. The initial conditions needed to solve nonlinear position equations are also included.

Table 1

Constructive data for the dynamic simulations of the CTC

Length (m)		Mass (kg)		Initial conditions (°)	
AB = 0.02	*EF* = 0.15	m_1 = 0.74	m_6 = 2.73	$(q_1)_0$ = 122	$(\varphi_5)_0$ = 315
BC = 0.45	*EM* = 0.60	m_2 = 16.,40	m_7 = 2.73	$(q_2)_0$ = 265	$(\varphi_6)_0$ = 214
CE = 0.45	*GH* = 0.30	m_{3_1} = 21.87	m_8 = 2.73	$(\varphi_1)_0$ = 350	
DE = 0.25	*HI* = 0.30	m_{3_2} = 12.00		$(\varphi_2)_0$ = 271	
DG = 0.30	*R* = 0.100	m_4 = 5.47		$(\varphi_3)_0$ = 37	
DI = 0.30		m_5 = 2.73		$(\varphi_4)_0$ = 133	

Even though this configuration of the torque converter is not labelled as optimal, the constructive data was not selected randomly. In fact, the simulations revealed some important considerations regarding its dynamic stability. These observations refer to the case where the angular velocity of the crank is constant and no resistive torque is imposed at the output shaft. First, to ensure the stability of the CTC, the simulations exhibited that the length of the crank *1* must be small compared to the length of the other elements. In this way, the motion of the joint *C* approaches a simple harmonic motion in a horizontal direction. It seems that the stability is increased when the joint *C* also moves on a horizontal line passing through the fixed points *A* and *H*. In this way, the joint *D* of the pendulum *3* moves mainly in a horizontal direction so that the elements *6* and *8* of the mechanical diode rotate continuously in an opposite direction. If, for any configuration, the joint *D* has a too large vertical amplitude, the branches of the mechanical diode will rotate in the same direction which may result in zero speed at the output shaft if they rotate against the allowed direction at the output. Also, if the angular speed of the motor is seen to be too large, the vertical motion of the joint *D* results in an unstable behaviour of the CTC. The vertical motion of the joint *D* can also be generated due to the location of the fixed point *F*. In fact, it is preferable to position the joint *F* on the abscissa axis so that the mean position of element 4 while it oscillates is near the vertical axis. These considerations may seem intuitive, but must be put in the foreground when sizing. When the CTC drives a machine to its output shaft, the resistance is simulated by a torque distributed to the elements 6 and 8 of the mechanical diode. In fact, if the direction of rotation allowed by the unidirectional bearings is the trigonometric direction, the elements 6 and 8 will feel this resistive torque only when they rotate in the same direction. Otherwise, these elements slide without friction around the output shaft. Mathematically, the implementation of the resistive torque in the vector of generalized forces (17) is written as follows:

$$T_6 = \begin{cases} -T_r, & \text{si } \dot{\varphi}_6 > 0 \\ 0, & \text{si } \varphi_6 < 0 \end{cases} \qquad T_8 = \begin{cases} -T_r, & \text{si } \dot{\varphi}_8 > 0 \\ 0, & \text{si } \varphi_8 < 0 \end{cases} \tag{19}$$

For a constant torque at the output shaft, the magnitude of the angular speed of the crank can result in undesirable behaviour. When this angular velocity is not chosen adequately, the motion of the pendulum *3* can bring the joint *E* of the element 4 to stabilize in the first quadrant, which occurs because of the fact that the amplitude of the vertical motion of the joint *D* is seen to be larger and larger. A study of the equilibrium points of the Constantinesco torque converter could be carried out in a later paper in order to obtain the conditions for which this undesirable, but still stable, position arises. This situation can also occur due to a sudden change of the resistive torque at the output shaft. In addition, as with any vibratory system, there are angular crank speeds for which the dynamic response is characterized by the phenomenon of beats. This is possible when the angular speed of the crank has a magnitude near the two natural frequencies of the CTC.

For the dynamic response of the torque converter be qualified as stable, several criteria are added to the observations mentioned previously. Among them, the variation of the kinematic parameters of all the elements must be periodic with a frequency in relation with the angular speed of the crank, in steady state, the average engine torque and the average angular speed at the output shaft are similar for each period and the variation of the motor torque as a function of the angular velocity at the output shaft follows a limit cycle.

As mentioned in the introduction, the Constantinesco torque converter has the capacity to adapt to a variation of the resistive torque at the output shaft. To observe this behaviour, the resistive torque profile of the left part of Fig. 5 is used.

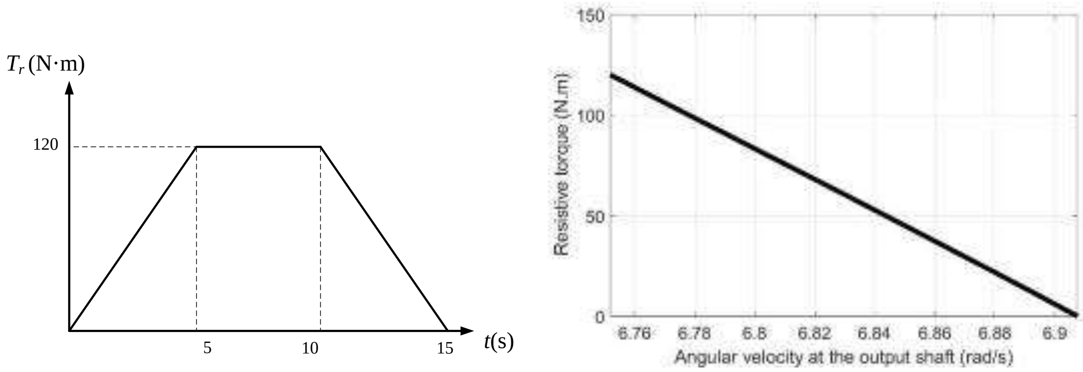


Fig. 5 – Left: Distribution of the resistive torque at the output shaft; Right: Relation between the output shaft velocity and the resistive torque

When the resistive torque progressively gains in magnitude, the CTC responds with a decrease in the angular speed at the output, an increase in the motor torque, but also an increase in the angular speed of the pendulum *3*; he fights against the resistance. As the resistive torque becomes constant, the magnitude of the angular velocity at the output shaft also tend to be constant. For the time interval when the resistive torque decreases, the motor torque and the angular speed of the pendulum *3* decreases and the angular velocity at the output shaft increases. This simulation demonstrates the expected behaviour: the CCC can adapt in the torque-speed space. Thus, for a constant angular speed of the crank, the magnitude of the engine torque moves according to the relation shown in the right side of Figure 5.

In the case where the output resistance is such that the Constantinesco torque converter cannot provide any angular velocity to the mechanical diode, the pendulum mainly accumulates the mechanical energy supplied by the motor until the moment the output can be put back in motion. This behaviour needs to be investigated in further simulations.

Simulations have also shown that the transmission ratio between the angular velocity at the output shaft and the crank is linear (left-hand side of Figure 6) and that the variation of the maximum motor torque in function of the magnitude of the crank angular speed follow a second-degree polynomial (right side of Figure 6).

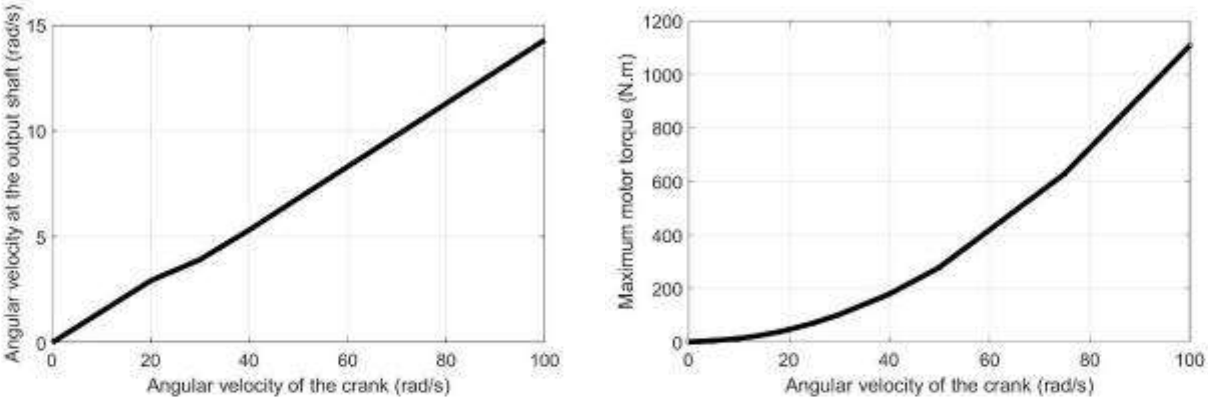


Fig. 6 – Left: Maximum speed at the output; Right: Maximum motor torque

The transmission ratio seems to be constant, and this, even if the magnitude of the resistive torque at the output shaft varies. To improve this transmission ratio, which is only approximately 0.14, a more in-depth study of the CTC synthesis (length and mass of elements) should be put forward. As for the maximum motor torque, in practice, the latter cannot vary without limit. In fact, the curve of Figure 6b can be used as a tool for the selection of an appropriate motor when the angular speed of the crank is fixed.

The modelling and simulation of the Constantinesco torque converter presented in this paper represent a first step in the study of the dynamic behaviour of this continuously variable transmission. Subsequent studies on stability conditions, resonance frequency calculation and performance optimization should be considered in order to introduce the CTC in practice.

CONCLUSIONS

A preliminary study on the dynamic behaviour of the Constantinesco torque converter was carried out. This mechanical transmission with variable ratios could be installed on agricultural tractors in order to lower the fuel consumption and reduce the number of mechanical components used to transmit power to the wheels.

The general aspects of the dynamic behaviour of this converter have been presented. Future developments on the CTC's potential in the agricultural field would aim at optimizing performance resulting in a synthesis that would maximize, for example, mechanical efficiency while investigating stability conditions. Then, a more in-depth comparative study could be carried out between the use of the Constantinesco torque converter and the mechanical transmissions presently used in practice.

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DECISION SUPPORT TOOL FOR FARMERS PRODUCING INDUSTRIAL TOMATOES IN ALGERIA
/
UN OUTIL D'AIDE A LA DECISION POUR LES PRODUCTEURS TOMATE INDUSTRIELLE EN ALGERIE

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ABSTRACT

The production of industrial tomatoes is now facing increasingly stringent requirements imposed by the Algerian market and the growing competition. Under these circumstances, and in order to remain competitive, the industrial tomato farmer must improve his production in terms of quantity and quality. It is therefore necessary for the farmer to follow a specific technical itinerary during the operation. In this study, we have developed a decision support tool, to partition optimally a certain amount of money kept on reserve to cover the costs of operation on the different activities of the technical itinerary, this partition allows to get as close as possible to an ideal technical itinerary in order to maximize the harvest, which implies maximizing profit.

RESUME

La production de la tomate industrielle se confronte aujourd'hui à des exigences toujours plus rigoureuses imposées par le marché algérien et l'accroissement de la concurrence. Afin de rester compétitive dans cette conjoncture, l'agriculteur de la tomate industrielle doit améliorer sa production en termes de quantité et de qualité. Pour faire, l'agriculteur doit suivre un itinéraire technique bien précis durant l'exploitation. Dans cette étude, nous avons développé un outil d'aide à la décision, pour partitionner d'une façon optimal une somme d'argent réservée pour couvrir les frais d'une exploitation sur les différentes activités de l'itinéraire technique, cette partition permet de se rapprocher le maximum possible d'un itinéraire technique idéal dans le but de maximiser la récolte ce qui implique une maximisation du profit.

INTRODUCTION

One of the main objectives of a farmer is to maximize his gain, which depends on several parameters including the production costs and the harvested quantity. In order to ensure a better yield, the farmer must follow a specific technical itinerary. Therefore, the respect of all the constraints of a typical technical itinerary leads sometimes to very high costs that exceed the financial ability of some farmers, these constraints them to ignore or to reduce certain stages of the technical route, in order to convene their financial. But, this ignorance involves considerable losses in terms of the harvested quantity and the profit consequently. That is why it is interesting to set up a decision support tool allowing to conceive a technical itinerary well adapted to the investment capacity.

For this end, a survey was conducted in the department of Guelma -East of Algeria-, where a huge industrial tomato production area is located. This regional concentration is due to the installation of the largest cannery tomato "CAB amor ben amor" with an annual production of 53.000 t of double tomato concentrate, which provides 50 percent of the national needs (*Bouzid A., Bedrani S., 2013*).

Our survey was conducted in close collaboration with the CAB and involved 150 farmers in the concerned area. The sampling was done randomly from a list of 300 farmers registered with the CAB for the delivery of industrial tomato. The research question which this paper will attempt to answer is: which ideal technical itinerary to adopte by farmers with adjusted financial capacity to get a better performance?

MATERIAL AND METHOD

- **Combinatorial optimization**

An optimization problem aims to find an instantiation of a set of variables in order to maximize (/minimize) a given criterion. When the values of the variables are discrete, this is called combinatorial optimization problems. Traditionally, solving a combinatorial optimization problem is related to the complexity theory which proposes a classification of problems depending on the efficiency of the resolution algorithm to find an optimal solution.

Others are inevitably difficult, such as the problem of commercial traveler who seeks a path among a combinatorial number of choices.

Next, a classic problem of combinatorial optimization is presented:

- **Knapsack problem**

The " knapsack problem " is a selection problem that consists in maximizing a quality criterion under a linear resource capacity constraint. It owes its name to the analogy that can be made with the problem that arises to the hiker at the time of filling his backpack: he must choose the objects to be carried so as to have a bag the most "useful" possible, while respecting its volume.

More formally, it can be described as follows: let's consider a set of n elements and an available resource in a limited supply b. For $j = 1$ to n, we denote by P_j the profit associated with the selection of the element j and we denote a_j the quantity of the resource required by the element j if it is selected. The coefficients p_j and a_j take positive values for all $j = 1$ to n. The backpack problem consists in choosing a subset of the n elements that maximizes the total expected profit, while respecting the quantity of available resources (*Nemhauser G.L., Wolsey L.A.,.1988*).

We associate to each element j a selection variable, x_j , binary, equal to 1 if j is selected, equal to 0 otherwise. The optimization problem can then be written as:

$$\begin{cases} \text{Max} \quad \sum_{j=1}^{n} p_j \, . x_j \\ \boldsymbol{s.c} \quad \sum_{j=1}^{n} a_j \, . x_j \leq b \\ \quad x_j \in \{0,1\}, \qquad \forall \, j = 1 \dots n \end{cases}$$

The problem of knapsack has been the subject of various works proposing accurate methods for its resolution. A detailed state of the art of these approaches is presented in (*Martello et. al., 2000*). The proposed algorithms fall into three main types of methods. Firstly, separation and evaluation algorithms type were proposed in the 1970's, making it possible to deal effectively with small instances. These performances were subsequently improved by adding supplementary constraints to reinforce the boundaries in the search tree. Secondly, algorithms based on the identification of a critical variable and an associated subset of variables, on which a truncated tree search is applied, have made it possible, from the 1980's, to increase the number of the variables within the optimization problem - (up to n = 100000). Thirdly, effective dynamic programming algorithms have been proposed. In particular, in (*Martello S., 1999*), dynamic programming is combined with the identification of a critical variable and the use of terminal building techniques.

- **Accurate resolution approaches for combinatorial problems**

In order to explore all the configurations, it is advisable to break it down into several small subsets. For that, a tree structure seems to be the appropriate solution where the root represents the set of all the configurations to explore, and the nodes correspond to subsets of smaller and smaller configurations as one goes down in the search tree. This research strategy is based on the principle of separation and evaluation (Branch and Bound) (*Belhoul L., 2014*).

It is to solve the root of the tree the linear relaxation of the combinatorial problem through the simplex algorithm (technique used in most optimization tools: CPLEX, Gurobi, CLP, etc.

- **Modelization**

Modeling this problem involves the following steps:

A. Determine the ideal technical route:

To determine the ideal technical route that a farmer must follow or get closer to account his financial capacity, we made use of a study by 'Technical Institute of Vegetable and Industrial Cultures' in Algeria. Where they presented a technical manual valued all stages of an ideal technical itinerary (*Valuation Datasheets for vegetable and industrial crops*).

B. Determine the value of the activities of the best technical itinerary

A rational farmer will invest in the activities that generate the most added value, the ranking of the latter will be done in order of importance in terms of costs and gain. For our survey and based on farmers' responses on the activities in which they can invest the most if they have additional capital are: planting density, irrigation system, fertilization and phytosanitary treatments.

Huat (2006) confirms that significant differences between farmers' practices in the production of industrial tomatoes in Senegal are observed in terms of planting density, frequency of irrigation and treatments.

➢ **Hybrid plants**

Farmers surveyed who do not source their seedlings from the CAB but who produce their seedlings themselves in an artisanal way from traditional and hybrid seed varieties. These farmers all own small areas cultivated with tomatoes (less than 5 ha). The self production of plants aims to reduce their production costs, the self produced plant returning to them to 0.75 DA or 0.0054 euro, while the price of plant purchased from the CAB returns to 2.5da or 0.018 euro. They differ from their predecessors in that they have larger tomato areas.

When comparing yields, farmers buying their plants from the CAB have yields above 50 tonnes per hectare (on average 65 t/ha) while those who produce their plants themselves do not achieve this performance but only 45 t/ha on average (*Bouzid A., Bedrani S., 2013; Benmehaia M.A., Brabez F.; Benmehaia M.A., 2017)* .

➢ **Irrigation spraying vs drip irrigation**

From the survey carried out among farmers, those who use drip irrigation and hybrid seed varieties achieve yields in excess of 100 T/h. While those who use spraying their yields do not exceed 65T/ha

➢ **Fertilizers and phytosanitary treatments**

Some conditions force farmers to contribute; it is in case of prolonged rain making the ground impenetrable over a long period after planting (almost a month). The start of plant growth is best when it finds nutrients.

Several pathogens attack industrial tomatoes such as aphids, heliothis, mites in hot weather and fungal diseases. Phytosanitary treatments must be applied in a preventive manner to preserve the yield (*www.cawjijel.org*).

The following Table shows the importance of all the activities of the technical itinerary which represents the value of each activity for our resolution approach:

Operations	degree of importance
- Seed (hybrid)	**10**
- Sowing + Treatment + Maintenance	**6**
- Mold	**5**
Manure spreading NPK	**6**
	6
- plowing	**5**
- disking	**5**
- Shelving	**5**
- laying and installation Irrigation	**7**
- Pre-irrigation	**6**
- Planting	**10**
- Replacement missing	**5**
- Irrigation + Fertilization	**10**
- Weeding	**6**
- Treatments	**6**
- Maintenance fertilizer	**5**

- **Determining the best technical route for any farmer**

In this model we opted for the model of *the fractional knapsack problem* with additional constraints and a relaxation of decision variables such as:

- **The parameters of the model:**

B : the maximum spending capacity of the farmers.

c_i : the cost of the activity *i.*

v_i : the value of the activity *i.*

d_i : minimal expenditure on the activity *i.*

- **The decision variables**

x_i : a proportion that varies between 0 and 1.

- **The constraints of the model**

-

I. The total expenses must not exceed the maximum capacity of the farmer:

$$\sum_{i=1}^{n} x_i \, .c_i \leq B \quad (1)$$

II. The expenditure on an activity must not be less than a certain constant to ensure the minimum of this activity:

$$x_i \, .c_i \geq d_i, \quad i = 1 \ldots n \,(activities)$$

- **The objective function**

The goal is to follow the best technical route while ensuring the most important activities first.

$$\max(z) = \sum_{i=1}^{n} x_i \, .v_i \quad (2)$$

- **The mathematical model**

$$\begin{cases} \max(z) = \sum_{i=1}^{n} x_i \, .v_i \\ \quad\quad\quad\quad \boldsymbol{s.c} \\ \sum_{i=1}^{n} x_i \, .c_i \leq B \\ x_i \, .c_i \geq d_i, \quad \forall\, i = 1 \ldots n \,(activities) \\ x_i \in [0,1], \quad \forall\, i = 1 \ldots n \end{cases}$$

- **Resolution**

The resolution of this problem goes through two stages, the first, consists of solving the mathematical model by the greedy algorithm, and the second part will be dedicated to the interpretation of the obtained results.

1- Resolution of the mathematical model

- **Greedy algorithm**

A greedy algorithm is an algorithm that follows the problem solving heuristic of making the locally optimal choice at each stage with the hope of finding a global optimum. In many problems, a greedy strategy does not usually produce an optimal solution, but nonetheless a greedy heuristic may yield locally optimal solutions that approximate a globally optimal solution in a reasonable amount of time.

Step $i \; (i \leq n)$ is nothing other than the setting of the value of the variable x_i, knowing that the variables $x_1, \ldots, x_{i-1}$ have been fixed before (*Elhavedh O.A.M., 2009; Tison S., 2010*).

- **Adaptation of the greedy algorithm for our problem**

We proposed a resolution algorithm in order to satisfy the constraints of the mathematical program and to reach the desired objective, the algorithm proceeds as follows:

- Allocate a minimum amount for each activity of the technical itinerary
- Sort the activities in descending order of their importance
- Ensure important tasks first

More precisely the algorithm as follows:

input: B, c_i, v_i, d_i $with\ i = 1..n$
Output: S a solution

$B = B - \sum_{i=1}^{n} d_i$
Sort the activities in descending order of the report v_i/c_i
Initialize S: $S(i) = d_i, for\ all\ i = 1 \dots n$
$i = 1$
while $(B > 0)$ and $(i \leq n)$
Do
If $B \geq c_i$
$S(i) = 1$
Else
$S(i) = S(i) + B/c_i$
$B = B - c_i$
$i++$
End

We implemented our mathematical model on Cplex. And, from the data of any farmer, the algorithm provides a vector of the costs that a farmer can assume for each activity in order to get as close as possible to the best technical route to be followed during the operation to improve the yield and maximize profit

2- Interpretation of the results

This part consists of interpreting the results obtained by the algorithm of resolution to give a practical sense to the mathematical solution. We consider that an activity can have two ways of doing according to the budget allocated for the latter, so from the cost vector obtained by our algorithm, we choose how to ensure each activity according to the budget allocated by the algorithm, the following Table presents the minimum and the maximum cost for all the activities of the technical.

Operations	min	max
- Seed (hybrid)	4500	27000
- Sowing + Treatment + Maintenance	3000	4800
- Mold	0	8400
Manure spreading NPK	17300	34600
	36000	48000
- plowing	4600	4600
- disking	2300	2300
- Shelving	6000	6000
- laying and installation Irrigation	6000	18000
- Pre-irrigation	600	12000
- Planting	15000	30000
- Replacement missing	3000	5000
- Irrigation + Fertilization	19600	30000
- Weeding	4100	6000
- Treatments	30400	50000
- Maintenance fertilizer	0	12600

RESULTS

From the database of farmers of the industrial tomato of the Guelma willaya in Algeria (*Bouzid A., Bedrani S.*), we were able to distinguish four categories of farmer according to their financial capacity. The results obtained by the Cplex program for different categories of farmers are shown in the Table below:

	Category 1	Category 2	Category 3	Category 4
Financial capacity	**17000 da**	**210000 da**	**260000 da**	**300000 da**
- Seed (hybrid)	4500	12000	27000	27000
- Sowing + Treatment + Maintenance	4800	4800	4800	4800
- Mold	8400	8400	8400	8400
Manure spreading NPK	17300	17300	26900	34600
	36000	36000	36000	48000
- plowing	4600	4600	4600	4600
- disking	2300	2300	2300	2300
- Shelving	6000	6000	6000	6000
- laying and installation Irrigation	6000	18000	18000	18000
- Pre-irrigation	4100	12000	12000	12000
- Planting	15000	15000	30000	30000
- Replacement missing	5000	5000	5000	5000
- Irrigation + Fertilization	19600	19600	30000	30000
- Weeding	6000	6000	6000	6000
- Treatments	30400	30400	30400	50000
- Maintenance fertilizer	0	12600	12600	12600
Total	**170000**	**210000**	**260000**	**299300**

CONCLUSIONS

In this work, we have developed a decision support tool, for the optimal partition of an amount of money kept on reserve to cover the costs of an industrial tomato farm on the various activities of the technical itinerary, to get as close as possible to an ideal technical route, and thus maximizing the harvest and profit from this farm. For the modeling of this problem, the fractional backpack model was used with additional constraints. In this problem, the greedy algorithm provides in most cases an optimal solution; this justifies the use of this algorithm for the resolution of our problem. We implemented our mathematical model on Cplex, then we applied this approach on a set of farmers.

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RESEARCHES ON THE REALIZATION OF A TECHNOLOGY TO OBTAIN GRANULAR ORGANO-MINERAL FERTILIZERS BASED ON PEAT
/
CERCETĂRI PRIVIND REALIZAREA UNEI TEHNOLOGII DE OBȚINERE A ÎNGRĂȘĂMINTELOR ORGANO-MINERALE GRANULARE PE BAZĂ DE TURBĂ

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ABSTRACT

Lately, researches in fertilizer fields focuses on reducing the negative impact of using them on the environment and consumers, and finding new, less costly fertilizer sources. The paper presents the results of the research regarding the realization of a technology for obtaining of peat based granular organo-mineral fertilizers. In order to improve the fertilizer role of the peat, the production formula used contains urea as a source of nitrogen, monoammonium phosphate (MAP) as a source of phosphorus and nitrogen, molasses from sugar beet as a source of organic nitrogen, potassium and vitamins, protein hydrolyzate, as a source of proteins, polypeptides and amino acids and other microelements.

REZUMAT

In ultimul timp, cercetările în domeniul fertilizantilor se concentrează asupra reducerii impactului negativ al utilizării acestora asupra mediului si consumatorilor și asupra găsirii de surse de îngrășăminte noi, mai puțin costisitoare. In lucrare se prezintă rezultatele cercetarilor privind realizarea unei tehnologii de obtinere a ingrasamintelor organo-minerale granulare pe baza de turba. Pentru imbunatatirea rolului fertilizant al turbei, reteta de fabricatie utilizata contine uree, ca sursa de azot, monoamoniufosfat (MAP), ca sursa de fosfor si azot, melasa din sfecla de zahar, ca sursa de azot organic, potasiu si vitamine, hidrolizat proteic, ca sursa de proteine si alte microelemente.

INTRODUCTION

Organic agriculture is practiced on approx. 1% of the global agricultural area, and its importance continues to grow, being perceived by many as having less negative environmental effects than conventional agriculture (*Lorenz et al, 2016*).

As a result, fertilizer research has recently focused on reducing the negative impact of its use on the environment and consumers and finding new, less costly fertilizer sources. It is aimed at making more concentrated organic fertilizers, easier to apply and more stable during plant growing periods.

Organic soil fertilization reduces or even eliminates the need for agrochemicals and mineral fertilizers, of which extensive use leads to economic and environmental imbalances. The combined application of organo-mineral fertilizers has proven to be a better approach to increase and sustaine soil fertility and yields than applying only chemical or organic fertilizers (*Aguilera et al, 2012*).

The requirements introduced by the environmental protection legislation (*Ministry of Environment and Water Management, 2005*) and the provision of sustainable agriculture along with modern fertilization technologies have led to an increase in the diversity of organo-mineral fertilizers.

According to the European Parliament's regulation on fertilizer products bearing the CE marking, an organo-mineral fertilizer is composed of one or more inorganic fertilizers and a material containing organic carbon and nutrients of exclusively biological origin (*CE no. 1069/2009 and CE no. 1107/2009, Annex 1, 2016).*

Organo-mineral fertilizers are the result of an optimal blend of organic and mineral substances, depending on plant nutritional needs, which will lead to products that release nutrients (nitrogen, phosphorus, potassium, magnesium and other microelements) which, besides supplying deficient nutrients to plants, also have the qualities of improving soil attributes *(Blaga et al, 2008).*

Due to its advantages, the use of peat, as the basis and source of organic matter for fertilizers, has gained increasing popularity lately.

Organo-mineral fertilizers offer several advantages over organic or mineral ones taken separately, namely: they improve the plant-mineral interaction by reducing phosphorus absorption, increase the activity of rooting young plants, influence the oxidation-reduction reaction in soil. (*Parent. L., et al, 2003*). At the same time, these products together with the methods of fertilization constitute and represent modern technologies with significant quantitative, qualitative effects, with positive economic and environmental impact.

Considering the importance and role of organo-mineral fertilizers for the growth and support of soil fertility and crop yields, this paper presents the results of the research on the development of a technology for obtaining peat-based granular organo-mineral fertilizers, which involves the combination of fertilizers (N, P, K) with biostimulators such as humic acids, fulvic acids, phytohormones, etc. to ensure both the efficiency of the use of macroelements and the quantitative and qualitative increase in agricultural production.

MATERIAL AND METHOD

In order for the product to meet the requirements of European regulations in the field *(EC 1107/2009, Annex 1, 2016)* and to carry out an efficient fertilization of the vegetable crops for which it is intended, it is proposed that the components added to the peat provide the following nutrients listed in Table 1.

Table 1

Value ranges of macroelements and microelements in organo-mineral fertilizer composition

Fertilizing elements		Minimum values, %	Maximum values, %
Macronutrients	Nitrogen, N	14,0	18,0
	Phosphorus, in the form of phosphorus pentoxide, P_2O_5	22,0	26,0
	Magnesium, as Magnesium Oxide, MgO	1,0	3,0
	Sulfur, S	0,8	2,4
Micronutrients	Zinc, Zn	0,5	1,5
	Copper, Cu	0,4	1,2
	Iron, Fe	0,6	1,8
	Manganese, Mn	1,1	3,3
	Cobalt, Co	0,3	0,9

In order to improve the role of peat fertilizer, which is the basic raw material and supply with fertilizing macronutrients and micronutrients, the proposed formula will contain urea as a source of nitrogen, monoammonium phosphate (MAP) as a source of phosphorus and nitrogen, molasses sugar beet, as a source of organic nitrogen, potassium and vitamins, proteic hydrolyzate, as a source of protein, cobalt sulfate, zinc sulfate, copper sulfate, iron sulphate and manganese sulphate.

Urea also contributes to the release of humic and fulvic acids from the peat and, together with molasses, serve as binders to ensure the cohesion of the recipe components.

To determine the proportion of ingredients that bring in the formula the nutrients within the mentioned limits proceeded as follows:

Since the Monoammonium phosphate (MAP) containe 62% phosphorus pentoxide, P_2O_5 and 12% nitrogen, N, therefore, to ensure the minimum and respectively maximum phosphorus demand, the following quantities of MAP are required:

$$MAP_{min} = 22/0,62 = 35,50 \text{ kg}; \; MAP_{max} = 26/0,62 = 41,94 \text{ kg};$$

Nitrogen results from MAP and Urea. Since MAP contains 12% nitrogen, it results that from the amount of MAP needed for P2O5 are obtained:

at minimum value: 35,5 x 0,12= 4,26 kg nitrogen and at maximum value: 41,94 x 0,12= 5,04 kg nitrogen

From urea, we have the difference in nitrogen needed. Since urea has 46% nitrogen, it results:

$$Urea_{min} = (14-4,26)/0,46 = 21,17 \text{ kg}; \; Urea_{max} = (18-5,04)/0,46 = 28,17 \text{ kg};$$

Magnesium sulphate contains 33.3% Magnesium oxide, MgO and 26.7% Sulfur, S. It follows that the following quantities of Magnesium Sulphate are required to ensure the required minimum and maximum Magnesium Oxide:

$MgSO_{4min}$= 1/0,333 = 3 kg ; $MgSO_{4max}$ = 3/0,333 = 9 kg;

These amounts of magnesium sulphate, $MgSO_4$ provide a percentage of sulfur, S:

S_{min}= 3 x 0,267 = 0,8 % ; S_{max}= 9 x 0,267 = 2,4 % ;

Zinc sulphate contains 40% Zinc, Zn. To ensure the minimum and maximum zinc requirements, the following quantities of zinc sulphate are required:

ZnSO4min= 0,5/0,4 = 1,25 kg ; ZnSO4max = 1,5/0,4 = 3,75 kg;

Similarly, depending on the percentage content of microelements in the sulphates, the minimum and maximum quantities of sulphates are set.

Copper sulphate

$CuSO_{4min}$= 0,4/0,4 = 1,0 kg ; $CuSO_{4max}$ = 1,2/0,4 = 3,0 kg;

Iron sulphate

$FeSO_{4min}$= 0,6/0,37 = 1,62 kg ; $FeSO_{4max}$ = 1,8/0,37 = 4,86 kg;

Manganese sulphate

$MnSO_{4min}$= 1,1/0,36 = 3,05 kg ; $MnSO_{4max}$ = 3,3/0,36 = 9,15 kg;

Cobalt sulphate

$CoSO_{4min}$= 0,3/0,36 = 0,83 kg ; $CoSO_{4max}$ = 0,9/0,36 = 2,50 kg;

It results the total mass of the components without peat:

M_{min}=67,95 kg ; M_{max}=102,37 kg;

Taking into account the composition of the formula and the mass of the other ingredients making up, for the use of a a percentage (25-30%) of dry peat results in a quantity of dry peat (MTU) of:

MTU_{min}=0,3/0,7 x M_{min}= 29,12 kg ; MTU_{max}=0,30/0,7 x M_{max}= 43,87 kg;

RESULTS

The calculations made with the purpose of providing fertilized macro and microelements have led to the establishment of the formula components underlying the development of the technology for obtaining peat-based granular organo-mineral fertilizers. Thus, the percentage of components is between the following limits: (25-30)% peat with humidity of 30%, (30-40)% monoammonium phosphate MAP, (2.5-7.5)% Magnesium sulphate MgSO4, (20-25)% Urea, (2-10)% Molasses containing 0.5-2.1% nitrogen and 2-5% potassium, (2-5)% Protein hydrolyzate containing 10-15% amino acids, (1,2-3,6)% zinc sulphate ZnSO4, (0.7-2.1)% CuSO4, (1.5-4.5)% FeSO4, (3-9)% manganese sulfate MnSO4, (0.9-2)% cobalt sulfate CoSO4.

Figure 1 shows the diagram of technological process to obtain granular organo-mineral fertilizers based on peat.

The technological process comprises the following phases:

Preparation of raw materials consists of grouping and mixing them into categories:

- mixture of solid components, consisting of dry peat at 30% moisture, monoammonium phosphate (MAP) and starch. The mixture thus formed was milled in the hammer mill, using a 3.5 mm sieve, at a rotor speed of 3000 rpm, thus rendering the texture and granulation corresponding to the feed of the extruder through the pulverulent dispenser.

- mixture of liquid components consisting of the protein hydrolyzate in which urea, molasses and microelements in the form of sulphates are dissolved.

Supplying the extruder with the two categories of mixtures is done through the two feed points, dosing the mixture of solid components in the extruder funnel with a two screw feeder and dosing the liquid mixture with a peristaltic pump.

The supplying is continuous, any supplying interruption resulting in variations in the flow and properties of the finished product. Supplying rates are set so as to meet the proportions according to the formula that ensure the needed nutrient in the granules,to be possible to process the blends in the extruder and the product obtained has the characteristics necessary for it to be manipulated and applied in the field. The ratio of the two feed rates determines among others the amount of binder in the final product, with great influence on its quality.

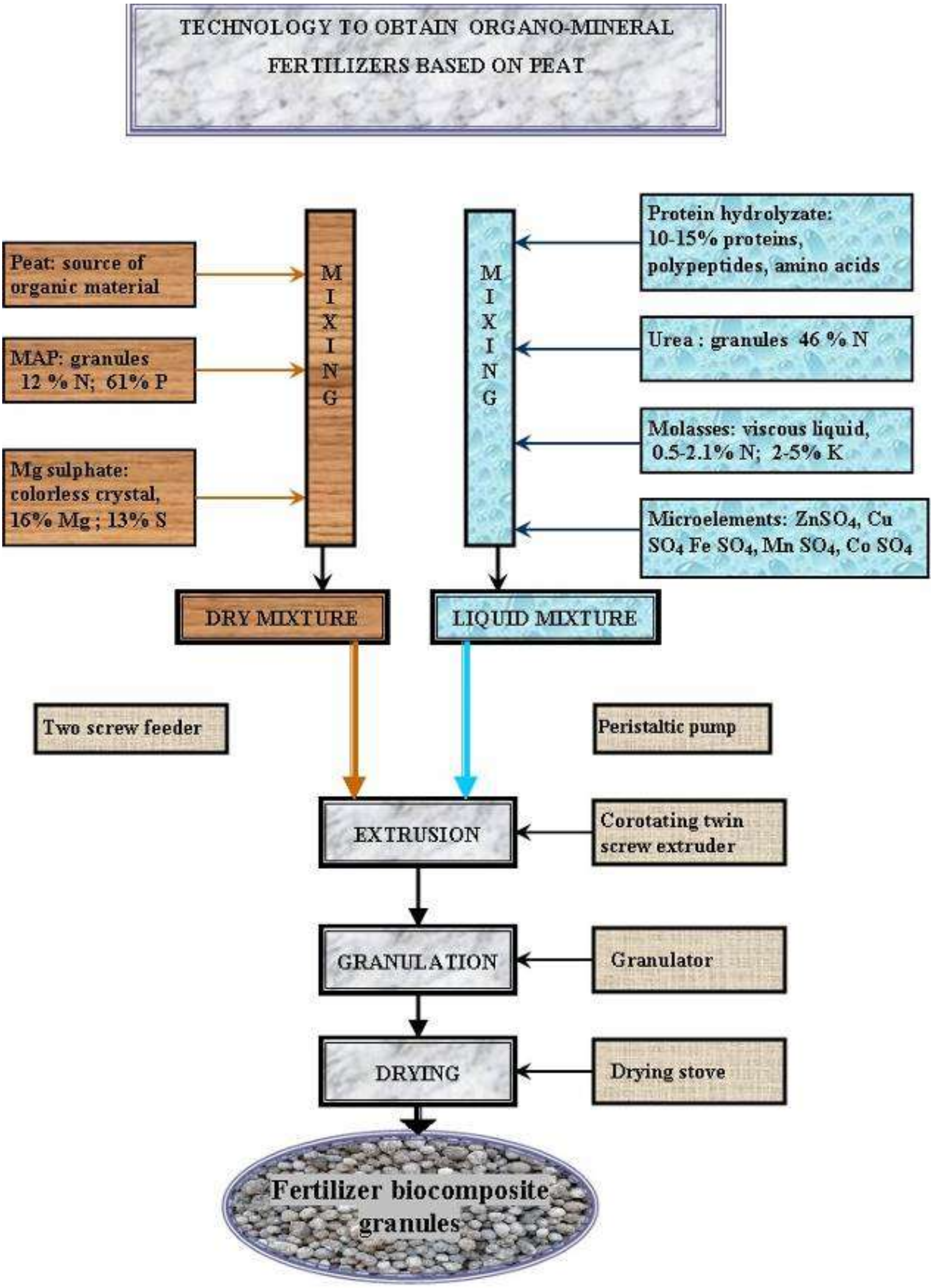

Fig. 1 – Diagram of technological process for obtaining granular organo-mineral fertilizers based on peat

Extrusion. Mixtures dosed through the two feed points of the extruder, Figure 2, are taken up by the two corotative screws which homogenize and process them by shearing and heating while being moved to the die. On the other hand, due to the rotation of the screws, there is an increase in pressure to the die.

The temperature of the cylinders is preset and maintained at the values set by the cylinder heating and cooling system. The speed of the screws is adjustable, allowing the material to pass through the extruder. When passing through the die, the material must have the temperature and pressure required to obtain a finished quality product.

Fig. 2 – Extrusion plant type „ZK 25", production Collin

In order to preserve the properties of the components in the formula, especially of the peat, the temperature and pressure regime in the extruder must be moderate. Table 2 shows the parameters of the extrusion process.

Table 2

Parameter	U.M	Value					
Temperature in the area	^{0}C	Z1	Z2	Z3	Z4	Z5	Z6
		30	30	40	60	80	100
Flow rate of solid components	Kg/h	3,3					
Flow rate of liquid components	Kg/h	2,2					
Solid/liquid feed flow ratio	-	1,5					
Extrusion pressure	barr	60					

Granulation has the purpose of ensuring the flow properties of the finished product and is carried out in a hammer mill whose 220 mm diameter rotor is driven at 1000 rpm with a single-phase electric motor having the power of 500 W.

Drying aims to reduce the humidity of the granules and improve their mechanical properties and is carried out in an air recirculation oven and placing the granules on a sieve in a single layer, with the possibility of bringing the hot air to the entire surface of the granules. The drying temperature is 40-60 ^{o}C.

CONCLUSIONS

The application of organo-mineral fertilizers is a better approach to sustain soil fertility and crop yield than applying only chemical or organic fertilizers. Due to the advantages it presents, peat is a basis and source of organic matter for fertilizing biocomposites.

The manufacturing formula that underpinned the development of the technology to obtain granular organo-mineral fertilizers based on peat aims to achieve an optimal blend of organic and mineral substances, depending on the nutrition needs of plants. It contains urea, as a source of nitrogen, monoammonium phosphate (MAP) as a source of phosphorus and nitrogen, sugar beet molasses as a source of organic nitrogen, potassium and vitamins, protein hydrolyzate as a source of protein, cobalt sulphate, zinc sulphate, copper sulphate, iron sulphate and manganese sulphate.

Obtaining the organo-mineral fertilizers according to the developed technology is achievable by thermo-plastic extrusion and granulation.

ACKNOWLEDGEMENT

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STUDY AND RESEARCH ON ENERGY CONSUMPTION FOR CEREAL GRAIN STRAINS CUTTING
/
STUDII ȘI CERCETĂRI PRIVIND CONSUMUL DE ENERGIE LA TĂIEREA TULPINILOR UNOR CEREALE PĂIOASE

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Keywords: *strains, cutting force, mechanical work*

ABSTRACT

The paper presents the results of the researches on mechanical work for cutting wheat, barley, oats and triticale strains using combine harvesters' finger blade cutting units.

In order to obtain these experimental data it has been used a home design laboratory stand, which allows strains cutting at three speeds, two strains positions and three knife blade sharpening angles.

Experimental tests have been carried out for cutting units of the most known combine harvesters (SEMA, CLASS, FENDT, JOHN DEERE) at a technological harvesting humidity.

REZUMAT

Lucrarea prezintă rezultatele cercetărilor cu privire la lucrul mecanic de tăiere a tulpinilor de grâu, orz, ovăz și triticale, în cazul aparatelor de tăiere de tip cuțit-deget de la combinele de recoltat.

Pentru obținerea datelor experimentale s-a folosit un stand de laborator de concepție proprie care permite tăierea tulpinilor la trei viteze ale cuțitului, două poziții ale tulpinii și trei unghiuri de ascuțire a lamelor cuțitului.

Determinările experimentale s-au făcut pentru aparatele de tăiere ale principalelor combine de recoltat (SEMA, CLASS, FENDT, JOHN DEERE), la umiditatea tehnologică de recoltare.

INTRODUCTION

Cutting of plant strains is a basic operation in harvesting technology of cereal grains, being influenced by their physical and mechanical properties, respectively by the constructive features and kinematic status of the cutting units. Reaping machines are designed for cereal grains harvesting, with the possibility to be adapted also to other crops harvesting.

The process of cutting plant strains is complex and requires more or less energy, depending on the factors it influences. As a structure, plant strains are considered viscoelastic materials, dependent on their degree of ripeness and humidity (*Dange et al. 2011; Esehaghbeygiat et. al. 2009*). In case of cereal grains, strain cutting will be done on the node or between nodes, the necessary energy being bigger when cutting is done on the node (*Alizadeh et. al. 2011*).

For grain cereals harvesters, finger blade cutting units are exclusively used, with an alternative rectilinear motion. Constructively, they are of a normal cut type, where the blade pitch is equal to the fingers pitch, and the cutting speed does not exceed 3 m/s. As a result of combining the blade motion with the machine movement, during cutting, plants are tilted in both longitudinal and transverse direction, so that plants cutting will be of tilted type.

Finger blade cutting units from the cereal grains harvesters work in different conditions, depending on the crop. Thus, plants density ranges from 200 to 800 plants/m^2, the stalks have a thickness between 1.5 and 4.5 mm, humidity between 10 and 20%, which causes a variation of the force required to cut the strains (*Bochat A, 2009*).

When designing finger blade cutting units, experimental data are used, both for constructive elements sizing and necessary power needed to drive them. The literature recommends values between 0.58 and 1.18 kW/m, in case of cereal grains harvesting, and from 1.10 to 1.84 kW/m, in case of fodder plants.

In order to reduce energy consumption when cutting plant strains, it is necessary to know how constructive elements and kinematic mode of the knives influence the cutting operation.

MATERIAL AND METHOD

For the study of the mechanical work required to cut the strains in some cereal grains, constructional elements of the cutting units from SEMA, CLASS, FENDT and JOHN DEERE harvesters were used. The constructional parameters of the knives are shown in Figure 1 and Table 1.

For the knives equipping SEMA harvesters, three sharpening angles were made: standard at 20º, 15º and 10º.

Wheat, barley, oat and triticale crop strains have been studied, at the time of harvesting, being measured the strain diameter and their humidity.

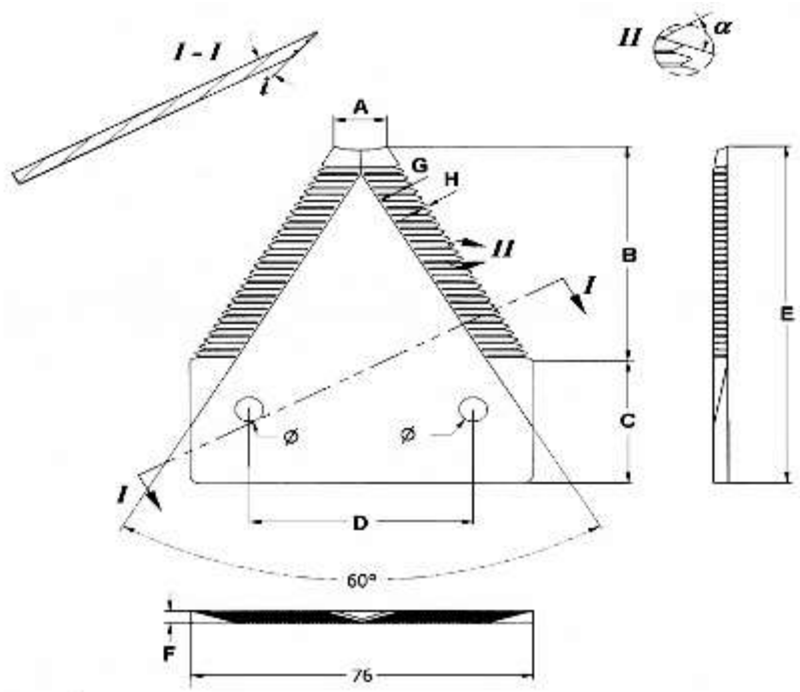

Fig. 1 - Geometrical elements of the knife

The cutting operation of the strains was carried out for two positions of the knife towards the strain: cutting by shearing (the knife moves perpendicularly - at 90^0 - towards the longitudinal axis of the strain) and tilted cutting (the knife moves in a tilted direction at 45^0 towards the longitudinal axis of the strain.

The knife speed is an important element as regards cutting process. It is known the fact that this is variable because actuators, which transform the rotation movement of the motor shaft in alternative rectilinear motion, cause a velocity of the sinusoidal knife.

For the experimental tests a laboratory stand has been used, whose schematic diagram is shown in Figure 2.

Table 1

Values of the geometrical elements of the knife

Type of knife	A mm	B mm	C mm	D mm	E mm	F mm	G mm	H mm	*I* ⁰	α ⁰
SEMA	7	58	17	50	75	2.3	5	1.45	20	55
CLASS	16	51	33	51	84	2.44	9	1.83	19	31
FENDT	15	50	30	51	80	2.61	7.5	1.75	19	38
JOHN DEERE	13	50	31	51	81	2.67	5.5	1.4	19	46

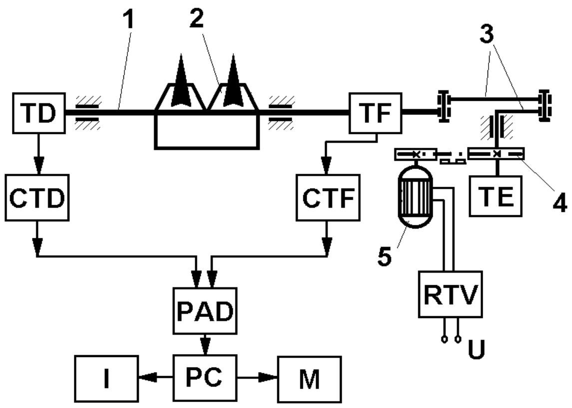

Fig. 2 - Stand's schematic diagram

The stand is made up of: TD – displacement transducer; CTD – displacement transducer converter; TF – force cell; CTF – force cell converter; PAD – data capture board; PC – computer; I – printer; M – monitor; TE – electronic revolution counter/meter; RTV – variable motor controller; U – 24 V supply voltage from the power supply – S; 1 – steering guide rod ; 2 – cutting unit; 3 – crank-rod mechanism; 4 – worm gear drive; 5 – direct current electric motor. The force cell type CTS63200KC-250 is connected to a converter type TA4D/2 and through this to a data capture board type NI USB-6008.

The displacement transducer type TLDT 50 is connected to a converter identical with the above one and through this to the data capture board. The signals taken by those two transducers are converted and processed, the results being displayed on a computer by means of specialized software Lookout HMI-SCADA (*Nuțu and Cârlescu, 2017*).

RESULTS

The experimental results obtained following measurements performed on laboratory stand are listed in Tables 2 - 6. The Figures represent the maximum values of the cutting force as an average of at least six tests, for strains with the same diameter and humidity.

In Table 2 are presented the experimental results obtained by measuring the cutting force and the mechanical work necessary to cut wheat strains with a diameter of 4.51 mm and a humidity of 11.7 %. Testes have been carried out for sharpening angles of knife blades of 20^0, 15^0 and 10^0, respectively for knife speeds of 0.2 m/s, 1 m/s and 2 m/s.

Table 2

Variation of mechanical work in cutting wheat strains with SEMA model knives

Sharpening angle (^{0})	Strain diameter (mm)	Strain humidity (%)	Knife position against strain (^{0})	Cutting force (N)	Cutting mechanical work (Nm)
Knife speed = 0.2 m/s					
20	4.51	11.7	90	29.55	0.328
			45	21.39	0.283
15	4.51	11.7	90	24.25	0.405
			45	19.35	0.254
10	4.51	11.7	90	18.35	0.313
			45	16.32	0.259
Knife speed = 1 m/s					
20	4.51	11.7	90	23.38	0.259
			45	15.44	0.208
15	4.51	11.7	90	20.16	0.337
			45	15.34	0.202
10	4.51	11.7	90	12.38	0.211
			45	11.44	0.181
Knife speed = 2 m/s					
20	4.51	11.7	90	14.44	0.160
			45	7.04	0.092
15	4.51	11.7	90	11.04	0.184
			45	5.22	0.068
10	4.51	11.7	90	3.59	0.061
			45	3.20	0.500

As expected, the cutting force by shearing wheat strains decreases from 29.55 N, corresponding to a cutting speed of 0.2 m/s and a sharpening angle of 200 to 18.35 N for the same cutting speed conditions and a sharpening angle equal to 100, a trend proved by the cutting mechanical work, respectively from 0.328 Nm to 0.313 Nm. The issue addressed in case of the sharpening angle of the knife blades is the fact that, for small sharpening angles there is a high wear and tear, which required a re-sharpening of knife blades after shorter time intervals, in comparison with the standard angle of 20^0, not being profitable from the economic point of view.

To remove this desideratum, it has been performed a titanium nitride coating, procedure known as titanium covering, on the knife blades in a thin layer equal to 3 – 8 µm. It is known from the literature that knife blades are tempered by high frequency currents (CIF), on a distance of 10 – 15 mm from the outside towards the inside, for a hardness of 55 – 60 HRC. Through titanium nitrite coating it is obtained a superior hardness in comparison with that achieved with high frequency currents (CIF).

The same decrease in force, as well as of mechanical work on cutting, occurs as the cutting speed increases, an important factor being also the inertia of the moving knife. Tilted cutting at which the knife position is displayed for an angle of 5^0 (basically, the strain is tilted) highlights the fact that the cutting force and mechanical work record lower values of cutting by shearing, for similar working conditions.

Experimental tests and results obtained in case of triticale trains cutting Table 3) highlight the same trends as in the case of wheat strains, but because of strains structure and size, they have much higher values. In this case, the degree of wear and tear or blunting of knife cutting edge is much higher than in the case of the wheat strain, reducing the operating time between two re-sharpening procedures.

Table 3

Variation of mechanical work in cutting triticale strains with SEMA model knives

Sharpening angle (^{0})	Strain diameter (mm)	Strain humidity (%)	Knife position against strain (^{0})	Cutting force (N)	Cutting mechanical work (Nm)
Knife speed = 0.2 m/s					
20	6.04	13.2	90	102.9	1.146
			45	77.54	0.789
15	6.04	13.2	90	84.56	1.184
			45	76.42	0.971
10	6.04	13.2	90	60.13	0.940
			45	55.04	0.925
Knife speed = 1 m/s					
20	6.04	13.2	90	97.03	1.080
			45	72.10	0.735
15	6.04	13.2	90	90.12	1.260
			45	71.26	0.905
10	6.04	13.2	90	55.08	0.861
			45	49.48	0.832
Knife speed = 2 m/s					
20	6.04	13.2	90	88.00	0.980
			45	55.86	0.569
15	6.04	13.2	90	80.30	1.125
			45	62.31	0.791
10	6.04	13.2	90	45.26	0.707
			45	41.37	0.695

Experimental tests have also been carried out for knives which are used for cereal grains CLASS, FENDT and JOHN DEERE models, for a standard sharpening angle of 19^0.

Table 4

Variation of mechanical work in cutting wheat strains with CLASS, FENDT and JOHN DEERE model knives

Type of knife	Strain diameter (mm)	Strain humidity (%)	Knife position against strain (^{0})	Cutting force (N)	Cutting mechanical work (Nm)
Knife speed = 0.2 m/s					
CLASS	4.51	11.7	90	23.43	0.308
			45	22.41	0.342
FENDT	4.51	11.7	90	26.49	0.495
			45	24.41	0.337
JOHN DEERE	4.51	11.7	90	19.35	0.241
			45	16.32	0.223
Knife speed = 1 m/s					
CLASS	4.51	11.7	90	18.30	0.240
			45	17.26	0.236
FENDT	4.51	11.7	90	21.44	0.401
			45	16.50	0.248
JOHN DEERE	4.51	11.7	90	14.56	0.181
			45	11.70	0.160
Knife speed = 2 m/s					
CLASS	4.51	11.7	90	9.66	0.127
			45	8.62	0.131
FENDT	4.51	11.7	90	12.36	0.231
			45	6.28	0.094
JOHN DEERE	4.51	11.7	90	4.58	0.057
			45	2.72	0.037

Table 5

Variation of mechanical work in cutting triticale strains with CLASS, FENDT and JOHN DEERE model knives

Type of knife	Strain diameter (mm)	Strain humidity (%)	Knife position against strain (^{0})	Cutting force (N)	Cutting mechanical work (Nm)
Knife speed = 0.2 m/s					
CLASS	6.04	13.2	90	92.72	0.962
			45	72.34	0.865
FENDT	6.04	13.2	90	93.74	1.553
			45	80.50	2.047
JOHN DEERE	6.04	13.2	90	89.66	1.523
			45	78.46	1.969
Knife speed = 1 m/s					
CLASS	6.04	13.2	90	87.60	0.909
			45	67.49	0.807
FENDT	6.04	13.2	90	89.09	1.476
			45	75.16	1.912
JOHN DEERE	6.04	13.2	90	84.76	1.440
			45	73.18	1.824
Knife speed = 2 m/s					
CLASS	6.04	13.2	90	78.48	0.814
			45	59.27	0.709
FENDT	6.04	13.2	90	79.40	1.315
			45	65.20	1.658
JOHN DEERE	6.04	13.2	90	75.36	1.280
			45	63.39	1.580

In this case, the tests have been carried out for those three working speeds of the knife, namely cutting by sharing and tilted cutting for wheat crops (Table 4) and triticale crops (Table 5). There are some differences in the cutting force and mechanical work between those three types of knives, depending on the crop and the speed of the knife, so that a certain model or constructive type cannot be established to achieve the lowest values for both crops. Also here, there is a normal trend to decrease those two parameters with the increase of the cutting speed.

Within the experimental researches, have been carried out also tests of the cutting force and mechanical work for oat and barley strains, for these ones being used SEMA type cutting knives. Experimental data and working conditions are listed as follows in Table 6. The experimental results listed are obtained in the conditions of cutting the strain between nodes, because the positioning in this way is simpler than cutting on node, here the research are to be continued.

Table 6

Variation of mechanical work in cutting oat and barley strains with SEMA model knives, at a 0.2 m/s knife speed

Sharpening angle (^{0})	Strain diameter (mm)	Strain humidity (%)	Knife position against strain (^{0})	Cutting force (N)	Cutting mechanical work (Nm)
Oat					
20	2.82	13.5	90	11.22	0.086
			45	8.16	0.072
15	2.82	13.5	90	6.12	0.067
			45	5.10	0.067
10	2.82	13.5	90	4.08	0.083
			45	3.06	0.062
Barley					
20	3.02	12.3	90	11.22	0.179
			45	9.18	0.118
15	3.02	12.3	90	10.20	0.115
			45	7.14	0.086

From the preliminary data obtained, the cutting force of the strains on node, in similar working conditions (cutting speed of 0.2 m/s and cutting by shearing) varies between 61.13-68.26 N for wheat, between 18.25-26.67 N for barley, between 95.78 and 131.81 N for triticale, and respectively, between 21.39 -29.23 N for oat.

CONCLUSIONS

From the experimental tests it can be seen that the cutting force and the mechanical work for cutting the strains of some cereals depend on the knife geometry (sharpening angle), the fibre-ligneous structure at the time of harvest, marked by humidity, and the knife speed during the cutting.

As the cutting speed fluctuates in time, the maximum cutting force of the strains and displacement of the knife during cutting were calculated on the stand, using transducers connected to a data capture board.

There is no knife model which has the smallest cutting force, respectively the smallest mechanical work used for cutting, for all the crops analyzed. Also, it can be seen that, SEMA model does not achieve values near to the minimum ones, so it's still necessary to find solutions for energy consumption decrease when cutting plant stems.

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ASSESMENT OF SEDIMENT TRANSPORT RATE AND NON-SILTING VELOCITY IN IRRIGATION CANAL
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ОЦЕНКА НА НАНОСНОТО КОЛИЧЕСТВО И НЕЗАТЛАЧВАЩАТА СКОРОСТ В НАПОИТЕЛЕН КАНАЛ

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Keywords: *Sediment transport, Irrigation canal, Malka Vitska Irrigation Project, Bulgaria*

ABSTRACT

Siltation is a significant factor, affecting the efficient operation and maintenance of the irrigation canals which influence the hydraulic behavior of the canals and economic benefits of irrigation. In last 25 years a tendency of silting up at the irrigation canals in Bulgaria is observed due to the following reasons: decreased area under irrigation, fluctuation in supply, non-regime section, "berming" of the canal, economic, crime and safety situation. The large number of bed load and permissible velocity formulas available and the significant differences between obtained results enforce selection of appropriate sediment transport formulas in each particular case. Discharge and velocity approach are used in this study for estimation of sediment transport and deposition rates at Babreka Canal, Malka Vitska Irrigation Project in Bulgaria. In this study seven equations for prediction total bed load transport rates and five equations for minimum permissible velocity are compared. Two formulas for total bed load and two formulas for minimum permissible velocity are selected as appropriate for study canal.

РЕЗЮМЕ

Затлачването на напоителните системи с наноси е значим проблем при експлоатацията им, оказващ както пряко така и косвено влияние върху хидравличните характеристики и икономическия ефект от напояването. През последните двадесет и пет години в България се наблюдава тенденция на затлачване на напоителните канали с наноси, дължащо се на : намаляване на напояваните площи, колебания в подаваните водни количества, каналите не работят „в режим", икономическа и криминогенна обстановка. Наличието на голям брой формули за определяне на наносното количество и критичната скорост на течението, но най-вече големите различия в резултатите налагат определянето на подходящи зависимости за всеки конкретен случай. В настоящата разработка е използван методът на критичната скорост и е определено наносното количество за МК „Бъбрека" на НС „Малка Витска". Сравнени са резултатите от седем уравнения за прогнозиране на наносното количество и пет уравнения за определяне на критичната незатлачваща скорост. Избрани две уравнения за определяне на наносното количество и две уравнения за определяне на критичната незатлачваща скорост като подходящи за този канал.

INTRODUCTION

Siltation is a significant factor, affecting the efficient operation and maintenance of the irrigation canals which influence the hydraulic behaviour of the canals and economic benefits of irrigation. Irrigation canals have been designed to ensure a transport capacity equal to or greater than the amount of incoming sediment. In last 25 years a tendency of silting up at the irrigation canals in Bulgaria is observed due to the following reasons: decreased area under irrigation, fluctuation in supply, non-regime section, "berming" of the canal, economic, crime and safety situation. An irrigation canal silting is important problem in their operation and maintenance and is capable of exerting direct and indirect effects on the hydraulic characteristics and economic benefits of irrigation.

The large number of bed loads and permissible velocity formulas available and the significant differences between obtained results enforce selection of appropriate sediment transport formulas in each particular case.

MATERIAL AND METHOD

Determination of bed load rate is important to irrigation canal behavior understanding including the carrying capacity, sediment deposition, growth of vegetation. In generally irrigation canals are designed on the requirement that all sediment which enters the canal should be transported through without sedimentation. According to *Wallingford HR* (*1992*) three methods for design stable canals are used: regime method, tractive force method, and rational theory. The regime design methods are sets of empirical equations derived from observations of canals and natural rivers. Tractive force method is based on a consideration of the balance of forces which act on sediment particle and include the method of permissible velocity and the method of critical shear stress. The tractive force methods are in use for shear stress and sediment transport determination. The rational theory includes the semi-empirical methods and it is based on the conveying the sediment load through the canal system based on energy dissipation considerations. At least 100 published transport rate equations can be found in the literature and verification of the accuracies of this formulas is mainly based on laboratory and limited field data (*Yang et al., 2009*).

Seven well-known equations for bed load transport rate determination are chosen for comparison in this paper.

Meyer-Peter and Muller equation (*Quesnel, 1974*):

$$q_s = \frac{8}{\sqrt{\rho_w}}\left(\tau_b - 0.047\left(\gamma_s - \gamma_w\right)d_{50}\right)^{3/2} \tag{1}$$

where:

q_s represents volumetric transport rate of bed load per unit width [kg/s m];
ρ_w - density of water [kg/m^3];
τ_b – bed shear stress;
γ_w – specific weight of water [kN/m^3];
γ_s - specific weight of sediment [kN/m^3];
d_{50} – median size of particle size distribution.

Einstein - Brown equation (*Hug, 1975*):

$$q_s = \sqrt{(s-1)gd^3}\,\frac{K\exp\left(-0.391/Fr^*\right)}{0.465}, Fr^* < 0.182 \quad q_s = 40\sqrt{(s-1)gd^3}KFr^{*3}, Fr^* \geq 0.182 \tag{2}$$

where:

s represents relative density $s = \frac{\rho_w}{\rho_s}$;
Fr* - dimensionless shear stress or Shields stress;
Fr_{crit}* - critical Shields stress;
g - acceleration of gravity [m/s^2];
K- coefficient - $K = \sqrt{\frac{2}{3} + \frac{36\nu^2}{d^3(s-1)}} - \sqrt{\frac{36\nu^2}{d^3(s-1)}}$.

Selim Yalin equation (*Hug, 1975*):

$$q_s = 0.635\sqrt{(s-1)gd^3}\,r\sqrt{Fr^*}\left[1 - \frac{1}{\sigma r}\ln(1+\sigma r)\right] \tag{3}$$

where:

$$r = \frac{Fr^*}{Fr^*_{crit}} - 1, \sigma_1 = 2.45\frac{\sqrt{Fr^*_{crit}}}{s^{0.4}}.$$

Gomez equation (*Gomez, 2006*):

$$q_s = \frac{0.0725\gamma QJ}{bd_{50}^{0.51}} \tag{4}$$

where:

Q represents water discharge [m^3/s];

J – energy gradient;
b – canal length [m].

Van Rijn equation (*Van Rijn, 1984*):

$$q^* = \frac{0.053}{d^{*0.3}}\left(\frac{Fr^*}{Fr^*_{crit}} - 1\right)^{2.1} \tag{5}$$

where:
q* - represents dimensionless bed load transport rate;
d* - dimensionless particle diameter.
Nagakawa-Tsujimoto equation (*Van Rijn, 1984*):

$$q_s = 0.02\rho_s Fr_* \sqrt{(s-1)\,gd_{50}}\left[1 - \frac{0.035}{Fr_*}\right]^3 \tag{6}$$

where:
ρ_s represents density of the sediment [kg/m^3].
Nielsen equation (*Nielsen, 1992*):

$$q^* = 12\left(Fr^* - Fr^*_{crit}\right)\sqrt{Fr^*} \tag{7}$$

The minimum permissible velocity or non-silting velocity is the lowest velocity that will not initiate sedimentation and will not allow the growth of vegetation. According Chow (*Chow, 1973*) the average velocity from 0.6 to 0.9 m/s would prevent sediment deposition and higher velocity than 0.75 m/s would ensure vegetation-free canal. Therefore, the minimum permissible velocity should be in the range of 0.75-0.9 m/s. Non-silting velocity depends on the sediment diameter. Five well-known equations for minimum permissible velocity determination are chosen for comparison – Zamarin, Grishkan, Roer, Poslavskii (*Korpachev, 2009*) and Kennedy equations (*Das, 2012*).

Zamarin equation:

$$v_{min} = a\sqrt{R} \tag{8}$$

where:
R represents hydraulic radius;
a – coefficient depend on particle size (Table 1).

Table 1

Values of coefficient a

d [mm]	0.1	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	3.0
a	0.2	0.45	0.67	0.82	0.9	0.95	1.0	1.02	1.05	1.07	1.1	1.11

Grishkan equation:

$$v_{min} = kQ^{0.2} \tag{9}$$

where:
k represents a coefficient depend on fall velocity ω;
If fall velocity ω<1.5 mm/s - k=0.33;
If ω is between 1.5 and 3.5 mm/s - k=0.44;
If ω>3.5 mm/s - k=0.55.
Roer equation:

$$v = A\left[\frac{m+2}{2}(\rho_p - 1)\omega\right]^{0.326} R^{0.473} \tag{10}$$

where:
A represents a coefficient equal to 39.3;
m - width-to-depth ratio.
Poslavskii equation:

$$v_{min} = 0.34\sqrt{NR^{1/3}} \tag{11}$$

where:

N represents capacity refers to the maximum amount of sediment of a given size that a stream can transport in traction as bedload.

Kennedy equation:

$$v_{min} = 0.84h^{0.64} \tag{12}$$

RESULTS

Malka Vitska Irrigation Project is located in Dolni Dabnik Municipality, south Bulgaria and it is owned and managed from Irrigation System SOJSC, Pleven Branch. The Vit River, Krushovits-3 Reservoir, Dolni Dabnik Reservoir and Valchovets Reservoir are the source of water for the scheme. Babreka canal is a main canal with trapezoidal cross-section. Bottom width of the canal is b=2 m, side slope – m=1 and for water discharge Q=0.728 m3/s water depth h=1.08 m and energy gradient J=0.149‰ (*Gadjev, 1989*).

During the inspection of the Danube Basin Directorate, in 2009 vegetation and sediment deposition has been found in front of intake sluice gate the Malka Vitska Irrigation Project. Sediment deposition and vegetation has been found 200 meters upstream from intake in the Vit River (*http://dariknews.bg/*). The Danube River Basin Directorate has been given instructions for sediment removing, but there is no press release on whether it has been implemented.

Currently, a poorly maintained irrigation system is not fully used. Only vegetables and tobacco are irrigated in Dolni Dabnik Municipality. There are no water users associations. The potentially irrigated area on the territory of the Municipality is 99602000 m^2, of which 19440000 m^2 are not properly irrigated due to amortized hydraulic structures. The real irrigated area is less than 8000000 m^2.

The bed load transport rate for Babreka Canal is determined in the range from 0.1 mm to 3 mm by equations (1), (2), (3), (4), (5), (6) and (7). The results shown in Fig. 1 indicate that the Nielsen formula (7) and Mayer-Peter Muller formula (1) is more appropriate for diameter particle bigger than 3 mm. Nagakawa-Tsujimoto formula (6) have downward trend with particle diameter increasing and (6) is not appropriate for this case. Gomez formula (4) is low predictor. Van Rijn formula (5) and Yalin (3) formula have the similar results.

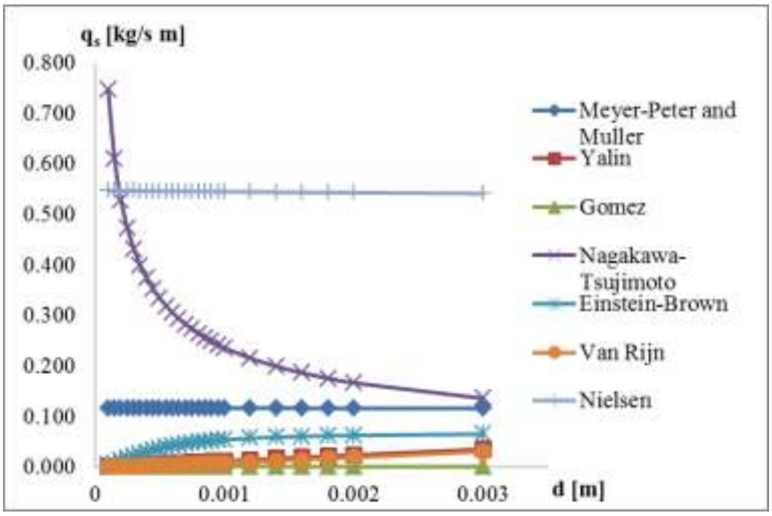

Fig. 1 - Bed load transport rate results for Babreka Canal

As shown in Figure 2, after selection (2) and (5) for bed load transport rate is appropriated for study canal. The minimum permissible velocity determination for Babreka Canal is determined in the range from 0.1 mm to 3 mm by equations (8), (9), (10), (11) and (12).

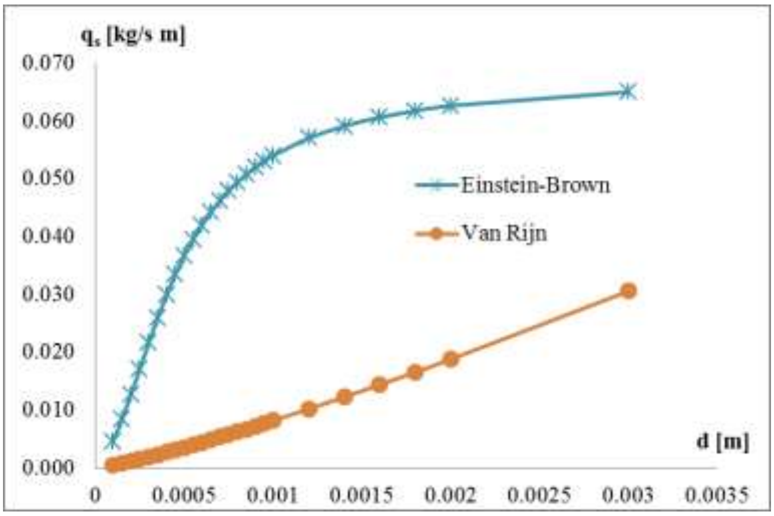

Fig. 2 - Bed load transport rate results appropriate for Babreka Canal

The results shown in Figure 3 indicate that the Poslavskii formula (11) have downward trend with particle diameter increasing and (11) is not appropriate for this case. Kennedy formula (12) and Grishkan formula (9) is more appropriate for diameter particle bigger than 3 mm.

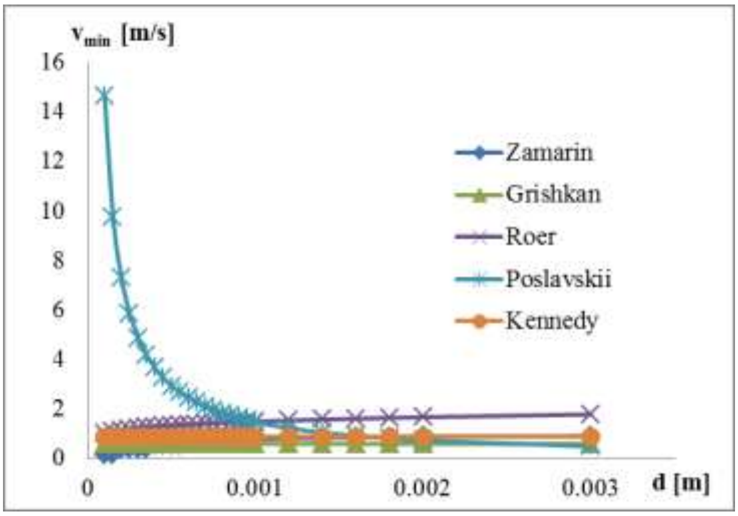

Fig. 3 - Minimum permissible velocity results for Babreka Canal

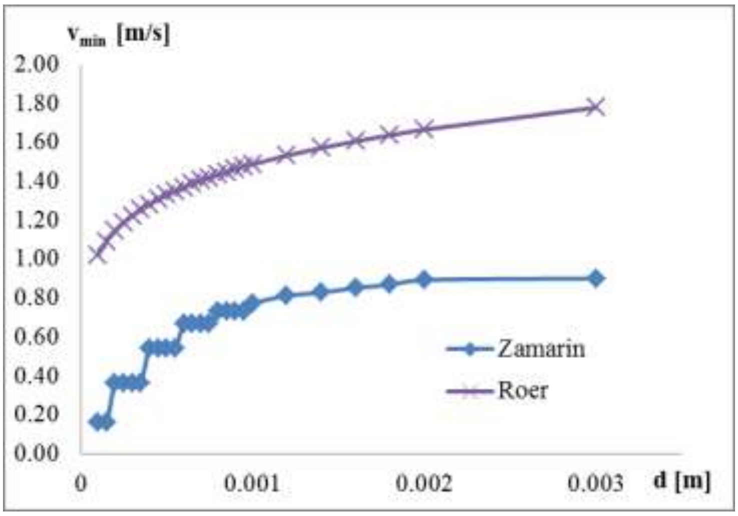

Fig. 4 - Minimum permissible velocity results appropriate for Babreka Canal

CONCLUSIONS

The results show substantial differences in performance of the different formulas. Einstein - Brown formula (2) and Van Rijn formula (5) for bed load transport rate and Zamarin formula (8) and Roer formula (10) for minimum permissible velocity are selected as appropriate for study canal.

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EFFICIENCY OF USING THE ORGANIC MINERAL MIXED LIGAND CU IN THE PIG FEEDING
/
ЕФЕКТИВНІСТЬ ВИКОРИСТАННЯ ОРГАНІЧНО-МІНЕРАЛЬНОГО ЗМІШОНОЛІГАНДНОГО Cu В ГОДІВЛІ СВИНЕЙ

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Keywords: *complex organic mineral mixed ligand Cu, crossbreed young pigs, quality of meat*

ABSTRACT
Experimental materials with justification of expediency of complex organic mineral mixed ligand Cu using in young pigs rations are presented. Positive effect for the putting of this complex into compound feed of crossbreed young pigs (Large White Landrace pig x Duroc pig) is established, which helps the metabolism and assimilation of nutrients, increases nutritional value of rations, average daily growth of animal and animal productivity.

АНОТАЦІЯ
Представлені експериментальні матеріали обґрунтування доцільності використання комплексу органічно-мінерального змішанолігандного Cu у раціонах молодняку свиней. Встановлено позитивний впливза введення даного комплексу до складу комбікорму помісного молодняку свиней (великої білої х ландрас х дюрок, який сприяє на обмін і засвоєння поживних речовин, підвищення поживності раціонів, середньодобових приростів тварин та продуктивності тварин.

INTRODUCTION
Particular attention is being paid to the problem of increasing the production of competitive meat products with the improvement of quality indexes (*Bagchi Debasis, Swaroop Anand, Bagchi Manashi 2015*).

Modern animal breeds and crosses require increased macro- and micro- elements in mixed fodders due to a significant increase in growth and productivity (*Gonzales-Eguia et. Al., 2009, Khalak and Lunyk, 2015)*.

It is believed that proteins, energy, and minerals should be digested in a more accessible form *(Dyachenko et. al., 2017).*

The value of mineral substances for the normal life of the organism is very difficult to overestimate. However, inorganic salts of transition metals (Zinc, Copper, Iron, Manganesse) due to low digestibility transit and in combination with the concomitant salts of heavy metals pollute the environment *(Huang et. al., 2010;. Khavturina and Bomko, 2015; Bomko and Dolid, 2015).*

So, traditional approaches to mineral nutrition of farm animals require substantial revision. The analysis of publications confidently attests about the benefits of using microelements from organic compounds in fodder production. This is related primarily with higher bioavailability, which reduces significantly their introduction in the feed mixtures *(Merzlov S. V., 2009; Marshalok and Bomko, 2012; Huang et. al., 2015).*

A significant reduction of the level of microelements in organic forms of mixed fodders greatly reduces the access to heavy metals and improves the quality of livestock products *(Liao et. al., 2017).*

Cuprum is an important part of the metal proteins which regulates oxidative and reconstructive processes of cellular respiration, photosynthesis, assimilation of molecular nitrogen. As part of hormones Cuprum affects growth and development, reproduction, metabolism in general, processes of gamma globulin formation, promotes the transformation of reticulocytes into mature erythrocytes. Cuprum is required for the formation of melanin pigment, affects the development of bones, and increases the content of vitamins B_{12} and C in the liver.

The purpose of the research was to study the effectiveness of using the complex organic mineral mixed ligand Cuprum on the quality of pig meat *(Sologub et. al., 2004).*

MATERIAL AND METHOD

Scientific and economic research about the effectiveness of using the complex organic mineral mixed ligand Cuprum in rations of crossbreed young pigs (Large White Landrace pig x Duroc pig) on their meat productivity and qualitative indexes of meat were carried out in the private limited company “Agrofirma named after Horkii” in Dnipropetrovsk region.

To formulate the experiment on the principle of pair-analogues 3 groups of young pigs of 10 heads in each aged 60 days were formed. Animals of the 1st control group received a general diet, which contained of Cuprum in sulfate form. Young pigs of the 2nd experimental group received Cuprum in sulfate form as a part of the general food ration, which was replaced on mixed ligand complex only in 50% and animals of the 3d experimental group received feeding where Cu sulfate was completely replaced by a complex organic mineral mixed ligand Cu. Duration of the experiment was 150 days.

Animals of all experimental groups were kept in the same room and served by one operator. Keeping of pigs were in groups without walking. All experimental animals were clinically healthy. The parameters of the microclimate in the building were supported by the combined extract and input ventilation and conformed to the norms. The animals were fed twice a day, and the drinking was carried out using automatic drinking system.

Ration for young pigs were adjusted depending on age, live weight and intensity of growth and were calculated to obtain average daily increments within 650-700 g. The fodder was of a full value *(Petukhova et. al., 2010).*

RESULTS

The influence of organic mineral mixed ligand complex on dynamics of live weight of pigs is established. The conducted researches on using in ration of feeding of young pigs the complex organic mineral mixed ligand Cuprum showed that it influenced positively on the live weight of pigs on fattening (Figure 1), *(Melnichenko et. al., 2006).*

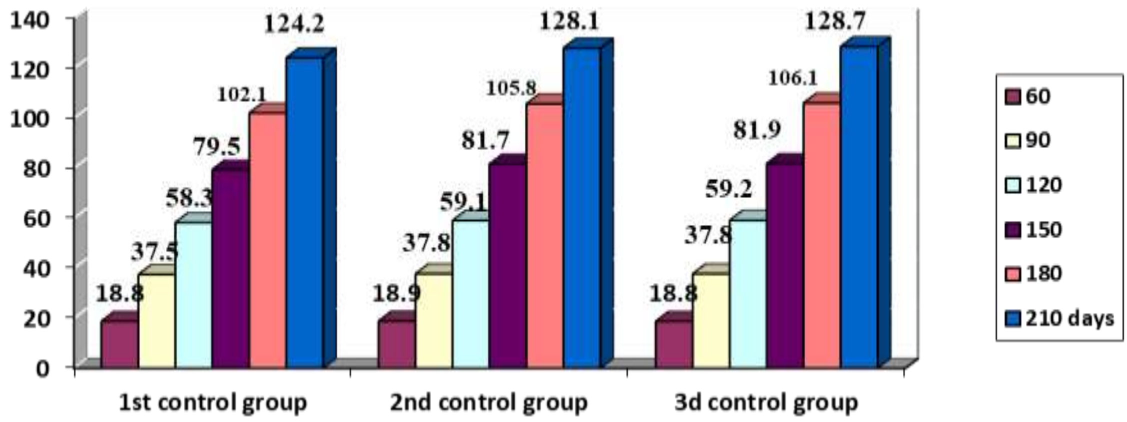

Fig. 1 - Dynamics of live weight of experimental pigs, kg

Throughout the period of fattening, the animals of experimental groups exceeded the weight of peers from the control group. By the end of the experiment, the difference in live weight of animals in the 2nd and 3rd experimental groups compared to the control group was 3,9 and 4,5 kg, or 3,14 % ($P<0,05$) and 3,63 % ($P<0,01$).

The absolute growth of live weight as a whole during the experimental period in young pigs exceeded control and was in the 2nd experimental group 109.2 kg, in the 3rd experimental group 109.9 kg, which is 3.6% ($P<0.01$) and 4.2% ($P<0.001$) higher than control.

During growing, the highest absolute growth of live weight was recorded in experimental groups pigs in the period from 151 to 180 days, which was 24,1 kg in the 2nd experimental group, 24,2 in the 3rd experimental group against 22,6 in control. However, it should be noted that in the period from 91-120 days of fattening there was a significant increasing in the absolute growth in live weight of young pigs of experimental groups.

This indicates a high bioavailability of organic mineral mixed ligand Cu, which activated metabolic processes in the pig's body. And, as a result, the animals of experimental groups exceeded the analogues from the control group for the average daily gain of live weight.

During the experiment, the average daily increment of pigs in the 2nd experimental group exceeded the control on 18,7 g (2,63 %); P<0,05, 3rd on 23,4 g (3,29 %); P<0,01. Higher intensity of live weight gain of animals in the experimental groups relative to control was observed throughout the fattening period.

Animals of experimental groups in indexes of relative growth exceeded the analogues from the control group throughout the entire period of breeding. Pigs' growth rates in experimental groups also were higher and made up 6.78 in the 2nd experimental group, 6.85 in the 3rd experimental group, 6.61 in the control group.

Replacing the sulfate compound of Cu in rations of feeding pigs on organic mineral mixed ligand Cu had a positive effect on the growth rate of animals of experimental 2nd and 3rd groups.

The most important indicators of meat productivity are slaughter weight and mass of carcasses. The results of slaughter control showed a positive effect of organic mineral mixed ligand Cu on growth, development and meat productivity of pigs. Before slaughter pigs mass of experimental groups exceeded control on 4,3 kg (3,55 %), P<0,05 and 4,7 kg (3,88 %), P<0,01; mass of carcass on 4,72 kg (6,32 %), P<0,01 and 5,04 kg (6,74 %), P<0,001; slaughter output on 1,42 % (P<0,05) and 1,58 % (P<0,05), and carcass output on 1,65 and 1,7 (Figure 2).

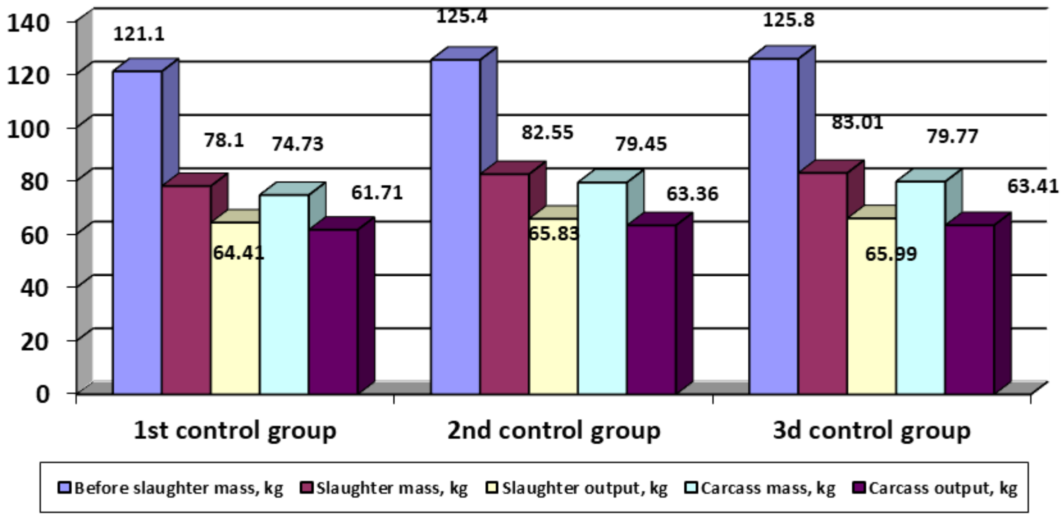

Fig. 2 - Slaughter and meat qualities of experimental animals

The most important method of evaluation, which gives the most complete description of the quality of meat, of its physiological maturity, energetic and biological value, is an analysis of its chemical composition.

The results of a chemical analysis of the average muscle test of carcass found that in comparison with the control dry substance contained in pig meat in 2nd and 3rd experimental groups was more on 0,52 (P<0,05) and 0,54 (P<0,05), protein on 0,46 (P<0,05) and 0,48 (P<0,05).

The content of fat in the animals average sample meat compared with control animals revealed no significant differences.

Thus, according to the indexes of the chemical composition of the average sample of meat from the pigs back longest muscle of the carcasses in the experimental groups which received organic mineral mixed ligand Cu in the ration differed profitably from the animals of the control group.

Deeper and more objective information on the meat and lard rates of pigs can be obtained by analyzing the morphological composition of carcasses (Table 1). In the first 6 months after birth, the pigs' muscles form in the most intensive way and, accordingly, their relative weight in the body increases. Later, the growth of muscles slows down and fat deposition increases. Therefore, the age of pigs is one of the decisive factors that determines the type of feeding and its success.

The data of experimental butchering of carcasses show that the using the general food ration in fattening pigs in the 1st control group containing Cu all in sulfate form, in pigs feeding of the 2nd experimental group with the general food ration where Cu sulfate was replaced by only 50% on the mixed ligand complex Cu and animals of the 3rd experimental group, where Cu sulfate was replaced completely by the organic mineral mixed ligand compound of this metal generally contributed an increase in the total amount of lard in carcasses by 0,8-2,2%, and meat - by 0,9-2,8%.

Table 1

Morphological composition of carcasses of experimental animals

Group	Amount of heads	Morphological composition, %			The ratio of meat and lard in the carcass	Coefficient of meatiness
		meat	lard	bones		
1 control	4	61,58	27,34	11,08	1:0,44	5,56
2 experimental	4	60,68	28,11	11,21	1:0,46	5,41
3 experimental	4	58,73	29,59	11,68	1:0,50	5,03

Accordingly, a general tendency was observed for reducing the meatiness coefficient by 0.15 and 0.50 units in accordance with control. Thus, summing up the obtained material, it can be stated that the using of the mixed ligand complex Cu contributed to a steady tendency to increase the slaughtered yield of carcasses and increased the general fattiness of animals, the effect of the mixed ligand complex Cu was most tangible in increasing these parameters in animals of the 3rd experimental group, however the difference in these indicators was not probable.

Replacement in the diet of fattening pigs Cu sulfate, which has an inorganic origin, on organic origin mixed ligand complex Cu had a positive effect on the growth and development of internal organs (Table 2).

The results of the experiment on replacing Cu sulfate with Cu chelation showed that these drugs have a positive effect on hematopoiesis and biochemical parameters of metabolism, which leads to increasing of animal productivity and in a certain way affects the mass of individual internal organs. Given that the liver performs functions of secretion of bile, metabolic, antibacterial, anti-toxic, regenerative and other, changes in the mass of this organ of the pigs in the control and experimental groups fluctuated at the level of 0.7-4.4%. There is no reliable difference between the animals.

Table 2

Mass of internal organs of experimental pigs

Index	Groups		
	1 control	2 experimental	3 experimental
Internal fat, kg	1,05±0,12	0,92±0,1	0,82±0,04
Mass of head, kg	5,10±0,34	5,37±0,22	5,75±0,47
Mass of legs, kg	0,84±0,05	0,88±0,03	0,74±0,03
Mass of skin, kg	5,85±0,2	5,38±0,28	5,73±0,26
Liver, kg	1,93±0,11	1,62±0,11	1,78±0,1
Heart, kg	0,25±0,04	0,25±0,02	0,22±0,01
Lungs, kg	0,34±0,05	0,43±0,02	0,37±0,01
Spleen, kg	0,13±0,01	0,11±0,01	0,11±0,01
Stomach, kg	0,73±0,05	0,85±0,02	0,82±0,07

The results of the analysis of heart mass indexes indicate that significant differences between animals in control and experimental groups have not been established.

The results of the determination of the lungs and kidneys mass indicate that there were no significant deviations of the pigs in the control and experimental groups.

It is known that the mass of the spleen increases with increasing of hematopoiesis cells death, and decreases - with the death of cells of the lymph and erythropoiesis. The obtained results of spleen weighing indicate that the average weight of the spleen was the highest in pigs of the 1st group. According to the indicator of the animals of this group, 2.8% of the pigs of the control group prevailed, but this difference was not reliable. Animals of the 2nd and 3rd experimental groups did not differ from the control analogs by the mass of the spleen.

The results of weighing of internal fat showed that its largest mass was fixed in pigs of the 1st group. The weight of the internal organs of the pigs in the experimental groups was at the control level, the difference was not probable.

Thus, the feeding of the organic-mineral additive of Cu in fattening of pigs for meat contributed positively to the slaughter rates of these animals. However, the best slaughter qualities were noted in those animals which diets contained of 100% of mixed ligand complex Cu. By weight of the internal organs of pigs between all groups difference is not observed.

It is known that young pigs produce meat carcasses with less amount of fat than adults. The level and quality of feeding determines the speed of reaching the necessary condition of fattening pigs, feed costs and quality of pork. The more intense the feeding, the faster the fattening ends and the lower feed expense per unit of output is. High levels of protein contribute to the formation of muscles, and significant levels of energy - deposition of fat in the pigs' bodies. The quality of the lard depends on the fat content of the feed. The consumption of significant quantities of vegetable fats by pigs is responsible for the decline in the quality of pork. The fat of such pigs is mild and fusible, unsuitable for smoking. Data on measurements of the subcutaneous layers of fat thickness are given in Table 3.

Table 3

The thickness of the subcutaneous fat, sm

Index	Groups		
	1 control	2 experimental	3 experimental
On the neck	3,12±0,11	3,37±0,12	3,17±0,31
On the withers	4,87±0,11	5,92±0,45*	6,1±0,58*
On the 6-7 ribs	3,3±1,12	3,75±0,38	4,07±0,41
On sacrum	3,6±0,3	3,57±0,28	4,25±0,43
On the back	3,12±0,11	3,65±0,18	4,22±0,44
Average	3,6±0,15	4,05±0,28	4,36±0,43

From the data of the table it can be seen that the replacement of sulfur Cu with organic and mineral mixed ligand Cu in feed on 50% and 100% leads to a tendency of increasing the average thickness of lard in pigs of the 2nd group by 12.5%, and the third - by 21.1%, which has a direct correlation with the increasing in the mass of internal fat in carcasses of pigs of experimental groups. The tendency to thicken the lard in the experimental groups occurs at practically all measuring points. A probable difference is observed only on the withers ($P<0.05$). The obtained data show that the diets with a mixed ligand complex causes the intensification of fat deposition in carcasses.

CONCLUSIONS

In the results of the control slaughter, the chemical composition of meat, the morphological composition of carcasses, the mass of the internal organs and the thickness of the lard indicate that the young pigs of the 3rd experimental group which received a complex of organic mineral mixed ligand complex Cu had precedence in our studies.

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DETERMINATION OF SOME AERODYNAMIC PROPERTIES OF "BALO" BELL PEPPER FOR PNEUMATIC SORTING
/
"BALO" DOLMALIK BİBERİN PNÖMATİK SINIFLANDIRMA İÇİN BAZI AERODİNAMİK ÖZELLİKLERİNİN BELİRLENMESİ

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Keywords: *Pepper, aerodynamic properties, terminal velocity, drag coefficient*

ABSTRACT
Aerodynamic characteristic of agricultural products have long been carried out to determined convey or separate properties of seeds and grains in post-harvest operations but not used for determined for sorting processing. To design machines to sort out of bell peppers in different size, aerodynamic properties (terminal velocity, drag force and coefficient in x and y axis of pepper and Reynold number) of "balo" bell pepper were determined in this experimental study. The terminal velocity of the bell pepper ranged from 18.83 to 28.29 m/s and average value of it is 24.17 m/s. Drag coefficient the samples ranged from 0.324 to 0.746 in y axis and from 0.364 to 0.814 in x axis and drag force of the bell pepper ranged from 0.81 to 1.35 N in y axis and from 0.64 N to 1.20 N in x axis. Also, Reynold number was determined between 82698.31 and 137682.

ÖZET
Hasat sonrası işlemler için uzun zamandır tohum yada tahılların taşıma ve ayırma özelliklerinin belirlenmesi için tarımsal ürünlerin aerodinamik karakteristikleri üzerine çalışmalar yapıldı fakat sınıflandırma işlemi için kullanılmamıştır. Bu çalışmada dolmalık biberleri farklı boyutlarda sınıflandıracak bir makina tasarımı için biberin kritik hızı, x-y ekseninde sürüklenme kuvveti, sürüklenme katsayısı ve Reynold sayısı belirlenmiştir. Dolmalık biberin kritik hızı ortalama 18.83 ile 28.29 m/s arasında belirlenmiştir. Sürüklenme katsayısı için belirlenen ortalama değer y ekseninde 0.327 ile 0.746 ve x ekseninde ise 0.364 ile 0.814 arasındadır. Dolmalık biberin sürüklenme kuvveti değerleri y eksenin 0.81 ile 1.35 N ve x ekseninde 0.64 ile 1.20 N arasında değişmektedir. Ayrıca, Reynold sayısı 82698.31 ile 137682 arasında belirlenmiştir.

INTRODUCTION
Determining the physical and engineering characteristics of agricultural crops is very important to optimize the design parameters of agricultural equipment and machines used in their production, handling and storage processes. Hence, it is necessary to determine the database of aerodynamic and mechanical properties of these kinds of products because these properties play an important role in designing and developing of specific machines and their operations such as sorting, separating and cleaning.

Aerodynamic properties such as drag force, terminal velocity, drag coefficient and Reynold number are the most important, which should be known for pneumatic conveying, separation, cleaning, harvesting and drying of agricultural products. The terminal velocity at which the particles are suspended stationary in vertical air stream can be determined by using different methods. These methods are free-fall, vertical air tunnel and elutriate or method *(Mohsenin, 1980; Grift et al, 1997).* The terminal velocity of grains can be calculated by using the equations theoretically developed as well as laboratory studies. A few methods were developed to determine theoretical terminal velocity for some grains *(Gorial and O'callaghan, 1990; Song and Litchfield, 1991).*

The researchers carried out a study to enable easy seed and waste separation at head feed combine by measuring the terminal velocity. It was found that, it is difficult to separate seeds with primary branches and straws from a single seed in the tank because the terminal velocity of the seed with primary branches and straw was more than the single seed. The suitable limits of the separating air velocity were from 2.3 to 6.5 m/s *(Nonami and Nelson, 2002).* The other researcher studied on the drag coefficients for grain and the resistance coefficient (drag coefficient×frontal area) for straw from the experimentally obtained terminal velocities *(Zewdu, 2007).*

Khoshtaghaza and Mehdizabeh (2006) reported that mass and moisture content have significant effects on the terminal velocity. *Turgania latifolia* (a common weed) seeds were separated from wheat seeds by pneumatic separation since its seeds have lower terminal velocity values from 6.775 to 6.877 $m \cdot s^{-1}$ than wheat seeds from 9.587 to 9.25 $m \cdot s^{-1}$*(Nalbandi et al., 2010; Shahbazi, 2013).* Important operational features are terminal velocity while the important properties are moisture content and bulk density *(Masoumi and Tabil, 2008).*

The aim of this study was to determine some aerodynamic properties of "balo" bell pepper to optimize the best design parameters for new aerodynamic sorting machine in three harvest time.

MATERIAL AND METHOD

The experiments were conducted at the Department of Agricultural Machinery and Technology Engineering Faculty of Agriculture, Akdeniz University. The Balo bell peppers used for the study were obtained from local greenhouse in the Antalya, Aksu that were cultivated in the same conditions, in 2008 cultivation season.

A particle having projected area (A_i) and immersed in flowing fluid with velocity (V_k), density (q_f) and drag coefficient (C_d) is subjected to a drag force (F_d) given by *Menzies and Bilanski (1968):*

$$F_d = m.g = C_d.A_i.q_f.V_k^2 / 2 \tag{1}$$

The dimensionless drag coefficient characterizes the interaction between the bell pepper and the airflow and is expressed by the formula *(Tabak and Wolf, 1998; Dilmac et al, 2016; Bakhtiari and Ahmad, 2015; Shahbazi, 2015)*

$$C_d = \frac{2mg}{A_i.\rho_f.V_k^2} \tag{2}$$

where;
C_d is the drag coefficient of the bell pepper; m is the mass of the bell pepper in kg;
g is the acceleration of gravity in m s^{-2};
V_k is the terminal velocity in m s^{-1}; ρ_f is the air density of 1.223 kg m^{-3}; and A_i is the projection area in m^2.

In this study, the Reynolds number (*Re*) was calculated using the terminal velocity of each bell pepper sample. Reynolds number (dimensionless) equations include a velocity term using the following relationship (*Mohsenin, 1978*).

$$Re = \rho_f.V_k.D_g/\mu \tag{3}$$

where: D_g is geometric mean diameter of bell pepper (m);
ρ_f is the air density of 1.223 kg m^{-3} μ is air viscosity at room temperature (1.816×10-5 N s m^{-2});
V_k is the terminal velocity in m s^{-1}

The terminal velocities of bell pepper were determined by means of a vertical air column constructed in the Department of Agricultural Machinery and Technology Engineering Faculty of Agriculture University of Akdeniz. It consists of a fan, electronic revolution regulator, electric motor, plenum chamber, airflow straightener, vertical transparent tube which diameter and length was 150 and 1000 mm, respectively, (*Masoumi et al, 2003; Razavi and Farahmandfar, 2008; Ozturk et al., 2009; Kalkan ve Kara, 2011; Ghamari et al, 2010*).

RESULTS

The duncan results and average values of terminal velocity, drag coefficient, Reynold number and drag force of "Balo" bell pepper at different harvest time are presented in Table 1. The analysis of variance showed that there was a significant difference terminal velocity, drag coefficient, Reynold number and drag force of "Balo" bell pepper at different harvest time.

Measured terminal velocities for bell pepper ranged from 18.83 to 28.59 m/s, with a mean of 24.17 m/s and a standard deviation of 0.44 in October harvest time, from 17.24 to 27.40 m/s, with 22.80 m/s and a standard deviation of 0.37 in January harvest time and from 18.83 to 31.22 m/s with 26.23 m/s and a standard deviation of 0.44 in June harvest time. As you seen in Table 1, the highest terminal velocity was determined as 26.23 m/s in June harvest time. The analysis of variance showed that there was a significant difference terminal velocity for different harvest time (p=0.01)

Table 1

Results of Duncan multiple range tests for comparing the means of the aerodynamic properties for harvest time

	October	January	June	Level
Terminal velocity	24.17±0.44^{b}	22.80±0.37^{c}	26.23±0.44^{a}	***
Drag coefficient				***
in x axis	0.274±0.045^{c}	0.376±0.061^{a}	0.316±0.040^{b}	
in y axis	0.301±0.039^{c}	0.424±0.067^{a}	0.395±0.049^{b}	
Drag force (N)				***
in x axis	1.15±0.27^{b}	0.91±0.13^{c}	1.21±0.27^{a}	
in y axis	0.72±0.02^{b}	0.87±0.02^{b}	0.95±0.23^{a}	
Reynold number	109379.66±2093.62	100464.84±1821.06^{c}	105236.23±2093.62^{b}	**

***%1, **%5

According to the Duncan test results, the terminal velocity and drag force of bell pepper in the harvest season of June, drag coefficient in February harvest period and the reynold number showed difference in October harvest time.

As shown in Table 1, the terminal velocity values and the drag coefficient values varied within wide limits. This is due to the physical properties of the bell pepper. Products with the same and similar linear dimensions may differ aerodynamically.

Drag coefficients were determined in two axis of bell pepper, highest value of drag coefficient was measured in x axis as 1.21 in June harvest time and the lowest value was determined in y axis as 0.72 in October harvest time. Measured drag coefficient for bell pepper ranged from 0.324 to 0.746, with a mean of 0.274 and a standard deviation of 0.045 in October harvest time for x axis, from 0.364 to 0.814, with 0.301 and a standard deviation of 0.039 for y axis. Also, drag coefficient showed that different values for January and June harvest time in x and y axis (Table 1). The analysis of variance showed that there was a significant difference drag coefficient for different harvest time (p=0.01)

The average drag force of bell pepper was found to be 1.15, 0.91 and 1.21 N for October, January and june harvest time in x axis, respectively and also, 0.72, 0.87 and 0.95 N for October, January and June harvest time in y axis. The analysis of variance showed that there was a significant difference drag coefficient for different harvest time (p=0.01)

Measured Reynold number for wind tunnel ranged from 82698.31 to 137682.44, with a mean of 109379.66 and a standard deviation of 2093.62 in October harvest time, from 68405.63 to 132630.58 with a mean of 100464.84 and a standard deviation of 1821.06 in January harvest time, from 82698.31 to 137682.44 with a mean of 105236.23 and a standard deviation of 2093.62 in june harvest time. The analysis of variance showed that there was a significant difference Reynold number for different harvest time (p=0.05)

CONCLUSIONS

There was a significant difference between harvest time for terminal velocity at 5% probability level ($p<0.05$). The highest terminal velocity found in June harvest time as 26.23 m/s.

There was a significant difference between harvest time for drag coefficient both x and y axis at 5% probability level ($p<0.05$). The highest drag coefficient measured in y axis for January harvest time.

The drag force value of bell pepper was significantly higher ($p<0.05$) at different harvest time. The highest drag force determined in x axis for June harvest time.

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PRINCIPLES OF DESIGNING AND JUSTIFICATION OF PARAMETERS OF THE COAXIAL SCHEME OF THE POWER CONTOUR OF THE STAND FOR RESOURCE TESTS OF DRIVE LINES
/
ПРИНЦИПЫ КОНСТРУИРОВАНИЯ И ОБОСНОВАНИЕ ПАРАМЕТРОВ КОАКСИАЛЬНОЙ СХЕМЫ СИЛОВОГО КОНТУРА СТЕНДА ДЛЯ РЕСУРСНЫХ ИСПЫТАНИЙ КАРДАННЫХ ПЕРЕДАЧ

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Keywords: *resource test, stand, power contour, drive line*

ABSTRACT
Reliability of units of transport and technological machines is provided by experimental working off at bench resource accelerated tests. The quality of test stands is caused by perfection of a design of a power contour and availability of service systems. Perspectives of development of tests are connected with justification of the coaxial scheme of configuration of the loading and tested elements for ensuring reliability of results, realization constructive unification of the stand and object of tests, rated justification of design data of nodes and also the automated control of the modes of loading and parameters of technical condition.

РЕЗЮМЕ
Надежность агрегатов транспортных и технологических машин обеспечивается путем экспериментальной отработки при стендовых ресурсных ускоренных испытаниях. Качество испытательных стендов обусловлено совершенством конструкции силового контура и наличием сервисных систем. Перспективы развития испытаний связаны с обоснованием коаксиальной схемы компоновки нагружающих и испытываемых элементов для обеспечения достоверности результатов, реализацией конструктивной унификации стенда и объекта испытаний, расчетным обоснованием конструктивных параметров узлов, а также автоматизированным контролем режимов нагружения и параметров технического состояния.

INTRODUCTION
Worldwide, sharing of the recovered parts of technological and transport vehicles in the total amount of consumption of spare parts reaches in the developed countries 30-35%. For increase in technology level and increase in volumes of recovery of parts in Russia it is necessary to develop the following priority directions (*Chernoivanov V., Lyalyakin V., Golubev I., 2016*): modernization of repair production, creation of the specialized repair and technology centers and quality providing the recovered parts on the basis of current advanced technologies.

In the technical sphere of agriculture act as basic regulators of quality of the made products and services (*Chernoivanov V. et al., 2011*): machinery and equipment; machine production technologies of products as process of use of the equipment; technical services in maintenance of cars in operating state; production services in performance of technology, transport, technical and other processes. However, in the course of working off of operational actions for ensuring operating state of parts of cars it is necessary authentically and with the minimum expenses of time to establish comparative quality indicators of the new, modernized and recovered products.

For mechanical transmissions of agricultural machinery, the assessment of reliability level and competitiveness is offered to be carried out by means of bench resource accelerated tests on comparative figures. At the same time, requirements of completeness of modeling of parameters of the modes of loading and control of parameters of technical condition similar under operating conditions on the equipment are imposed to stands. In practice of bench tests technical solutions on stands with a consecutive and parallel arrangement of elements of a power contour which allow to carry out accelerated tests with a possibility of forcing of parameters of loading with preservation of a physical picture of forming of refusal of the tested object (*Erokhin M., Pastukhov A., 2008*). However, possibilities of such designs are limited to durability of the technology (loading) transfers as which use tooth gears more often. In transmissions of transport and technological machines drive lines on the basis of hinges of unequal angular speeds with quill bearings are widely used (*Sărăcin I., Pandis O., Sărăcin I.A., 2017*). Owing to design features, specific loading and kinematic configuration of mechanical transmissions with drive lines, the last have low durability and limit durability of transmissions (*Ašonja A. et al., 2012*).

This paper aims to solve problems of formulation of the basic principles of designing and justification of the coaxial scheme of a power contour of the stand for resource accelerated tests of drive lines on the basis of analytical researches of a ratio of loading and durability of the technology (loading) tooth cone gears and the tested drive lines with joints IV of a standard size and quill bearings 804704K5C10.

MATERIAL AND METHOD

The stand is developed for carrying out the accelerated resource bench tests of drive lines taking into account influence of kinematic and dynamic characteristics of tooth gears by authors (Fig. 1) according to the scheme of a coaxial arrangement of the technology and experienced transfers in the closed power contour (*Sigaev A., Pastukhov A., Lopatin G., 1999*). The operation principle of the stand consists in the following: the electric motor 1 via the coupling 2 transfers power to the driving shaft 3 established in support 4 through cogwheels of technology transfer 5 and 6, by means of the managed coupling 7 through a driven shaft 8 to the tested drive line 9. The size of a torsion torque in a power contour is caused by the size of an angle of twisting of coaxial elements of the managed loading sleeve. The size of a corner of a break of joints of the drive line is defined by the angle of crossing of shaft 3 and 8.

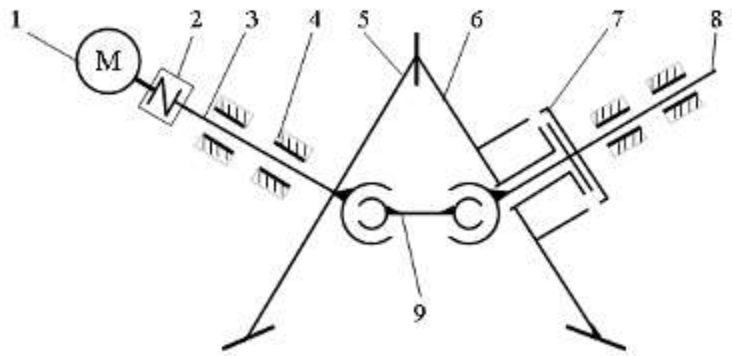


Fig.1 – The kinematic scheme of the stand for resource accelerated tests of drive lines

1 – electric motor; 2 – gum sleeve; 3 – a driving shaft, 4 – a support; 5 – leading cogwheel; 6 – the conducted cogwheel; 7 – the power managed coupling; 8 – driven shaft; 9 – drive line

Due to forming of failure of tooth gears because of contact fatigue life cycle of cone gear at a varying duty of loading is defined on the basis of a condition of summing of damages and the equation of an inclined branch of curve fatigue (*Birger I., Shorr B., Iosilevich G., 1993*):

$$t_k = \frac{a\sigma_R^m N_G}{60\sum \sigma_i^m n_i}, \qquad (1)$$

where:

t_k – period of operation of the tooth gear at the set level of tension, [hour];
a – empirical coefficient;
σ_R – limit of endurance of the tooth gear material, [MPa];
m – exponent of curve fatigue;
N_G – number of cycles of tension in an inflection point of curve fatigue;
σ_i – tension corresponding to the level of an alternating load, [MPa];
n_i – number of cycles before destruction at the set level of tension.

Life cycle of drive lines is determined by fatigue durability of cardan bearing blocks on quill bearings by the equation (*Erokhin M., Pastukhov A., 2008*):

$$t_j = \frac{2{,}2\cdot 10^6}{n\cdot\beta\cdot\sqrt{\Delta_H}}\cdot\left[\frac{C\cdot(H-L_w)}{T\cdot K_d}\right]^m, \qquad (2)$$

where:

t_j – period of operation of the drive line, [hour];

n – rotating speed of the drive line, [min^{-1}];
β – break corner in cardan joints, [°];
Δ_H – initial radial play in bearing blocks, [micron];
C – dynamic loading capacity of a quill bearing, [N];
H – distance between end faces of thorns of the crosspiece, [mm];
L_W – length of a needle roller of the bearing, [mm];
m – exponent of curve fatigue of a bearing block;
T – transferred torsion torque, [N·m];
K_d – dynamical coefficient.

Contact tension on working surfaces of teeths of technology cone gear of the stand is determined by a formula (*Birger I., Shorr B., Iosilevich G., 1993*):

$$\sigma_{Hk} = Z_E \cdot Z_H \cdot Z_\varepsilon \cdot \sqrt{\frac{3{,}85 \cdot 10^3 \cdot K_H \cdot T}{\gamma \cdot (1 - k_{be}) \cdot k_{be} \cdot d_{e1}^3 \cdot u}}, \qquad (3)$$

where:
σ_{Hk} – contact tension in a contact point of teeths of transfer, [MPa];
Z_E – coefficient characterizing mechanical properties of material of transfer, [MPa$^{1/2}$];
Z_H – coefficient characterizing a form of mating surfaces of teeths;
Z_ε – coefficient characterizing the total length of contact lines;
K_H – coefficient of increase in nominal tension;
γ – coefficient of lowering of bearing capacity of cone gears;
k_{be} – coefficient of width of a ring gear;
d_{e1} – outer dividing diameter of a cogwheel, [mm];
u – gear ratio.

Contact tension in any point of a contact pad of the cardan bearing at initial linear contact is determined by a formula (*Perel L., Philatov A., 1992*):

$$\sigma_{Hj} = \frac{2 \cdot Q}{\pi \cdot L_W \cdot 3{,}34 \cdot 10^{-3} \cdot \sqrt{\frac{Q}{\Sigma\rho \cdot L_W}}},, \qquad (4)$$

where:
σ_{Hj} – contact tension in a point contact of bodies of the cardan bearing, [MPa];
Q – load of the most loaded roller at a normal radial play, [N];
$\Sigma\rho$ – sum curvature roller of the bearing and thorn of the crosspiece, [mm^{-1}].

Thus, for the purpose of ensuring operability of a power contour of the stand it is necessary to execute analytical researches of conditions of working capacity on parameters of loading and durability of the technology and experienced transfers on the basis of criterion of contact fatigue.

RESULTS

Working off of designs of a power contour at a design stage showed that the majority of the existing stands apply consecutive alternation of the technology and experienced transfers that results in identical loading of the last and doesn't allow to carry out resource tests as with refusal of the experienced transfer the refusal of technology transfer forms. In further researches we will show what features of configuration of stands with parallel, more precisely a coaxial arrangement of elements of a power contour.

We will be the scheme of an arrangement of parts of a power contour the basis for the analysis of the coaxial scheme of configuration of a power contour of the stand (fig. 2).

We will make a balance condition of a condition of equality of a torsion torque in the technology and experienced transfers (see Fig. 2)

$$F_{tk} \cdot d_{mk} / 2 = F_{rj} \cdot (H - L_w), \qquad (5)$$

where:
F_{tk} – district force in technology cone gear, [N];
d_{mk} – average dividing diameter of a conic wheel, [mm];
F_{rj} – radial force on a cardan bearing block, [N];
$H\text{-}L_W$ – shoulder of radial force in the cardan joint, [mm].

Accepting the following basic data (*Erokhin M., Pastukhov A., 2008*): d_{mk}=255 мм, $H\text{-}L_W$=90-18=72 мм, from a formula (5) we receive that radial force on a cardan bearing block at 1.77 times more, than district force in cone gear.

Further being set by basic data for conic and cardan transfers we will establish a ratio of their loading on contact tension. For cone gear we accept (*Erokhin M., Pastukhov A., 2008*): help coefficients - Z_E=190 MPa$^{1/2}$, Z_H=2.5, Z_ε=0.9, K_H=1.5, γ=0.85, k_{be}=0.3, u=1, m=6; calculation data – m_e=8 mm, Z=38, δ=81°, Σ=162°, R_e=154 mm, d_m=255 mm, h_e=17.6 mm, d_e=304 mm; the allowed contact tension for steel 40Cr10 - $[\sigma_{Hk}]$=1510 MPa. Substituting the accepted values in formula (3), is found the dependence of contact tension on a torsion torque in a look:

$$\sigma_{Hk} = 14{,}0 \cdot T^{1/2}. \tag{6}$$

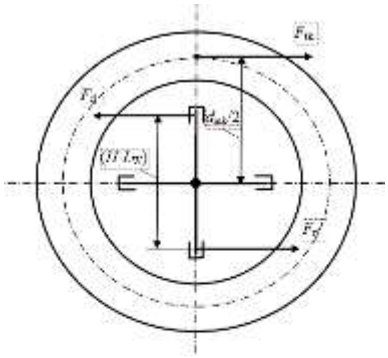


Fig. 2 – Scheme of an arrangement of parts of a power contour of the stand

For carrying out calculation on a formula (4) it is necessary to establish additional sizes. In particular, is determined the load of the most loaded roller of a quill bearing at a normal radial play by the formula (*Perel L., Philatov A., 1992*):

$$Q = \frac{5 \cdot F_{rj}}{i \cdot Z \cdot \cos\alpha}, \tag{7}$$

where:

F_{rj} – rated radial force on the bearing at torque transfer, [N];
i – number of rows of bodies of swing in the bearing;
Z – number of the loaded rollers among;
α – the angle of contact in the bearing, [°].

We determine the radial force operating on a quill bearing in the joint by a formula:

$$F_{rj} = \frac{10^3 \cdot T}{(H - L_w)} \cdot K, \tag{8}$$

where:

K – coefficient of load (K=1.3-1.5).

We carry out the accounting of geometrical parameters of the contacting bodies through the sum curvature a needle roller and a thorn of the crosspiece on a formula:

$$\Sigma\rho = \frac{2}{D_w \cdot \left(1 - {D_w}/{D_o}\right)}, \tag{9}$$

where:

D_W – diameter of a needle roller of the bearing, [mm];
D_o – average diameter of the bearing on the centers of rollers, [mm].

The following basic data for calculation of contact tension in cardan bearing blocks are accepted: geometrical parameters - H=90 mm, L_W=18 mm, i=1, Z=13, $\alpha=0°$, K=1.5, D_W=3.0 mm, D_o=25.0 mm, the allowed contact tension for steel 20Cr4 with HRC>58 - $[\sigma_{Hj}]$=3000 MPa. Substituting the accepted values in a formula (4), is found the dependence of contact tension on a torsion torque in a look:

$$\sigma_{Hj} = 107 \cdot T^{1/2}. \tag{10}$$

On the basis of formulas (6) and (10) at the set allowed contact tension, is defined a limit torsion torque for transfers:

$$T_{ultk} \le \left({[\sigma_{Hk}]}/{14.0}\right)^2 \le \left({1510}/{14.0}\right)^2 \le 11633 \text{ Nm}, \tag{11}$$

$$T_{ultj} \le \left({[\sigma_{Hj}]}/{107} \right)^2 \le \left({3000}/{107} \right)^2 \le 786 \text{ Nm.} \tag{12}$$

The analysis of these results shows that the potential loading of cone gear on a limit torsion torque in comparison with the drive line is 14.8 times higher, at the same time the level of loading of a power contour of the stand on a torsion torque shouldn't exceed 800 Nm (see Fig. 3).

Considering the fatigue nature of forming of failure of tooth gears and bearing blocks for technical system in the form of the stand we consider fair the equation of interrelation of loading and duration of tests on the basis of the equation of curve fatigue:

$$\sigma_{Hk}^{m_k} \cdot t_k = \sigma_{Hj}^{m_j} \cdot t_j \, . \tag{13}$$

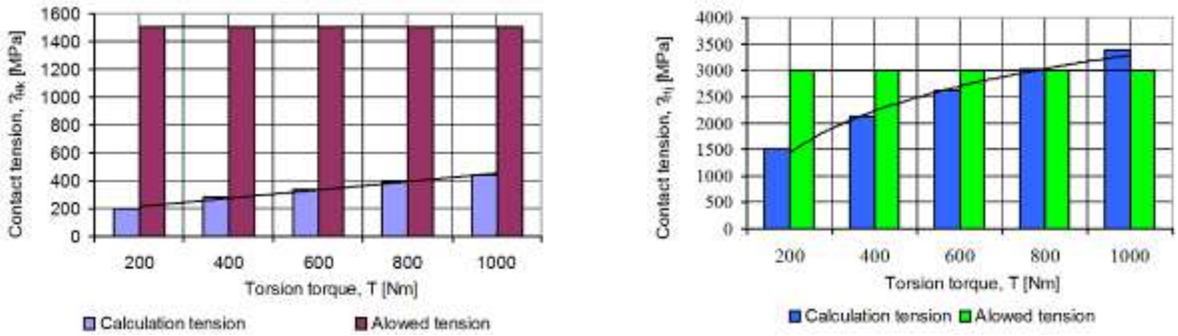
On the basis of formulas (1), (2), (6), (10) and (13) taking into account basic data and the modes of loading at the stand (Δ_H=50 micron, n=1000 min^{-1}, β=9°) we will determine duration of tests of drive lines before achievement of a limit condition of cardan bearing blocks. The equation of communication of durability of cone gear and a torsion torque in a power contour has an appearance:

$$t_k = {1.45 \cdot 10^{17}}/{T^{3.165}} \, , \tag{14}$$

and the equation of communication of durability of cardan bearing blocks and a torsion torque in a power contour has the following appearance:

$$t_j = {3.34 \cdot 10^{10}}/{T^{3.165}} \, . \tag{15}$$

The analysis of the equations (14) and (15) shows that the durability of technology cone gear significantly exceeds durability of cardan bearings (see Fig.4) that allows with one set of technology cone gear in a power contour to test a significant amount of objects - drive lines. Therefore, these results allow to claim about prospects of the coaxial kinematic scheme of an arrangement of elements of a power contour of the stand.



a) cone gear b) drive line

Fig. 3 – Contact tension in technology (a) and tested (b) transfers depending on a peredachayemy torsion torque

The given technique of engineering calculation is operable and yields reliable results if serial parts and nodes of tooth and drive lines from transmissions of transport and technological machines are applied to production of a power contour that staticizes broad unification of a design of the stand.

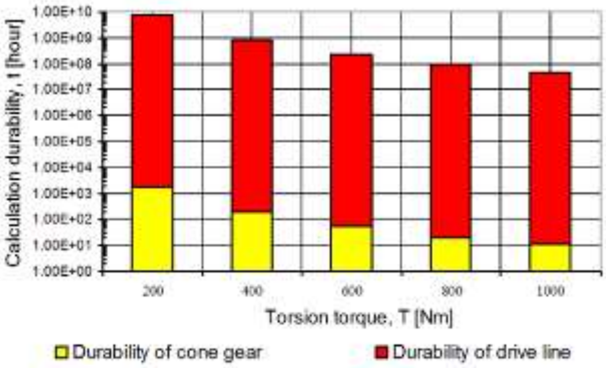


Fig. 4 – Graphic interpretation of durability of conic and cardan transfers within the range of a peredachayemy torsion torque

For ensuring reliability of modeling of conditions of operational loading in transmissions of cars, the basic power elements of the stand close to parameters of nodes and parts of transmissions of cars have to have strength and rigidity parameters (*Pastukhov A. et al. 2017*). In turn, the constructional systems of the stand have to provide modeling of the greatest possible parameters of the mode of loading (a torsion torque, rotating speed, a static and dynamic corner of a break of hinges, inertia force, dynamic influence of tooth gears and others) and control of technical condition (vibration, temperature in interfaces, a radial play, precision parameters and others) the tested objects.

Finally, for the purpose of ensuring innovation of the decision, it is necessary to provide the automated stationary and/or mobile hardware ensuring measurements and control of parameters of the mode of loading and technical condition of the tested elements allowing to carry out tests without stops, but with constant control of these tests (*Pastukhov A., Timachov E., Koshelev A., 2003*).

CONCLUSIONS

On the basis of the stated above data it is possible to draw the following conclusions.

1. Implementation of the given principles of designing of a coaxial power contour in relation to technology (toothed conic) provided to transfer and the experienced (cardan) transfer of stands creation of modern and perspective technical means for resource tests of drive lines (RU 2134412, RU 2205377).

2. As a result of rational configuration of a power contour increase in loading of elements of the experienced transfer in relation to technology at 1.77 time is reached that leads to decrease in calculated values of contact tension in cone gear in relation to the drive line more than by 7.5 times, at the same time the level of an ultimate load on a torsion torque is 800 N·m.

3. Comparison of rated durability of the technology and experienced transfers shows that at the level of a limit torsion torque in a power contour, the durability of cone gear significantly exceeds durability of the drive line that allows to increase number of the tested objects by one set of technology transfer.

4. Perspectives of researches in the field of resource tests are connected with experimental working off of designs of a power contour and metrological support of technical means and also techniques of accelerated tests, control of parameters of loading and technical condition.

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THE CONCEPT OF BIONIC DESIGN OF DEVICES FOR THRESHING COBS OF MAIZE VARIETAL
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КОНЦЕПЦИЯ БИОНИЧЕСКОГО КОНСТРУИРОВАНИЯ МОЛОТИЛЬНЫХ УСТРОЙСТВ ДЛЯ ПОЧАТКОВ СОРТОВОЙ КУКУРУЗЫ

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Keywords: *threshing, corn, grain, damage, bionics, modeling.*

ABSTRACT
The concept of designing threshing devices for high-grade maize is proposed on the basis of data on working organs of biological prototypes. The expediency of feeding cobs to threshing in a strictly oriented position in space is justified. The design of improved working bodies of threshing devices for high-grade corn is developed. Probabilistic mathematical models describing the process of transfer of cobs corn in a hopper from any chaotic position to the position necessary for effective threshing are proposed.

РЕЗЮМЕ
Предложена концепция конструирования молотильных устройств для сортовой кукурузы на основании данных о рабочих органах биологических прототипов. Обоснована целесообразность подачи початков на обмолот в строго определенном в пространстве положении. Разработана конструкция усовершенствованных рабочих органов молотильного устройства для сортовой кукурузы. Предложены вероятностные математические модели, описывающие процесс перевода початков кукурузы в бункере-накопителе из любого хаотичного положения в положение необходимое для эффективного обмолота.

INTRODUCTION
The research was conducted in accordance with the Federal scientific and technical program for the development of agriculture for 2017-2025 (decree of the government of the Russian Federation of August 25, 2017 № 996) and aimed at the effectiveness of the program in terms of increasing the number of technologies for processing and storage of cobs of varietal and hybrid corn.

At the present stage of development of threshing technology, it has not yet been solved the problem of preserving the integrity of the grain of high-quality corn when threshing it in the field and in stationary conditions. The reason for this is that the designers in the design of threshing devices solve the problem of minimizing insufficient threshing, at the same time, the percentage of grain damage is not taken into account

As a result, the threshing device separates 98.5 % of the grain from the cobs, but 30 % of the grain is damaged. Through damage to the internal tissues of varietal grains, penetrate various microorganisms and fungi, which subsequently significantly reduce the yield of corn.

It is proposed to take into account the existing experience in the design of threshing devices for corn, as a primary task to take the minimization of grain damage, which is achieved by using more advanced working bodies and optimized modes of their operation, providing differentiation of the force effect on the grain in the threshing chamber.

Scientifically based process of improving the design of working bodies of threshing devices for cobs of corn requires attention to the natural principles of construction the oral apparatus and the limbs of insects called grain pests because their design, proportions and shape as a result of long evolution, efficiency and functionality, brought to perfection.

Also, the cob of corn of any subspecies: zea mays: l. saccharata sturt; l. indurata sturt; l. indentata sturt; l. everta sturt; l. amylacea sturt it is an integral biological system, each grain of which is an independent living organism capable of reproduction. The cobs of corn has a biological symmetry, typical proportions and sizes that develop according to certain natural laws.

Therefore, these natural laws and principles should be put in the basis of the existing system of knowledge about the design of threshing devices for corn. This conceptual approach allows to combine all the research on this subject and create a unified theory of threshing corn cobs.

Within the framework of this publication, some aspects of this problem are revealed, based on which we propose to form the concept of bionic design of threshing devices for cobs of varietal maize both in the field and in stationary conditions.

MATERIAL AND METHOD

The object of research is the technological process of threshing corn. In work uses the methods of general theory of systems, methods of similarity theory of dimensions, as well as the basic provisions of physical and mathematical modeling, probability theory and modeling in applied computer programs.

RESULTS

Among the many different designs of threshing devices for corn, the most promising are those that use axial rotor systems (ARS). At present, ARS are widely used both in stationary conditions and in self-propelled combines, because they have high performance, are able to work effectively in a wide range of grain moisture, less material-intensive and require less energy for threshing relative to drum, disk and belt threshing systems. However, ARS and other system damage the grain while threshing *(Aldoshin and Zolotov, 2014).*

The technological process of threshing corn ears in the ARS consists of several operations combined at the place of time and purpose, such as: 1) feeding the cobs in the threshing chamber; 2) preliminary violation of the integrity of the grain structure of the threshed cobs; 3) the main stage of threshing; 4) final thresh. Each operation requires a different speed and trajectory of the cob and different force effects on them.

Therefore, the technological process of threshing corn in the ARS is primarily a process of continuous movement of cobs under the differentiated power action of the working bodies. In the process of threshing the cobs of corn, grain is in direct contact with the thorns of the deck the ARS.

The design and layout of these thorns is currently justified only experimentally, and the designers sought to make a universal system capable of threshing not only corn, but also other grains and legumes. In our opinion, this is not advisable, since the structure of the corn cob is unique and not comparable with the structure of the ear crops in principle. The correct design of ARS thorns is related to the shape and size of the corn cobs as a whole and grain separately.

The effective arrangement of the thorns deck ARS requires feeding the cobs parallel to the rotor axis, and this, in turn, requires the use of a special device for orientating the cobs in space and feeding them to the threshing chamber (OCSF).

This assumption is based on observations of living organisms, which show that before you make any action with a cob of corn in general, or individual grain, carried out its orientation in space in a rational position, and then the action is performed with minimal energy. Often in the wild, there is a need for multiple repetition of actions to achieve the best result. Therefore, before you start threshing the cob must be oriented in space in a rational position, and then apply them to the threshing device, where the working bodies of the optimal design and size by repeated actions with different intensity will separate the grain without causing damage to it. This approach combines all existing research in the field of differentiated threshing of corn.

To move the corn cobs in to the ARS parallel to the axis of the rotor, the OCSF must capture them from the storage hopper. Next need to do transfer corn cobs from any position in the required position and in this position to lay to the threshing chamber where the thorns of the deck of the correct shape and size arranged in a certain sequence, will be a differentiated force effect on the cob, as a result of which the grain will be separated from the rods without damage. Capturing of the corn cob from the mound is more effective if the working bodies are equipped with fingers. This assumption is also based on observations of living organisms.

As already mentioned earlier, we have made the assumption that when designing the thorns of the ARS deck and working bodies to capture the cobs of OCSF, it is necessary to focus on the principles implemented in nature. These principles as a result of evolution brought to perfection in the creation of organs of the oral apparatus and limbs of insects, called pests of grain. Analysis of the design of organs of the oral apparatus and limbs of grain pests was carried out by a double ratio of linear dimensions of the eight most common in the European part of Russia grain pests (Figure 1 and Figure 2).

The double ratio of the linear dimensions W are mathematically expressed in the form *(Petukhov S.V., 1981; Bakharev and Volvak, 2017)*:

$$W = \frac{(a + в)\cdot(в + c)}{в\cdot(a + в + c)} \tag{1}$$

where:

a, *в*, *c* – length of the surface areas of the working bodies of the studied biological prototypes, [mm].

The double ratio of the linear sizes of maize grain of the six most common in Russia subspecies was also analyzed, the average values of the length *l* of the width *b* and the thickness *h* of the grain are given in Table 1.

Statistical processing of the results of measurements and calculations of the double ratio of linear dimensions showed that:

– with a relative error of 0.45%, the double ratio of the linear dimensions of the analyzed organs of the oral apparatus is 1.29 *(Bakharev and Volvak, 2017)*;

– with a relative error of 0.51%, the double ratio of the linear sizes of the analyzed limbs is 1.21 *(Bakharev and Volvak, 2018)*;

– with a relative error of 1.05%, the double ratio of the linear grain sizes of the analyzed subspecies is 1.29.

As you can see the values of the double ratio of linear dimensions are very close, the difference is only 6%. Based on this, we can assume that the biological prototypes are chosen correctly.

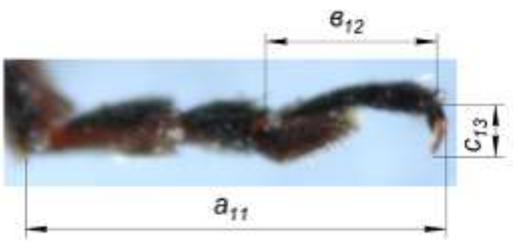


Fig. 1 – To determine the double ratio of linear sizes of three-link limbs, the most common in the European part of Russia of barn pests

a_{11} - the total length of the third link of the foot; $в_{12}$ - length of the area with the claw; c_{13} - length of the claw

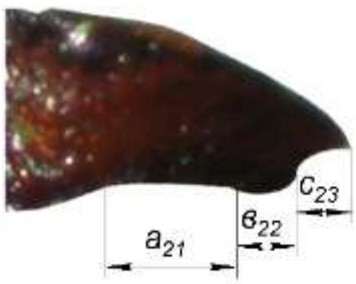


Fig. 2 – To determine the double ratio of the linear dimensions of the element of the oral apparatus, the most common in the European part of Russia of barn pests

a_{21}, $в_{22}$, c_{23} – length of the working surface areas the elements of the oral apparatus

After selecting the biological prototypes, it is advisable to assess the curvature of their working surfaces. As you can see from Figure 2 elements of the oral apparatus of grain pests have three sections of different curvature. Approximation of curves describing these areas in all analyzed prototypes gives a polynomial function *(Bakharev and Volvak, 2017)*.

In addition, a polynomial function is approximated by a curve that describes the working surface of the claw at the extremities of all the studied pests of grain.

Application of applied computer programs allowed establishing that it is advisable to use a quadratic Bezier curve defined by Bernstein polynomial to simulate the curves under study.

For the effective use of the dimensional characteristics of biological prototypes, adequate scale transformations are necessary. For this purpose, the method of geometric similarity was used *(Bakharev and Volvak, 2017)*. Implementation of the method of the geometric similarity was carried out using the solution to *π* - theorem, characterizing the similarity of dimensions. The result is a scale factor of the linear transformation:

$$k_{l(S)} = \frac{S_{KC}}{S_{KB}}, \tag{2}$$

where:

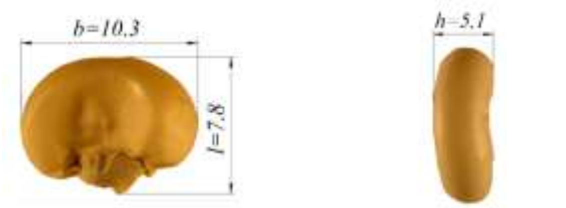
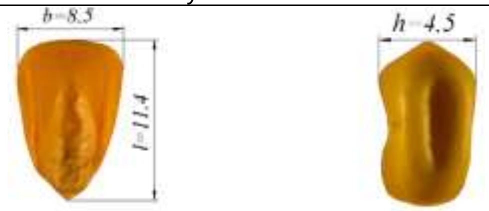
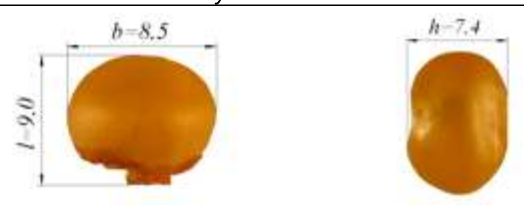
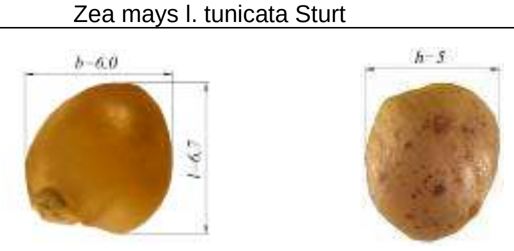
$k_{l(s)}$ – scale factor of linear transformation;

S_{KC} – the contact surface area of the grain in the cob, [mm^2];

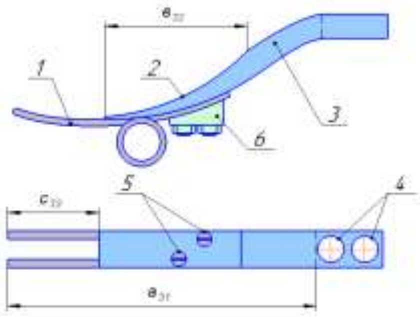
S_{KB} – the area of the working surface of the body of the biological prototype, [mm^2].

Table 1

Average values of thickness *h*, width *b* and length *l* of grain of the main subspecies of corn cultivated in Russia, [mm]

Zea mays: l. saccharata sturt	Zea mays l. ceratina Kulesh
	
Zea mays l. indentata sturt	Zea mays l. indurata sturt
	
Zea mays l. everta Sturt	Zea mays l. tunicata Sturt
	

After carrying out the corresponding measurements of the contact surface of the grain in the cobs of corn of the analyzed subspecies and the areas of the working surfaces the bodies of biological prototypes, a scale factor of the linear transformation $k_{l(s)}$, was obtained which amounted to 213.54. Knowing the curvature of the working surfaces, their shape and scale factor of linear transformation, the OCSF working fingers and the ARS thorns were modeled (Figure 3). Therefore, the threshing device should consist of two effectively working machines: OCSF, whose working organs for the qualitative capture of the cobs from the storage hopper should be equipped with fingers of the proposed design and ARS, the deck of which is equipped with thorns arranged according to a certain scheme, the proposed form (Figure 4).



I

II

Fig. 3 – New working organs

I – finger working organ OCSF; II - thorn of the deck ARS; 1 spring tip; 2 – flat part of the finger; 3 – the round part of the finger; 4 – hole for mounting; 5 – fastening screws of the spring lugs;6 – retainer spring tips; a_{31}*,* $в_{32}$*,* c_{33}*, as well as* a_{41}*,* $в_{42}$*,* c_{43} *– scaled dimensions preserving the aspect ratio, obtained by calculating the dual relationship in linear dimensions biological prototypes*

The circuit arrangement of spikes ARS and the theory of threshing corn cobs is the subject of our further studies, therefore, in this paper we theoretically revealed only some of the issues the bionic concept-oriented supply of varietal cobs of corn for threshing. Full description of the design of the proposed OCSF and its principle of operation is presented in the source *(Bakharev and Volvak, 2018)*.

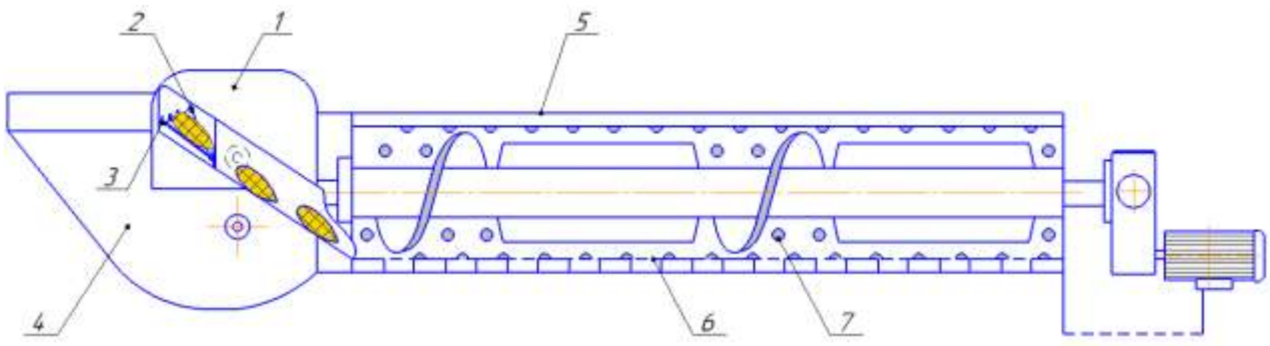


Fig. 4 – Threshing device for cobs of high-grade corn
1 – device for orientating the cobs in space and feeding them to the threshing chamber; 2 - the blade, exciting the cobs; 3 – fingers of the proposed design; 4 – storage bin for cobs; 5 – axial-rotor system 6 – deck; 7 – thorns of the proposed design

To give the corn cobs a strictly defined position in space, it is necessary to carry out their preliminary orientation in the storage bin (event A_1); primary orientation of the long side along the base plane of the blade, exciting the cobs (event A_2) and secondary orientation by means of a plate plane that relieves the cobs (event A_3). Each event has a probabilistic character and is indicated by $p(A_1)$; $p(A_2)$ and $p(A_3)$. Then, the probability of cobs orientation in the space $p(A)$ will be equal to:

$$p(A) = p(A_1) \cdot p(A_2) \cdot p(A_3) \tag{3}$$

Pre-orientation-this is an exception to the possibility of getting front and rear parts the cob corn on the working edge blade (Figure 5).

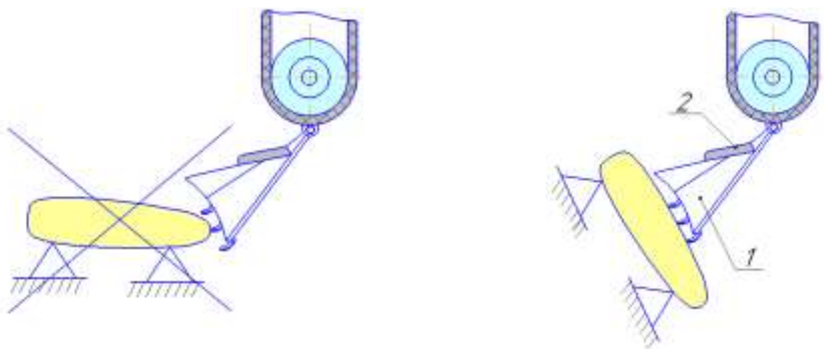


Fig. 5 – Illustration of options for preliminary orientation of cobs in the storage bin
a – unfavorable position for capture; б – position, contributing to the capture; 1 – base plane of the capturing blade; 2 – the surface that relieves the cob

Event A_1 can be considered to be accomplished regardless of whether OCSF will orient the cob corn the front or back part (two positions cob corn meet the requirements). Therefore, the probability of occurrence of an event A_1, taking into account the probability of interference from adjacent cobs $p(Q)$, can be found from the ratio of the solid angle of the cone of the neck of the hopper Θ_{GB} and the solid angle of the cob of corn Θ_{PB} (Figure 6) in:

$$p(A_1) = p(Q) \cdot \frac{\Theta_{GB}}{\Theta_{PB}} \tag{4}$$

As it can be seen from Figure 6, the considered solid angles are formed by straight circular cones. The solid angle at the top of a straight circular cone can be described by the expression *(Medvide M.V., 1963)*:

$$\Theta = 2\pi \cdot \left(1 - \cos\frac{\alpha}{2}\right), \text{ [cp].} \tag{5}$$

Then,

$$p(A_1) = p(\Pi) \cdot \left| \frac{\left(1 - \cos\frac{\alpha_{GB}}{2}\right)}{\left(1 - \cos\frac{\alpha_{PB}}{2}\right)} \right| \tag{6}$$

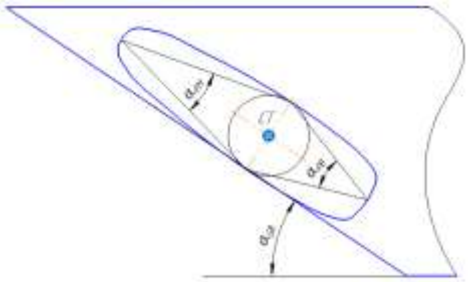
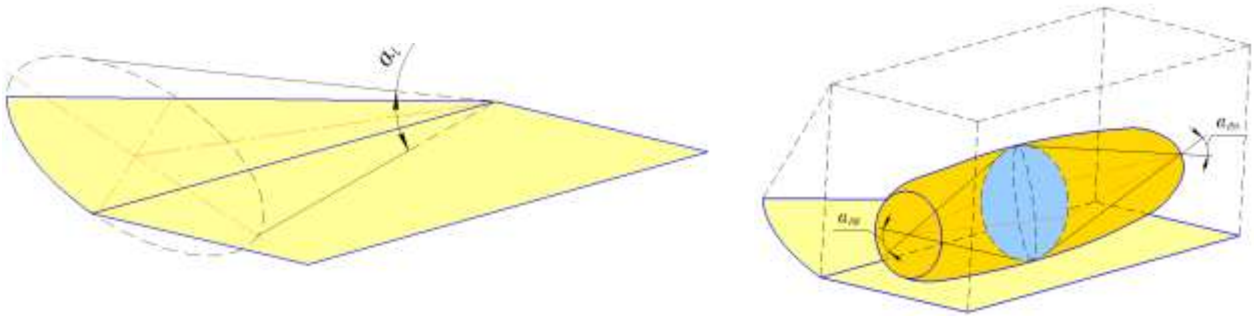


Fig. 6 – The location of the cob in the neck of the hopper drive
ЦТ – the center of gravity of the cob; $\alpha_б$, $\alpha_м$ – the angle at the top of the cob cone, forming a larger and smaller solid angle, respectively; $\alpha_{ГБ}$ – the vertex angle of the cone of the neck of the hopper

From the above it follows that for the implementation of the event A_1, to ensure effective pre-orientation of the corncob in the storage hopper, it is necessary to ensure the condition of equality of the solid angles formed by the cone of the hopper neck and the corncob.

The analysis of the size characteristics of the corncob showed that the angle at the top of the cob cone, forming its greater solid angle, is in the range of 30-38º. Therefore, the greater solid angle of the corncob is 0.22-0.34 steradian. The results of the studies described in the source *(Bakharev and Volvak, 2018)* show that the maximum angle of the natural slope of the corncob is 31.1°. Then, under the condition of stable rolling, the probability of occurrence of the event A_1 will tend to one under the condition of the slope of the walls of the hopper neck at an angle of 32-38º.

The probability of the event A_2, the primary orientation of the long side along the base plane of the blade, is determined if the corncob rotating around center of symmetry can take many different positions. These positions should be considered as equally probable and corresponding to the direction of one of the rays of the solid angle formed by the cone with the vertex α_{PB}. The surface of the gripping blade through which the primary orientation of the cob can be represented as a face of a regular tetrahedral prism connected to a part of a straight circular cone (Figure 7).



а *б*

Fig. 7 – To the definition of design features of the exciting blade
α_L – the angle at the top of the cone forming the curved part of the blade; а – curved and rectangular parts of the blade Assembly; б – the scheme of the blade with a corn cob located on it

The width of the capturing blade should be such that the cob can be rotated on it no more than an angle equal to the angle of the natural slope, under this condition the cob will not be located on the blade perpendicular to its longitudinal axis. The value of the length of the corn cob is in the range from 160-350 [mm]. Imagining this length as the diagonal of the rectangular part of the blade, its width will be 160-350·cos 31.1º=137-300 [mm] *(Petunina I.A., 2006; Petunina I.A., 2007; Truflyak E.V., 2008)*.

The cobs falling on the curved portion of the blade rolls down from it, therefore, there is a rolling conical cob on the part of a straight circular cone that forms this curved area. Then, by analogy with the event A_1, the probability of the event A_2 can be represented as:

$$p(A_2) = \left| \frac{\left(1 - \cos\frac{\alpha_L}{2}\right)}{\left(1 - \cos\frac{\alpha_{PB}}{2}\right)} \right| \qquad (7)$$

From the above it follows that for the implementation of event A_2, to ensure effective primary orientation of the long side of the cob along the base plane of the blade, it is necessary to ensure the condition of equality of solid angles formed by the curved portion of the blade and the cob of corn. The angle at the top of the cone forming the curved part of the blade α_L = 30-38º.

The probability of an A_3 event, secondary orientation by means of the support plane of the dumping plate, is determined provided that the cob is located on the blade slips off it, and through the window in the body of the OCSF enters the tray through which the cob moves to the ARS (Figure 4).

In the secondary stage of orientation of the cobs, being on the blade, in contact with its base plane on the site s_1 and the support plane of the dropping plate on the site s_2 (Figure 8). Provided that the angle of inclination of the gripping blade relative to the traction working body β and the angle of inclination relative to the horizon γ is equal to the probability of secondary orientation, event A_3 will depend on the ratio of the size of the support sites s_1 and s_2. Moreover, a condition must be provided under which the site s_1 will be larger than the site s_2, in this case, when sliding off the blade, the cob will be turned in the desired direction.

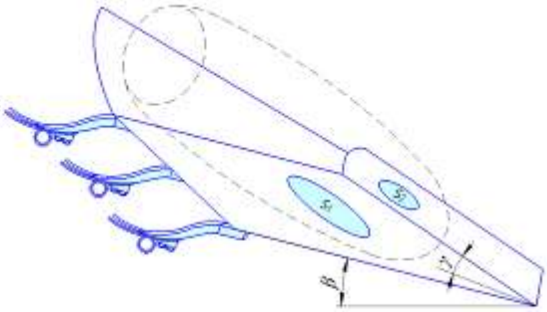


Fig. 8 – The determination of the probability of the secondary orientation of the cob of corn with a blade that captures

Therefore, the probability of an A_3 event can be represented as:

$$p(A_3) = 1 - \frac{s_1}{s_2} \tag{8}$$

where:

s_1 – the size of the contact area of the cob with the base plane of the blade, [mm^2];

s_2 – the size of the contact area of the cob with the support plane of the discharge plate, [mm^2].

It follows from the above that the probability of orientating the cobs when feeding to threshing depends on the angle of inclination of the walls of the discharge neck of OCSF storage hopper, the design features of the gripping blades and the angles of their installation relative to the horizon and the traction working body. In addition, the probability of orientating the cobs in space depends on the influence of interference of adjacent cobs in the storage bin, as well as the size of the cobs and the curvature of the outer surface.

When taking into account these conditions, uninterrupted operation of the OCSF is provided, on which the efficiency of the threshing device as a whole depends. Therefore, the correct choice of biological prototypes and their comprehensive system analysis allows developing the concept of construction of threshing devices for varietal maize, which combines all the main theoretical studies on this topic.

CONCLUSIONS

The solution to the problem of grain damage during threshing of high-quality corn is achieved by using threshing devices that use ARS loaded by means of OCSF, which allows:

– make the right choice and systematically analyze the biological prototypes of the working organs ARS and OCSF;

– serve cobs on thresh parallel to the axis of the rotor and use a rational arrangement of the ARS thorns;

– reduce the amount of damage to grain when threshing cobs of high-quality corn;

Feed the cobs to the threshing parallel to the axis of the rotor ARS requires the effective implementation of the three-step process the work of OCSF, with:

– preliminary orientation in the storage bunker will be implemented in case of equal solid angle cone of the neck of the hopper and the larger the solid angle of the cob of corn, which is achieved provided that the inclination of the walls of the neck of the hopper at an angle α_{GB} = 32-38º;

– the primary orientation of the long side along the base plane of the blade will be effective in the equality of the solid angle of the cone of the curved part of the blade and the greater solid angle of the corn cob, which is achieved by using a blade consisting of a flat rectangular and curved area, which is part of a straight circular cone with an angle at the top of α_L = 30-38º;

– the secondary orientation by means of the drop plate reference plane will be effective if the dimensions and the drop plate mounting angle are such that the support pad on the base plane of the blade is larger than on the drop plate.

Further expansion of the search for biological prototypes, system analysis of corn cobs as a complex biological system and a variety of theoretical and experimental studies will create a unified system of knowledge on this subject.

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RESEARCHES REGARDING THE EVALUATION OF THE BIOMASS POTENTIAL RESULTED FROM THE DORMANT PRUNING OF SOME VINE VARIETIES
/
CERCETĂRI PRIVIND EVALUAREA POTENȚIALULUI DE BIOMASĂ REZULTATĂ DE LA TĂIEREA ÎN USCAT A UNOR SOIURI DE VIȚĂ DE VIE PE ROD

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***Keywords**: biomass, vine plantations, solid fuels.*

ABSTRACT

Biomass is a primary carbon resource, together with other sources of renewable energy. Biomass may be used as raw material in order to produce energy, solid bio-fuels with high energetic value or biochemical fuels, all of them used for sustaining the economic activities. Nowadays, biomass is accounted for 12% of the primary energy production and in the developing countries this share may rise to 40-50% from the overall energy needs.

The debris resulted from the dormant pruning of vine may be also included among these types of raw materials.

In this paper are presented the results of the researches aiming to evaluate the biomass potential of the vine tendrils, resulted from the dormant pruning of vine in a plantation which is in its 5th year of production. The research was performed at the “Vasile Adamache” farm station of the University of Agricultural Sciences and Veterinary Medicine in Iaşi; the following parameters were evaluated: average quantity of tendrils (for each vine plant and for one surface unit); humidity of tendrils immediately after pruning; calorific value of the tendrils for each vine variety taken into account.

The experimental results show that pruning produces large amounts of biomass, which may be turned into pellets. The energetic potential of the tendrils depends on the variety of vine.

REZUMAT

Pe plan mondial biomasa reprezintă o sursă primară de carbon alături de celelalte surse de energie regenerabilă. Aceasta poate fi utilizată ca materie primă pentru a produce energie, biocombustibili solizi cu valoare energetică ridicată sau combustibili biochimici, necesare pentru desfășurarea unor activități economice. Astfel, în prezent biomasa contribuie cu aproximativ 12% la producţia de energie primară în lume, iar în statele în curs de dezvoltare aceasta ocupă 40 - 50% din necesarul asigurării cu energie.

In categoria acestei materii prime pot fi incluse și deșeurile rezultate de la tăierea în uscat a plantațiilor de viță de vie.

In cadrul prezentei lucrări s-au efectuate cercertări pentru a determina potențialul de biomasă sub formă de corzi (râpcă) rezultate de la tăierea în uscat a unor soiuri de viță de vie, de pe o plantație pe rod, aflată în anul 5 de exploatare. În cadrul cercetărilor efctutate la Ferma “Vasile Adamache”, de la Stațiunea Didactică și Experimentală din cadrul Universității de Științe Agricole și Medicină Veterinară “Ion Ionescu de la Brad” din Iași, s-au determinat următorii parametri: cantitatea medie de corzi rezultată de pe fiecare butuc și de pe unitatea de suprafață; umiditatea corzilor la momentul tăierii, precum și puterea calorică a corzilor pentru fiecare soi de viță de vie luat în studiu.

Din analiza și interpretarea rezultatelor reiese că din tăierea-curățarea plantațiilor de viță de vie se obțin cantități importante de biomasă, care poate fi valorificate superior, sub formă de pelete. Potențialul enegetic al corzilor este diferit, în funcție de soiul de la care s-au recoltat.

INTRODUCTION

The energy supplies of modern civilization come mostly from three types of sources: conventional fossil fuels, respectively coal, petroleum and natural gases; nuclear fossil fuels (especially uranium); renewable sources. The term renewable energy sources referrs to the energy sources which are not based on reserves, containing energy form natural renewable processes. This category includes numerous types of energy available from the environment: radiant solar energy, accumulated solar energy, the energy of running waters, wind energy, geothermal energy, potential chemical energy stored in biomass etc. (*Vlăduț et al., 2012; Picchi et al., 2013*).

An important part of renewable sources is represented by the energy contained in biomass, which contributes with 14% to the worldwide consumption of primary energy (*Hall, 1997; Tudor, 2009*). The term biomass is referring to the non-fossil organic matters as wooden debris, agricultural waste, forest, agricultural and industrial vegetable waste, seeds and fruits of different agricultural crops. In a broader understanding biomass includes all forms of vegetal and animal material, grown and developed on earth surface, in the water or on the water, as well as the substances resulted from biological development (*Tudor, 2009*), and the definition given by the EU Directive 2009/28/EC on the promotion of the use of energy from renewable source, "*biomass means the biodegradable fraction of products, waste and residues from biological origin from agriculture (including vegetal and animal substances), forestry and related industries including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste*".

Vegetable biomass is the most valuable renewable energy resource, as it is the result of the photosynthesis process: based on the CO_2 input from the atmosphere and water input from soil, under the effect of solar radiation, a product with high hydrocarbon content is produced. Vegetable biomass may be used as firewood (traditional use), liquid biofuel for engines, biogas, briquettes, pellets etc. When biomass is used as burning solid fuel the oxygen in the atmosphere is combined with the carbon contained by the plants, resulting in CO_2 and water. This is a cyclic process, as the carbon dioxide is again absorbed by the plants in what is known as the carbon cycle (Figure 1) (*Ion, 2006*).

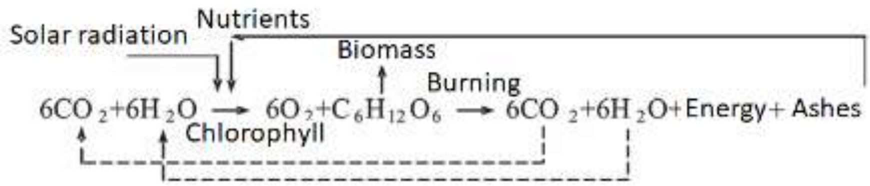

Fig.1 – *Carbon cycle in nature* (*Ion, 2006*)

Worldwide researches have proven that the waste resulted from the dormant pruning of vines is an important biomass resource. The quantity of biomass resulting from the pruning of vine depends on the growth system, the age of the exploitation, variety (Merlot, Cabernet, Chardonnay etc.), geographical location of vineyard etc (*Silvestri, 2011; Velazquez-Marti B et al., 2009*).

In the present paper the research was focused on the evaluation of the amount of biomass resulted from the dormant pruning of different varieties of vines and on the calculation of the energy potential assuming the superior use of the vine tendrils *(Spinelli et al., 2011)*.

The use of the tendrils resulted from the dormant pruning of vine is important both from an economic point of view and for the environment protection. Considering that vineyards in EU are accounted for more than 3.2 mil. hectares and that approximately 1 ton of biomass may be collected from each hectare, it results that more than 3.2 mil. tons of biofuel would available from the above mentioned surface. In the meantime, the superior use of this waste is environmentally friendly, avoiding the pollution with smoke, dust and unpleasant smell (*Silvestri, 2011; Velazquez-Marti B et al., 2011*).

MATERIAL AND METHOD

In order to evaluate the biomass potential from dormant pruning, vine tendrils were collected from the vineyard of Research Station of the University of Agricultural Sciences "Ion Ionescu de la Brad" from Iași, farm no. 3 „Vasile Adamachi".

The vineyard is placed on a terrain with the following features:

- the relief consists of positive and negative shapes. large plateaus with 2...3% slope, sides with 10...25% slopes and narrow valleys with altitudes between 80 and 180 m, with south-eastern exposition of the sides;
- the soil is a loamy chernozem, formed on loess loam;
- soil texture is differentiated in depth: loam and clay-loam down to 30 cm; loam at the depth of 30-50 cm; sand bellow 50 cm;
- soil structure is adequate due to the high humus content, well developed average acinose down to 30 cm and moderately developed under 30 cm, no specific aggregates being present;
- temperate-continental climate due to the geographic position, to the relief characteristics and to the influence of the Atlantic and Siberian anthropics, being integrated into the moderate-continental climate of

Central Moldavian Plateau and the excessively-continental climate of Moldavian Plain.

The vineyard covers 12 hectares and is divided into 11 plots, including 8 vine varieties; it is in second production year. The distance between the rows is 2.3 m and 1.2 m between the vines in a row. The semi-high train system is used, with the productive elements being placed on 60-80 cm high stems; there is a mixed pruning system, with the productive elements being placed on unilateral or bi-lateral cordons. Taking into account that the vines are young, formation pruning was applied.

In order to evaluate then biomass potential tendrils from 20 different vines, placed on different rows, were collected; the vineyard varieties were: Busuioacă de Bohotin, Fetească neagră, Fetească albă, Fetească regală, Sauvignon blanc, Muscat ottonel, Pinot noir and Cabernet sauvignon.

The tendrils collected from each vine and variety were weighted; the the humidity was calculated and, in order to measure the calorific value, the tendrils were chopped and dried.

The humidity (dry basis) was evaluated using the drying closet method, at 105 ^{0}C, the sample being maintained until no humidity variation was recorded. The humidity (dry base) was calculated with the formula:

$$U = \frac{m - m_0}{m_0} x100(\%) \tag{1}$$

where:

m – sample mass before drying (natural state) [g];

m_0 – mass of the same sample after drying [g].

The tendrils were chopped in two stages: rough chopping and fine chopping (5-25 mm particle length – Fig. 2). The garden chopper Hecht 6173 (Fig. 3) was used for rough chopping; fine chopping was achieved with a laboratory hammer mill grinder.

The grinded samples were dried to a humidity of 8% (Table 1), using a specialized laboratory rig. Fig. 4 presents the operating diagram of the laboratory drying rig; it is equipped with touch-screen and microprocessor for the control and surveillance of the drying process.

Fig. 2. - Tendril samples, grinded and dried:
1 - Busuioacă de Bohotin; 2- Fetească neagră; 3 - Fetească albă; 4 - Fetească regală; 5 - Sauvignon blanc; 6 - Muscat ottonel; 7 - Pinot noir; 8 – Cabernet sauvignon.

Fig. 3 - Garden chopper
Type: Hecht 6173; engine: 4 strokes S.I., 6 BHP, 173 cm^3

The gross and net calorific values were measured within the specialized laboratory at ICIA Cluj-Napoca. The gross calorific value takes into account both the heat generated by fuel combustion and the latent heat of condensation contained by the water vapour, while the net calorific value measures only the heat generated by fuel combustion. The calorific values were evaluated using standardized methods.

The gross and net calorific values of vineyard grapes samples were carried out using a Parr 6200 Isoperibol Calorimeter, according to standards DIN 51900 -1:2000 (Determination of gross calorific value of solid and liquid fuels using the bomb calorimeter, and calculation of net calorific value) and DIN 51900-2:2003 (Determination of gross calorific value of solid and liquid fuels).

Sample pellets of 1.0 g were used for each analysis. A nickel ignition wire was placed in contact with the pellet. The bomb was filled with oxygen at 25°C with 1.0 cm^3 distilled water added to the bomb. The calorimeter was placed in an isoperibol jacket with an air gap separation of 10 mm between all surfaces. The bomb calorimeter was submerged in a calorimeter and filled with distilled water. The calorimeter jacket was maintained at constant temperature by circulating water at 27°C. The gross calorific value of the samples was calculated from the corrected temperature rise and the effective heat capacity of the calorimeter.

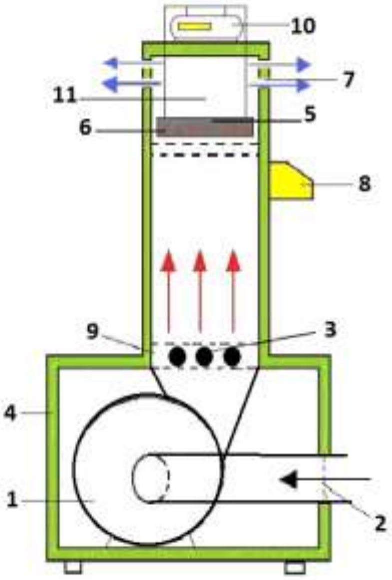

Fig. 4. - Operating diagram of laboratory drying rig:

1 –fan;
2 – air intake;
3 – grate;
4 – thermal insulation;
5 – product tray;
6 – products;
7 – drying agent discharge ports;
8 – touch – screen interface;
9 –electric heaters;
10 – electronic balance;
11 – drying chamber;
12 – electric motor.

The net calorific value differs from the gross calorific value in that the water in the samples before combustion and that formed during combustion of hydrogen-containing compounds in the sample in the gaseous state, at 25°C, after combustion. The net calorific value was calculated using the moisture, ash, carbon, hydrogen and sulphur contents of the samples.

The Ash content was determined by calcination at 550 °C according to standard ISO 1762:1974 (Pulps –Determination of ash). The moisture content was determined according to standard ISO 11465:1993 (Soil quality –Determination of dry matter and water content on a mass basis –gravimetric method).

The carbon, hydrogen and sulphur contents was determined by using a Flash EA 2000 CHNS/O analyser (Thermo Fisher Scientific, USA) according to standards ISO 10694:1995 (Soil quality - Determination of organic and total carbon after dry combustion (elementary analysis), ISO 13878:1998 (Soil quality -- Determination of total nitrogen content by dry combustion ("elemental analysis") and ISO 15178:2000 (Soil quality --Determination of total sulphur by dry combustion) (Table 1).

Table 1

Chemical composition used for the calculation of calorific value

Nr. crt.	Variety	N (%)	C (%)	H (%)	S (%)	Ash (%)	Moisture (%)
1	Busuioaca de Bohotin	0.837	43.6	5.89	<0.01	2.69	8.20
2	Fetesca Neagra	0.996	43.8	5.84	<0.01	6.01	7.78
3	Feteasca Alba	1.000	44.6	6.14	<0.01	5.92	8.01
4	Feteasca Regala	0.874	44.0	5.66	<0.01	6.48	8.07
5	Sauvignon Blanc	1.600	43.1	6.23	<0.01	5.92	8.19
6	Muscat Ottonel	0.896	44.1	6.05	<0.01	4.34	7.89
7	Pinot Noir	0.851	43.9	5.83	<0.01	5.83	8.02
8	Cabernet Sauvignon	0.902	43.9	5.98	<0.01	4.93	7.86

RESULTS

The tendrils which resulted from dormant pruning of vines were separately collected from each vine, were chopped and then wrapped in individually marked (plot number and current number) plastic bags.

Table 3 presents the amount of tendrils (biomass) harvested for each vine and variety, as the average value for 20 samples. In order to calculate the biomass potential for one hectare the distances between rows (2.3 m) and between vines in a row (1.2 m) were considered, resulting in 3623.19 vines/ha.

The analysis of data presented in Table 2 showed that the amount of harvested biomass depends on the vineyard variety; the lowest value of 0.327 kg/vine, respectively 1184.8 kg/ha was recorded for Cabernet sauvignon and the highest value of 0.433 kg/vine, respectively 1568.8 kg/ha for Muscat ottonel.

Table 2

The amount of biomass from each vine, variety and surface unit

Nr. crt.	Variety	Average amount of tendrils per vine (kg/vine)	Average amount of tendrils per hectare (kg/ha)	Humidity of tendrils (%)
1	Busuioacă de Bohotin	0.332	1202.9	49.75
2	Fetească neagră	0.367	1329.7	49.60
3	Fetească albă	0.347	1257.3	51.38
4	Fetească regală	0.343	1242.8	49.99
5	Sauvignon blanc	0.370	1340.6	53.35
6	Muscat ottonel	0.433	1568.8	49.20
7	Pinot noir	0.420	1521.7	50.91
8	Cabernet sauvignon	0.327	1184.8	48.28

The humidity of vines was comprised between 42.28% for Cabernet sauvignon and 53.35 for Sauvignon blanc.

In order to emphasize the energy level which could be obtained as a result of the dormant pruning operation, the amount of dry substance harvested from one hectare was calculated. The upper and lower calorific values were evaluated according to the described method and then the energy potential was calculated (Table 3).

Table 3

Energy potential of biomass harvested during dormant pruning of vine

Nr. crt.	Variety	Amount of biomass (dry base) [kg/ha]	Calorific value (dry base) [MJ/kg]		Energy potential (dry base) [MJ/(kg.ha)]	
			Gross	Net	Gross	Net
1	Busuioacă de Bohotin	604.45	15.90	14.47	9610.75	8746.39
2	Fetească neagră	670.17	17.405	15.99	11664.31	10716.02
3	Fetească albă	611.30	17.48	16.01	10685.52	9786.91
4	Fetească regală	621.52	2.00*	0.632*	1243.04*	392.80*
5	Sauvignon blanc	625.39	16.98	15.66	10619.12	9793.61
6	Muscat ottonel	796.95	17.07	15.62	13603.94	12448.36
7	Pinot noir	747.00	14.49	13.08	10824.03	9770.76
8	Cabernet sauvignon	612.78	17.21	15.77	10545.94	9663.54

*Note: for the Fetească regală variety the test will be repeated in the next season

The gross and net calorific values of the tendrils depend on variety, with values comprised between 13.08 MJ/kg for the net calorific value and 17.48 MJ/kg for the gross calorific value. The data show that the calorific value of the Fetească regală tendrils is much lower compared with the other varieties; as a result we take into account a re-evaluation of these results in the next pruning season and they were not used in the subsequent interpretation of the results.

When comparing the calorific value of vine tendrils with the one of dry firewood (which is comprised between 12.56 MJ/kg and 16.75 MJ/kg) we concluded that the values are very close to each other. The energy potential of the tendrils harvested from one hectare of vineyard is comprised between 8746.39 MJ/(kg.ha) and 13603.94 MJ/(kg.ha), which is equivalent to the energy contained by 696.37-812.18 kg of firewood. This confirms the value and energy potential of the vine tendrils, which turn out to be an important resource of renewable energy.

CONCLUSIONS

The analysis of both the elements presented in the first part of the paper and the experimental results led to the following conclusions.

- biomass is a primary source of carbon, together with the other sources of renewable energy;
- vegetable biomass is the most valuable of the renewable energy sources due to the cyclic evolution of carbon;
- the amount of biomass harvested from the dormant pruning of vine depends on the vine variety. being comprised between 1184.8 kg/ha and 1568.8 kg/ha;

- the calorific value of vine tendrils is comprised between 13.08 MJ/kg (net calorific value) and 17.48 MJ/kg (gross calorific value);
- a comparison between the calorific values of tendrils and firewood (12.56 MJ/kg...16.75 MJ/kg) shows that there are very small differences between them from this point of view;
- the energy potential of the tendrils harvested from one hectare of vineyard is comprised between 8746.39 MJ/(kg.ha) and 13603.94 MJ/(kg.ha), which is equivalent to the energy contained by 696.37- 812.18 kg of firewood

ACKNOWLEDGEMENT

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RESEARCH ON THE IMPORTANCE OF THE QUANTITY OF AVAILABLE BIOMASS AND ITS USE
/
CERCETĂRI PRIVIND IMPORTANȚA CANTITĂȚII DE BIOMASĂ DISPONIBILĂ ȘI UTILIZAREA EI

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Key words: *biomass, calorific value, moisture content, wood*

ABSTRACT

This research approaches a present topic in the field of energy production from energy renewable sources, evaluating the energetic potential of biomass, by increasing the caloric power and the efficiency of using the wood in combustion. Taking into consideration the fact that the biomass is a worldwide spread source and presents a potential to produce solid, liquid and gaseous fuel, an experimental research is necessary. The present researches must start from the determination of caloric power, to continue with the determination of moisture influence, and finally to move forward to the assessment of the efficiency of using wooden biomass by increasing the caloric power, by dry thermal treatment in oxygenated environment.

REZUMAT

Prezenta cercetare abordează o temă de actualitate în domeniul producerii energiei din surse regenerabile de energie, cu evaluarea potențialului energetic al biomasei, prin mărirea puterii calorice și eficienței utilizării lemnului în combustie. Având în vedere faptul că biomasa este o sursă larg răspândită în lume și prezintă potențial de a produce combustibil solid, lichid și gazos, este necesară cercetarea experimentală. Cercetările actuale trebuie să pornească de la determnarea puterii calorice, să continue cu determinarea influenței umidității, iar în final să se treacă la evaluarea eficienței utilizării biomasei lemnoase prin creșterea puterii calorice, prin tratarea termică uscată în mediu oxigenat.

INTRODUCTION

In 1870, at worldwide level, the biomass was covering approximately 70% of the necessary of energy, which then let the floor for the hydro and photovoltaic fuels, and nowadays is still the main fuel for the production of energy in the countries in developing process (*Cleveland 2009, Astbury 2008, Priddle 1998*).

The energetic sources present nowadays on the energetic market were classified on three categories: fossil fuels, nuclear resources and renewable energetic resources (*Lunguleasa, 2007*).

According to the descriptions of (*Swithenbank, 2011*), the first stage consisted on the decomposition of fossil fuels (1892) and the methods of obtaining energy from them, the second stage starts in the moment when the energetic crisis appeared in the 1970, which led the population towards new directions and visions of producing energy among which renewable energy sources. The third stage consists on exploiting and providing the necessary of energy.

There are known several methods to produce energy, respectively: water power, sun power, wind power, geothermal power, fossil fuels power and nuclear power. The development of the society depends on a great measure on the energy consumption. According to some researches it is considered that fossil fuel will be enough just until 2015 – 2020.

On a world-wide level there were implemented solutions to solve these problems with a tendency of using rationally the energy and discovering new sources of renewable energies. Nowadays, energy is mainly produced from fossil fuels, which are non-uniformly spread on the Earth. In the world, fuels might be found in three different shapes, respectively fossil fuels, nuclear and renewable fuels. Fossil and nuclear fuels, according to the research conducted by European Union are seriously harmful to the environment.

The biomass is one of the renewable energy sources used from the oldest times by people. Biomass is a renewable energetic source, because it increases from one year to another, it is widely spread world –

wide and presents low costs in comparison to the fossil fuels, the biomass resources, from which fuel material is produced may include wood and wooden wastes, agricultural cereals and wastes resulted from their production, aquatic biomass and algae.

Biomass is one of the forms of renewable sources which may be converted into solid, liquid and gaseous energetic fuel and which may generate energy as heat by its burning, as well as electrical energy by conversion processes (*Lunguleasa, 2007*).

Biomass is environmentally friendly and a neutral energy against the emissions of carbon dioxide. The carbon dioxide is absorbed by the plants during the growing process and forms a closed circuit, because the quantity of carbon dioxide which was absorbed by the plants during the growing process will be equal to the one which was eliminated during the complete burning process (*Eisentraut A, Brown A., 2012*). The biomass may be used in the combustion process and mainly it does not require very high investments as the hydro, solar, wind and geothermal energy do.

Currently, the biomass contributes with approximately 12% to the production of primary energy in the world, and in the developing countries it covers 40-50% of the necessary of energy. The biomass is the alternative source that, according to (*Berkesy, 2012*) contributed with 7% from the energy produced in the world. Presently, the use of renewable fuel materials such as wooden wastes for producing biofuels increases the chances of biomass in the availability level on the energetic market.

The research of energetic market highlighted the following fuel materials which produce energy: fire wood, sawdust, woodchips, briquettes, pellets.

The sawdust resulted from the wood processing has an important role in many European countries. Normally, the wood bark and the sawdust are organic materials which usually do not pollute the environment.

The frame saw sawdust combined with the rain, snow or waste water easily enters the environment and pollute the underground water or the lake close by carrying along the dissolved material, including substances used for treating the wood. According to the statistics, approximately 1600 tons of sawdust collected and processed yearly come from renewable resources, this thing means approximately 1600 tons of forest wood less or saving 9,2 hectares of forest, at an average of 218 m^3 of wood per hectare.

MATERIALS AND METHODS

1. Determining the caloric power of the bark

The installation used for determining the caloric power of the wooden biomass was the explosive burning calorimeter type XRY-1C, produced by Shanghai Changji Geological Instrument Co from China.

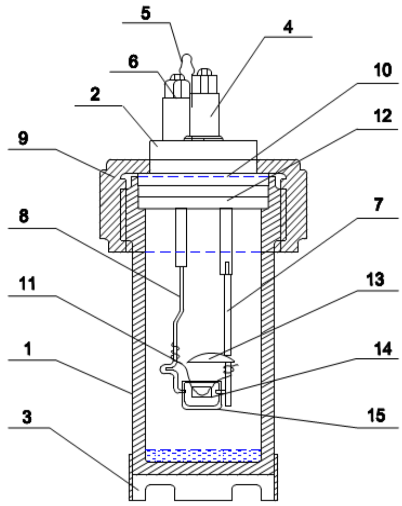

Fig.1 - Section view through calorimetric bomb

Before proceeding to the attempting, the gauging of the calorimetric bomb is made with benzoic acid, using benzoic acid with a value of known caloric power (26463 kJ/kg).

The inferior caloric power of wood is determined based on the superior caloric power.

$$PCi = PCs – 6\ (U + 9h)\ [kJ/kg] \tag{1}$$

where:

PCs- superior caloric power, kJ/kg

U- wood sample moisture, kJ/kg

h- hydrogen content of wooden sample, 3,6%.

The method to determine the caloric power of the wooden material refers mainly to the preparation of the raw material and the installation, then to the proper determination and finally to the obtaining of the result.

The testing sample 1 is tied to the cotton thread 2 and is put in the bomb box 3. The copper nickel thread 4 is tied to the sample and the cotton thread, after which the protection covers 5 is put correctly. The box is connected to the calorimetric bomb cover 6 through two electrodes 7 and 8, which continue with the electrical threads for calorimetric bombs coupling 9 and 10. By threading the cover the bomb 11 is coupled to fitting 12 to the oxygen cylinder, introducing 30 atmospheres.

2. Determining ash content

In order to determine the ash content of the grapes remains, the general method of standardized determination was used (ASTM D2866-11, 2012). According to this method, the milled and dried material until 0% humidity is baked at a temperature of 750°C in a lab oven, during 3 hours at least (Fig. 2). The advanced burning operation is made on a metallic melting pot resistant to high temperature, and the weighting was made on an analytical balance with a 3 decimal precision.

When determining the ash content it will be taken into consideration that the sample is completely dried and the cleaned and empty melting pot weight.

$$A_c = \frac{m_{a+c} - m_c}{m_{s+c} - m_c} \cdot 100\ [\%] \tag{2}$$

where:

m_{a+c} -mass of ash plus crucible;

m_{s+c}- mas of sample plus crucible;

m_c- crucible mass.

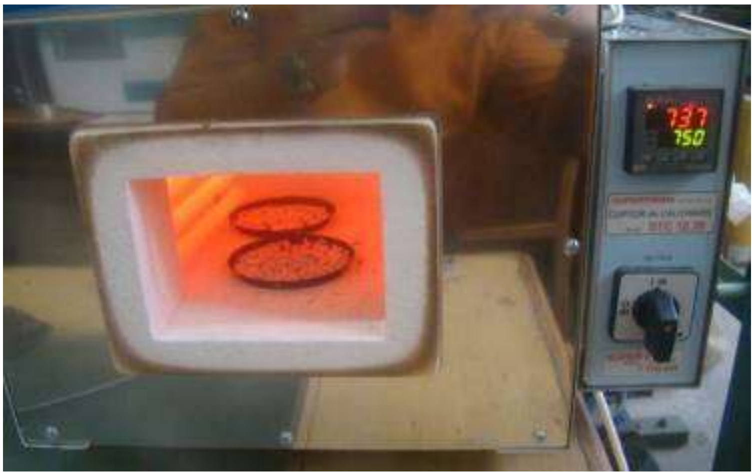

Fig. 2 - Baking oven for determining the ash content

RESULTS

The description of the process to determine the caloric power is presented in Figure 3.

The test consists in three different stages:

- The initial stage ("fore") has as purpose the determination of temperature variations of water in the calorimetric recipient, due to the heat exchange with the exterior before burning. During this period, usually for 5 minutes, it is indicated and read at one minute periods the temperature with the precision thermocouple. The last reading of the temperature form the initial period represents in fact the first temperature in the main period. The values of the temperature registered in this period are generally six. After registering the 6^{th} value the lighting of the material takes place and its reading on the menu bar (Burning time).
- The main period ("main") begins by burning the sample and has as consequence the increase of water temperature in the calorimetric recipient, due to the burning of wooden particles and heat delivery. To determine the final temperature the value of the temperature is indicated at one minute periods. The values

registered during this period vary according to the burning time of the fuel material in the calorimetric bomb. The number of values may vary between 19–42 values of temperature registered during this period.

- The final period ("after") has as purpose the determination of the average water temperature in the calorimetric recipient, due to the heat exchange with the exterior after burning. Identical to the first stage, the temperature is indicated at half minute periods, for 4-5 minutes, averagely there are registered 8-10 values of the temperature variation.

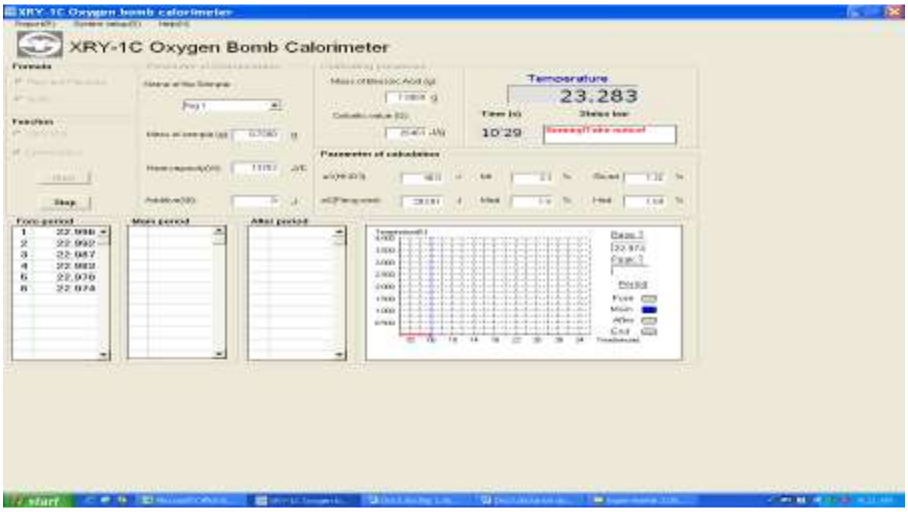

Fig. 3 - Description of the process to determine the caloric power

With measurement are performed values: for spruce of bark, mass sample 0.5100 g, net calorific value 19441 kJ/kg, gross calorific value 18943 kJ/kg, for U =0%, mass sample 0.4914 g, net calorific value 17372 kJ/kg, gross calorific value 16672 kJ/kg, for U =10%, mass sample 0.7100 g, net calorific value 15552 kJ/kg, gross calorific value 14153 kJ/kg, for 20%, mass sample 0.7890 g, net calorific value 10092 kJ/kg, gross calorific value 6594 kJ/kg, for U = 50% (Figure 4).

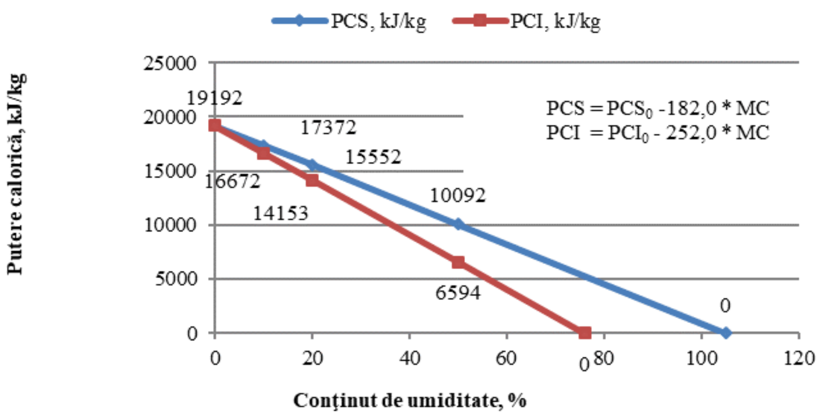

Fig. 4 - Calorific value for spruce bark

The following values are obtained from measurements: for poplar bark, mass sample 0.7400 g, net calorific value 19665 kJ/kg, gross calorific value 19152 kJ/kg, for U =0%, mass sample 0.4964 g, net calorific value 17563 kJ/kg, gross calorific value 16862 kJ/kg, for U =10%, mass sample 0.3800 g, net calorific value 15723 kJ/kg, gross calorific value 14321 kJ/kg, for 20%, mass sample 0.8730 g, net calorific value 10203 kJ/kg, gross calorific value 6698 kJ/kg, for U = 50% (Figure 5).

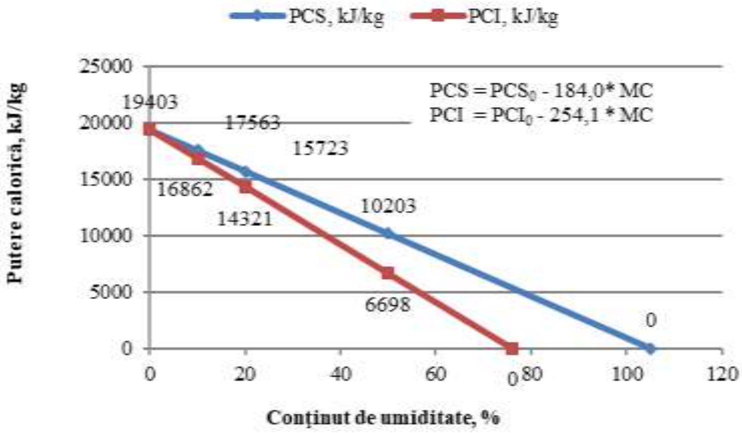

Fig. 5 - Calorific value for populus of bark

The following values are obtained from measurements: for beech of bark, mass sample 0.8900 g, net calorific value 19181 kJ/kg, gross calorific value 18681 kJ/kg, for U =0%, mass sample 0.6600 g, net calorific value 17137 kJ/kg, gross calorific value 16737 kJ/kg, for U =10%, mass sample 0.6371 g, net calorific value 15344 kJ/kg, gross calorific value 14544 kJ/kg, for 20%, mass sample 0.8790 g, net calorific value 9963 kJ/kg, gross calorific value 7963 kJ/kg, for U = 50% (Figure 6).

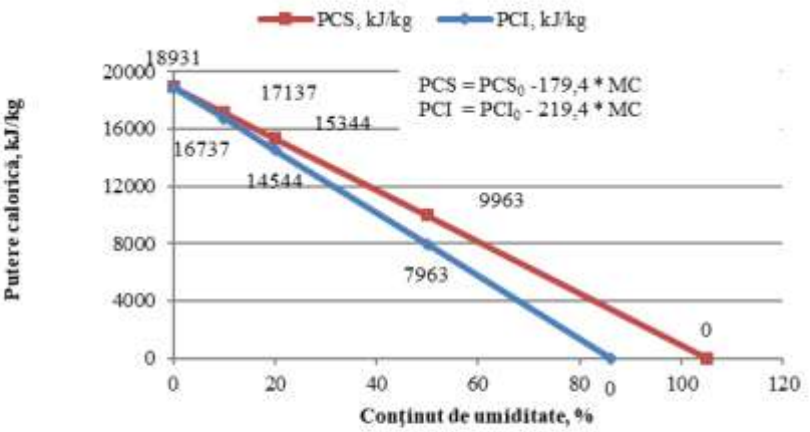

Fig. 6 - Calorific value for beech of bark

CONCLUSIONS

The incomplete combustion has severe effects on the environment discharging in the atmosphere a large quantity of carbon dioxide.

Generally, the burning process of the bark develops in the same conditions as the massive wood biomass. The sole difference is the content of ashes and the difference of chemical composition. This contributes to the implementation in the field of bark burning of the technologies adapted to large contents of ash. The ash content for spruce of bark is 2.6%, for populus of bark is 2.8%, for beech of bark is 2.9%.

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EXPERIMENTAL MEASUREMENTS FOR TESTING SOME AUTOMATED MONITORING SYSTEMS OF CONVEYOR BELTS IN THE COMPOUND FEED FACTORIES
/
MĂSURĂTORI EXPERIMENTALE PENTRU TESTAREA UNOR SISTEME AUTOMATIZATE DE MONITORIZARE A BENZILOR TRANSPORTOARE DIN FABRICILE DE NUTREȚURI COMBINATE

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Keywords: *conveyor belts, rotation, magnetic sensors, response time, productivity*

ABSTRACT

The main objective of any compound feed factory is to obtain finished products with a higher quality, in the shortest possible time and at lowest cost price. For this must be endowment with equipments with a high degree of mechanization, automation and computerization, with high productivity and low consumptions.

Considering the importance of the raw material transport activities, but also of the finished products obtained, this article proposes an experimental study regarding the possibilities to achieve some dedicated devices for monitoring and automatized control of conveyor belts from a compound feed factory (CFF).

The proposed experimental model for implementation involves the use of some magnetic sensors for monitoring the rotational speed of the drums that act on the conveyor belts, which by the measured parameters allow prompt transmission of signals to the control panel of signals to stop the motor operation if a change is detected at the optimal running rhythm established for that work installation.

ABSTRACT

Obiectivul principal al oricărei fabrici de furaje combinate este obținerea de produse finite cu o calitate superioară, în cel mai scurt timp posibil și la cel mai mic preț. Pentru aceasta trebuie dotată cu echipamente cu grad ridicat de mecanizare, automatizare și computerizare, cu productivitate ridicată și consumuri reduse.

Cunoscând importanța activităților de transport a materiilor prime, dar și a produselor finite obținute, acest articol propune un studiu experimental privind posibilitățile de realizare a unor dispozitive dedicate pentru monitorizarea și controlul automatizat al benzilor transportoare dintr-o fabrică de furaje combinate.

Modelul experimental propus la implementare implică utilizarea senzorilor magnetici de monitorizare a vitezei de rotație a tamburilor ce acționează benzile de transport, care prin parametrii măsurați permit transmiterea promptă către panoul de control a unor semnale de oprire a funcționării motoarelor în cazul detectării unei modificări în ritmul optim de funcționare stabilit pentru respectiva instalație de lucru.

INTRODUCTION

The increase of animal feed consumption in zootechnical farms has also determinated a diversification of the offers of compound feeds produced by the profile factories, according to the species and the age of animals for which are intended in the feed process, in accordance with the standards and the rules imposed by the specialists in this field (*Bădescu et al., 2005; Vasile, 2010*).

The production of compound feed is a high interest activity because they represent an important source of food for animals of the zootechnical farms, thus having a role essential in obtaining large and profitable productions in this field. Farmers who working in this field know that there are different recipes of compound feed, depending on the breed and age of the animals to be fed. Figure 1 presents the global-level repartition of the compound feed consumption by different animal species (*Căproiu and Chelemen, 1982; Goia et al., 1982*).

All these aspects determined an improvement of the activities in the technological flow in a CFF (compound feed factory), by using modern high-performance machinery and equipment, with a high level of mechanization, automation and computerization, to ensure the achievement of high quality final products with specific costs as low as possible (*Franke and Rey, 2006*).

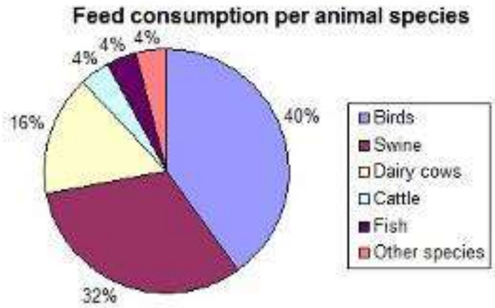

Fig. 1 - Global-level repartition of the compound feed consumption for animal species (*Vasile, 2010*)

The technological flow of obtaining the compound feed involves to carry on of several distinct activities, but each one with its importance. For ensure the proper functioning of the working installations of a compound feed factory, must to take into account also an automation control of the technological flow, which also assumes, among other things, a permanent monitoring of the horizontal and vertical conveyor belts (Figure 2), which have the role to transport the raw materials to the storage bunkers and to the other working installations (*Vasile, 2013*).

a b

Fig. 2 - Conveyor belts system from a compound feed factory consisting of
horizontal conveyor belts (a) and vertical elevators (b)

Horizontal conveyor belts are electromechanical installations made up of a metal chain linking, which forms a closed chain, over which a rubber band is placed and which are moved in a horizontal motion due to the drums driven by an electric motor, which also has a rotation reducer for controlling the speed of movement of these bands. Another electromechanical installation is the vertical elevator, which, unlike the previously presented type of conveyor belts, allows the vertical transport of the raw materials and consists of two vertical tubes parallel to a rectangular section, through which is moving a rubber conveyor belt on which are mounted, at equal distances, transport cups. These vertical elevators represent an important installation in tehnological flow in a compound feed factory, because they allow the lifting of raw materials from the level of storage bunkers located on the ground up to heights which can get to several tens of meters (*Vasile, 2010; Vasile, 2013*).

MATERIAL AND METHOD

The experimental researches presented in this article were carried out at an compound feed factory where the transport of necessary raw materials is made up using two succesive horizontal conveyor belts and a vertical elevator (Figure 3) (*Vasile, 2013*).

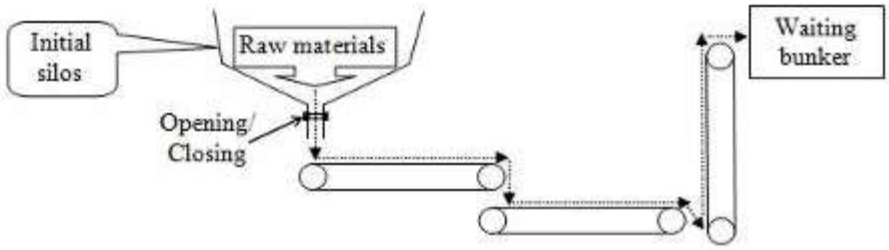

Fig. 3 - The system of conveyor belts in a CFF

By analyzing the shifting route of raw materials it can be observed that one critical point of the technological flow is placed at the base of the vertical elevator, meaning in the special marked zone in the Figure 3 (CP – critical point). In this place, the horizontal conveyor belts bring out a fairly large quantity of materials that should be taken in the cups of lifting, but because of different reasons may appear problems of functioning: overload with raw materials, unstable functioning of the motors which act the belts etc.

The studies which carried out were aimed precisely at avoiding such undesirable situations, because the rubber bands elongation of the vertical elevator leads to rubbing of the cups against the walls of the installation, possibly causing blockage or even breaking of the conveyor belt. This situation would lead to a stagnation in the technological flow, with time and cost loss.

One of the solutions which allow to avoid these situations is the implementation of a specialized automated control module of the conveyor belts. In order to obtain the optimal implementation variant, a test stand was constructed to determine the functional parameters of the magnetic sensors that ensure the coupling or disconnection of the motors which acting the drums (*Glodeanu et. al., 2017*; *Vasile, 2010*).

The electronic montage that have been used to obtain the experimental results (Figure 4), is composed of the following elements:

- rectifier 220 Vca-24 Vcc
- fan motor 80 W/1500 rotations per minute
- magnetic sensor for speed of rotation monitoring
- voltage variator to change the motor speed
- 2 intermediate relays and signaling lamps at 24 V.

Fig. 4 - The electronic montage of the test bench

The sensors functioning is based on the field lines modification principle generated by coils powered by a high-frequency oscillator and allow conversion of an non-electrical input (distance to a metal body) in a output of electrical nature (tension) (*Glodeanu et. al., 2017*). So, when approaching a metallic body to sensor, the magnetic field lines are changing, thus determining the damping of the oscillations and automatically generating the modification of the inductance of the magnetic circuit. The electronic circuit of demodulation (Figure 5) detect this modification and it switches the electric signal in active status ''1'' (Figure 6), which is amplified by the amplifier circuit and then sent to the sensor load, which is an start-stop relay which is part of the automatized projected controling circuit (*Popescu, 1986; Voicu, 2002*).

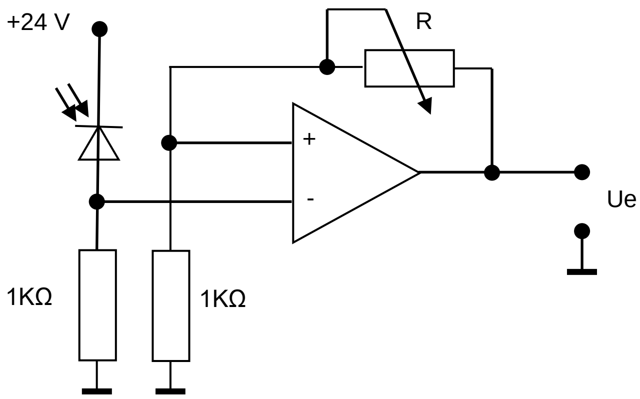

Fig. 5 - The electronic circuit used to obtain the electrical output (Ue)

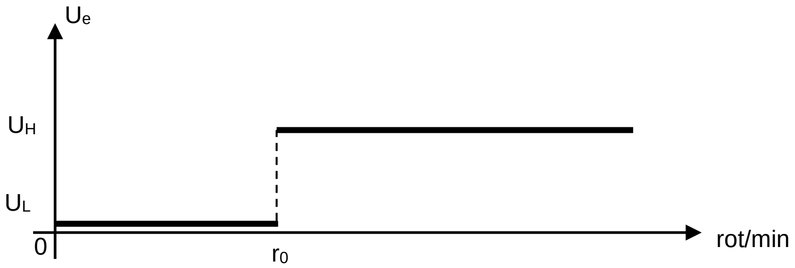

Fig. 6 - Electrical output (voltage) of a magnetic sensor

A magnetic sensor used for monitoring of motor speed is powered at 24-36 Vcc (according to the electric scheme in Figure 7) and works as a pulse generator whenever a metallic object passes around it (*Vasile, 2013*).

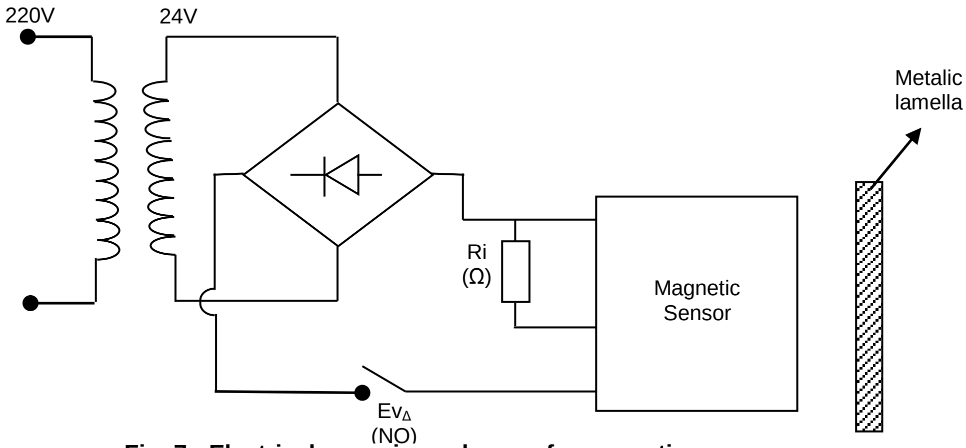

Fig. 7 - Electrical powering scheme of a magnetic sensor

For the testing of different types of speed sensors, the experimental measurements have been carried out using a tachometer by type EBRO DT-2236 (Figure 8), which recorded the speed rotation value for the metalic lamella attached to the rotor pallet, thus simulating the rotation movement of the stretching drum of the conveyor belts. The speed variator from this electronic scheme is designed to modify the powering of the rotor drive motor (the drum) with the purpose of generate different movement speeds of the metalic lamella which is attached to the rotor (*Popescu, 1986; Voicu, 2002*).

Fig. 8 - Measuring the speed of rotation of the metalic lamella with the electronic tachometer

RESULTS

In the case of the magnetic sensors for speed monitoring which were analysed and tested on the trying stand, was followed the highlight of two essential parameter, which will help the realisation of the automatized monitoring device of the conveyor belts under optimum conditions:

1 - the distance to which the sensor detects the metallic body attached to the motor drum being in rotation movement;

2 - the response time of the sensor when modifying the rotation speed, depending on the distance to which that monitored metallic body is situated.

The results of the experimental measurements obtained by successive tests on the trying stand are highlighted for each type of magnetic sensor, thus: for the NXP KMI15 type sensor in Table 1, for the ATS 653 sensor in Table 2, for the XSA-V11373 sensor in Table 3, for the SM351LT type sensor in Table 4.

Table 1

The determination of operating parameters for the speed sensor type NXP KMI15

Sensor response	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	no	-
Distance [cm]	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5
Response time [s]	0,4	0,5	0,5	0,6	0,7	0,8	0,8	0,9	1	1,1	1,2	1,3	1,3	1,5	1,7	1,7	1,8	1,9	1,9	2	-

Table 2

The determination of operating parameters for the speed sensor type ATS 653

Sensor response	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	no	-
Distance [cm]	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5
Response time [s]	0,5	0,6	0,6	0,7	0,8	0,9	1	1.1	1.2	1,3	1,4	1,4	1,6	1,7	1,7	1,8	1,9	2	2,1	-	-

Table 3

The determination of operating parameters for the speed sensor type XSA-V11373

Sensor response	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	no
Distance [cm]	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5
Response time [s]	0,4	0,4	0,5	0,6	0,6	0,7	0,8	0,8	0.9	1	1,1	1,2	1,3	1,4	1,6	1,7	1,8	1,8	1,8	1,9	-

Table 4

The determination of operating parameters for the speed sensor type SM351LT

Sensor response	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	no	-
Distance [cm]	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5
Response time [s]	0,6	0,6	0,7	0,8	0,8	0,9	1	1,1	1,2	1,3	1,5	1,5	1,6	1,7	1,8	1,9	1,9	2	2,2	-	-

From a graphical point of view, in Figure 9 it can be observed very clearly the reaction mode of the magnetic speed sensors that have been analysed in these experiments, according to the distance to which they are located towards the motor drum which activates the conveyor belts.

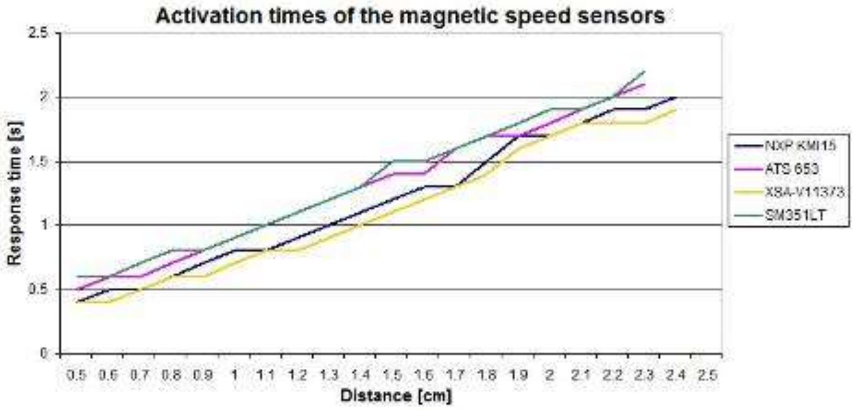

Fig. 9 - Activation times of the magnetic speed sensors in function of the location distance against the drum

However, considering the operating parameters and the purchase price, for the implementation of the electrical control scheme of the automatized control device, it was chosen to use the speed sensor type XSA-V11373 manufactured by TELEMECANIQUE.

CONCLUSIONS

To resist on the competitive market, but also for compliance with the rules of the European Union on the protection of the environment, all the compound feed factorys have acquired modern installations of work, with a high degree of mechanization, automatization and computerization of all activities in the technological flow.

The conveyor belts ensure the transport of raw materials from the incoming bunkers to the working installations and therefore represents a critical point of the technological flow of a compound feed factory (CFF), because their blocking can cause loss of material, of time and the default financial losses.

In this study were carried out some experimental measurements for the implementation some modules of automated control of the rotations of drums which is acting vertical and horizontal conveyor belts.

The implementation some special modules of automated control of the conveyor belts has at basis the use of some sensors, which to emit a signal of warning in the moment when is changing the normal rhythm of running of the displacement of them.

Knowing that exist a lot of types of magnetic sensors of rotation, for the verification of parameters of running them it was builded a stand of tries, which allow the simulation of automatized control for start and for stop of the conveyor belts, such that to analyse all events which can appear during the functioning and thus to eliminate possibles blockages or breaking of them.

By implementation of some automatic control devices of the conveyor belts is eliminated the possibilities of stopping the technological flow and minimizes the loss of raw materials, which causes an increase in working productivity.

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THE DESIGN OF AN ELECTRONIC SYSTEM FOR AUTOMATIC ADJUSTMENT OF THE WORKING PARAMETERS FOR SPRINKLING MACHINES
/
PROIECTAREA UNUI SISTEM ELECTRONIC DE REGLARE AUTOMATĂ A PARAMETRILOR DE LUCRU PENTRU MAȘINILE DE STROPIT

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Keywords: *sprinkling machines, liquid rate, displacement velocity*

ABSTRACT
One of the major requirements imposed for agricultural sprinkling machines is to ensure the stability of liquid rate. Non-compliance of the prescribed liquid rate may have adverse consequences on treatment efficiency and also on the environmental pollution with substances used for plant protection. This important requirement can be achieved only by equipping sprayers with advanced systems for automatic adjustment of working parameters.

ABSTRACT (ROM)
Una dintre cerințele majore impuse mașinilor de stropit este de a asigura stabilitatea normei de lichid. Nerespectarea normei de lichid prescrise poate avea consecințe nefaste asupra eficacității tratamentului și de asemenea asupra poluării mediului ambiant cu substanțe folosite pentru protecția plantelor. Această cerință majoră poate fi respectată numai prin echiparea mașinilor de stropit cu sisteme evoluate pentru reglarea automată a parametrilor de lucru.

INTRODUCTION
For the design and construction of an electronic adjustment system, that equips the sprinkling machinery, it must be taken into account the signals generated by the transducers for displacement velocity and liquid flow (x_q, x_v) *(Glodeanu, 2000; Glodeanu et al., 2016; Popescu and Ghinea, 1986).*

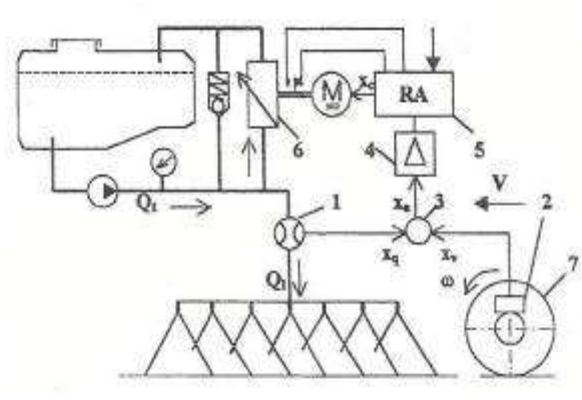

Fig. 1 - Scheme of an electronic adjusting system used for sprinkling machinery
1 - flow transducer; 2 - displacement velocity transducer; 3 - comparator circuit; 4 - power amplifier; 5 - automatic regulator; 6 - valve control; 7 - transport wheel

The ratio of these electrical signals will be compared with the report imposed for adjustment, using a comparator circuit (Fig. 1) *(Alexandru and Glodeanu, 2009; Popescu and Ghinea, 1986)*.

The deviation (x_a) obtained at the output of the comparator circuit will be amplified by an amplifier circuit and then transmitted to the automatic controller. In this way the automatic controller will generate suitable commands to the control valve (in order to correlate the liquid flow with the new value of the displacement velocity) *(Glodeanu, 2000; Glodeanu et al., 2017)*.

MATERIAL AND METHOD

In order to achieve the electronic block of the equipment it is necessary to have in view the block scheme of the automatic adjustment system, used for correlating the two work parameters: displacement velocity and liquid flow (Figure 2) *(Glodeanu et al., 2017; Glodeanu et al., 2016)*.

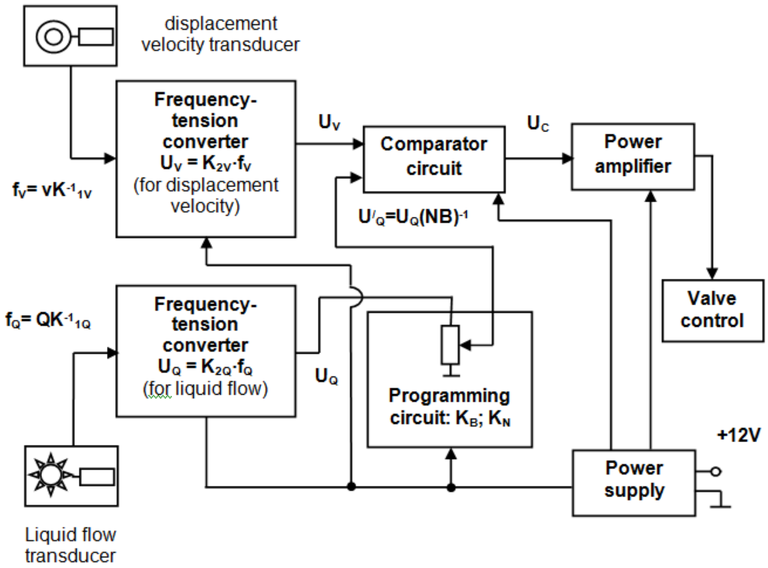

Fig. 2 - Block scheme of the automatic adjusting system of liquid flow with displacement velocity

The transducers for displacement velocity transducer and liquid flow are digital type, having the following the transfer function *(Brândușa et al., 2006; Glodeanu et al., 2016)*:

$$f_V = v \cdot K_{1V}^{-1};\ f_Q = Q \cdot K_{1Q}^{-1} \quad (1)$$

where:

f_V and f_Q are the frequencies of impulses generated by the transducers, [s^{-1}];

K_{1V} and K_{1Q} - coefficients of proportionality.

These signals will be transformed in analogical sizes (tensions) *(Glodeanu et al., 2016)*:

$$U_V = K_{2V} \cdot f_V \quad (2)$$

$$U_Q = K_{2Q} \cdot f_Q \quad (3)$$

where:

U_V is the continuous tension generated at the output of the displacement velocity transducer, [V];

U_Q - continuous tension generated at the output of the liquid flow transducer, [V];

K_{2V} and K_{2Q} - coefficients of proportionality.

Given the relationship of calculation the liquid rate (N) and taking into account the relations (1), (2) and (3), result *(Glodeanu et al., 2016; Glodeanu et al., 2017; Naghiu, 2008)*:

$$N = \frac{Q}{B \cdot v} = \frac{K_{1Q} \cdot K_{2V}}{K_{1V} \cdot K_{2Q}} \cdot \frac{U_Q}{U_V \cdot B} \quad (4)$$

If the coefficients of proportionality are chosen so that $\frac{K_{1Q} \cdot K_{2V}}{K_{1V} \cdot K_{2Q}} = 1$, it results:

$$U_V = \frac{U_Q}{N \cdot B} \quad (5)$$

Making the marking $U'_Q = \frac{U_Q}{N \cdot B}$, relation (5) became *(Glodeanu, 2000; Glodeanu et al., 2016)*:

$$U_V = U'_Q \quad (6)$$

The obtained relations show that for achieving the adjusting function, the electronic block must contain a comparator circuit which is designed to compare the tension U_V (corresponding to the displacement velocity), with a fraction of U_Q tension (corresponding to the liquid flow). In this case the dividing factor is N·B, where liquid rate (N) and work width (B) are prescribed sizes.

Having in view the theoretical considerations and the block scheme of the electronic adjustment system were designed the electronic circuits of components: frequency-tension converters for displacement velocity and liquid flow, the programming circuit of the liquid rate (N) and working width (B), the comparator circuit, power amplifier. By assembling the components resulted the electronic scheme of the adjusting system (Figure 3) *(Glodeanu et al., 2016; Grigorescu et al., 2006)*.

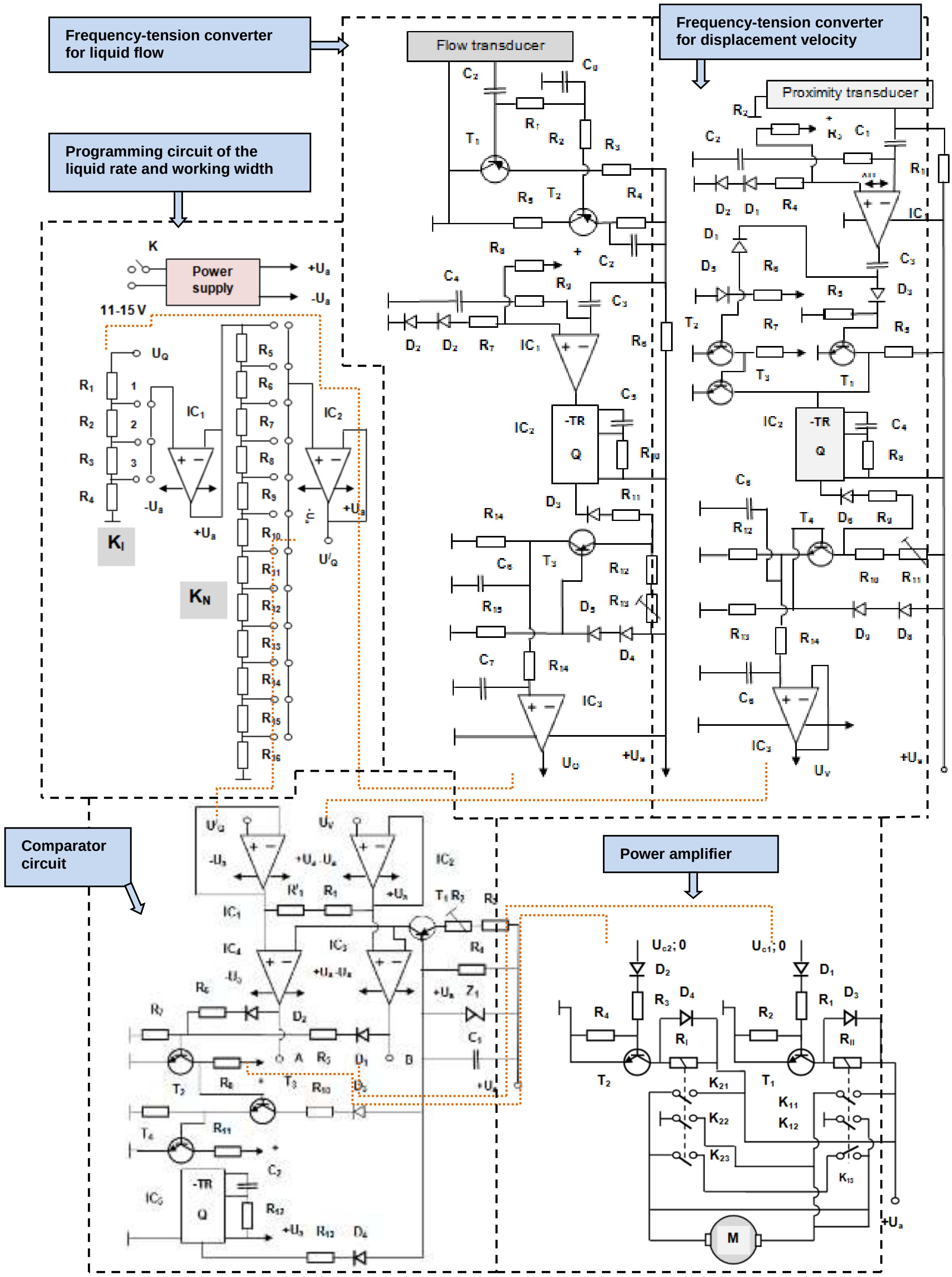

Fig. 3 - Electronic scheme of the designed adjustment system

For the experimental research on stand was used a method which involves the application of signals at the entrance of the system. The frequency of these signals go through a range of values, for which is measured (with adequate transducers) the output signal *(Brândușa et al., 2006; Ghiță and Cepișcă, 2007; Glodeanu et al., 2006; Glodeanu et al., 2017; Vasile, 2013)*.

For determining the characteristics of the two converters (for displacement velocity and liquid flow) was used a test stand, whose scheme is shown in Figure 4.

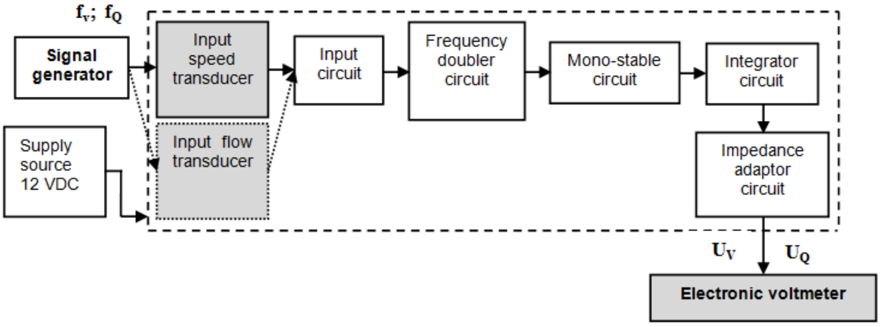

Fig. 4 - Stand for the determination the characteristics of the converters

The input signal level in the case of both transducers has been set to 200 mV. It was considered that the variation of the frequency input signal (applied to the input of the speed transducer) is in the range 16-60 Hz (corresponding for displacement velocities of 4 to 15 km/h). Also it has been considered that for a linear operation of this converter it is necessary that the maximum output voltage to be limited to 8 V (corresponding to a maximum frequency of 60 Hz) (*Glodeanu et al., 2011)*.

To fit in the mentioned parameters, the wide of impulse generated by the mono-stable circuit was set at 6 s^{-3} (*Glodeanu et al., 2011)*. Having in view that the work domain of the liquid flow transducer is in the range 10-100 liters/minute and the constant flow of this one is 10 cm^3/impulse, results that in a minute the transducer will generate a number of impulses between 10^3 and 10^4. In this way the frequencies generated by the flow transducer are within the range 16.6-166.6 Hz (*Glodeanu et al., 2011)*.

The wide of impulse (at the output of the mono-stable circuit) was set at 5,5 s^{-3}, such as at maximum frequency of 170 Hz (corresponding to 10^4 impulses/min), tension U_Q will be 8 volts (voltage measured using the electronic voltmeter) *(Brândușa et al., 2006; Ghiță and Cepișcă, 2007)*.

The linearity of functions $U_V=f(f_V)$ and $U_Q=f(f_Q)$ has been checked by measurements in the range: 10-60 Hz for the proximity transducer and 17-180 Hz for the flow transducer. Having in view the electronic scheme of the programming circuit of the liquid rate (N) and working width (B), it can be seen that the divider circuit for working width ensures the possibility of programming the three different values. It can be seen that the divider circuit for liquid rate allows scheduling 12 different values *(Glodeanu et al., 2015)*.

Analyzing the block scheme of the adjusting system, it can be observed that the voltage corresponding to the speed of movement (U_V) is compared by the comparator circuit with a fraction of U_Q tension (the division factor is determined by the K_B and K_N circuits) *(Glodeanu et al., 2006)*. By splitting the function $U_Q= f(f_Q)$ (with the aid of a K_B circuit) other three functions of the form $U_Q= m\cdot f(f_Q)$ are obtained, where m is a coefficient of less than one which represents the division factor achieved with resistors R_1, R_2, R_3, R_4 (components of the divisor circuit K_B).

Depending on the values of the coefficient m, it follows that *(Glodeanu et al., 2015)*:

- for $m_1=1$, tension U_Q is applied directly from the output of the integrated circuit IC_1 on the entrance of integrated circuit IC_2 (the switch "working width" is in position 3);
- for $m_2=0,85$, tension U_Q is divided with $R_1/R_2+R_3+R_4$ (the switch "working width" is in position 2);
- for $m_3=0,60$, tension U_Q is divided with $R_1+ R_2/R_3+R_4$ (the switch "working width" is in position 1).

The K_N divisor circuit divides the tension at the output of the integrator circuit IC_2 (the tension U_Q) in 12 distinct steps (corresponding to those 12 positions of the liquid norm of working domain).

The resistors $R_5…R_{16}$ of the divisor circuit K_N were thus elected as the values of the obtained norms of liquid (in domain of liquid flow as 10-100 l/min) to differ by a factor of 1.25, in accordance with the relation $N_n=1.25\ N_{n-1}$, where n can take values between 1 and 12 (function of switch positions) *(Glodeanu et al., 2015)*.

To check the operation of the comparator circuit it was used a testing stand (Figure 5) equipped with two signal generators: SG_I (that simulates the information concerning the displacement velocity), which is coupled at the entrance of the speed transducer and SG_{II} (that simulates the information from the liquid flow transducer). Thus, the information concerning the displacement velocity it is automatically correlated with the information concerning the liquid flow (SG_{II} being coupled at the entrance of the flow transducer) *(Glodeanu, 2000; Glodeanu et al., 2006)*.

Each generator ensures a rectangular signal with amplitude of 300 mV and frequencies located in the work domain of the transducers. The hysteresis voltage (ΔU_H) was set at 10 mV (by adjusting the potentiometer from the emitter of the transistor T_8) *(Brândușa et al., 2006; Glodeanu et al., 2017)*.

By means of an electronic voltmeter was monitored the status of the two outputs of the comparator circuit (depending on the difference between the input voltages U_V and U'_Q). The tests were performed for three values of the operating voltage of the frequency-tension converter (U_V=700 mV; U_V=4000 mV; U_V=8000 mV). At each determination was started from the equality U_V=U'_Q. Then, by increasing or decreasing the values of the frequency applied to the entrance of the flow transducer were obtained the values of U'_Q voltage *(Ghiță and Cepișcă, 2007; Glodeanu et al., 2006; Glodeanu et al., 2017)*.

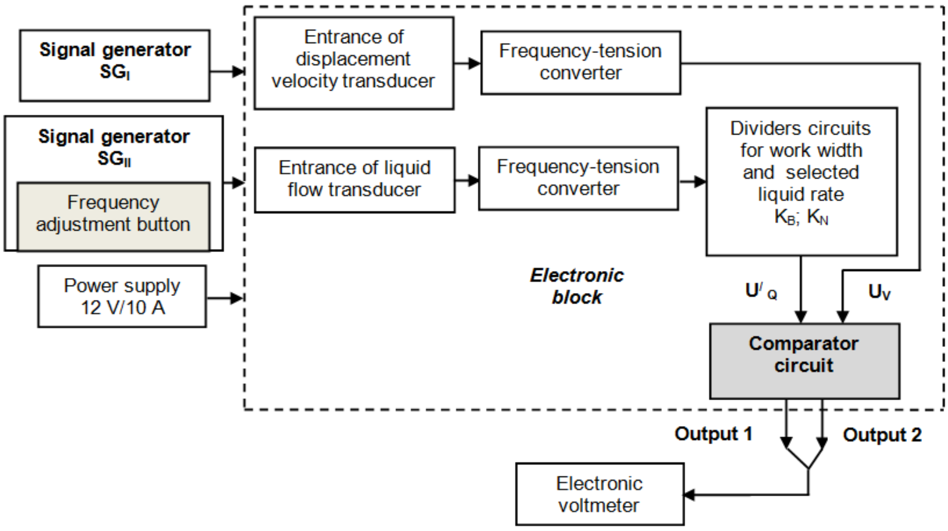

Fig. 5 - Stand for checking the operation of the comparator circuit

For checking the functioning of the power amplifier was monitored the operating mode of the electric motor (adequate reversal of the sense of rotation and placing into short circuit the motor rotor, when the control command is canceled) *(Vasile C., 2013)*. The scheme of the test stand used for this purpose is presented in Figure 6.

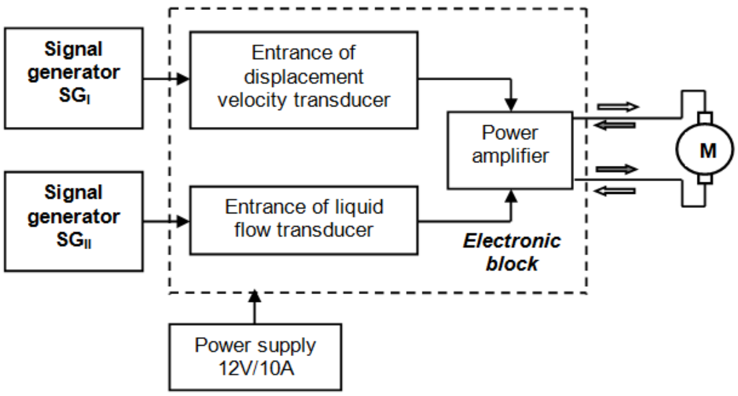

Fig. 6 - Stand for checking the operation of the power amplifier

Checking on stand the adjusting characteristic ensure by an electronic-type regulator has in view to establish the work capacity, in accordance with imposed requires. In order to achieve the experiment it has been used a stand for checking the control feature, specific for the studied system (Figure 7) *(Glodeanu et al., 2006; Glodeanu et al., 2016; Glodeanu et al., 2017)*.

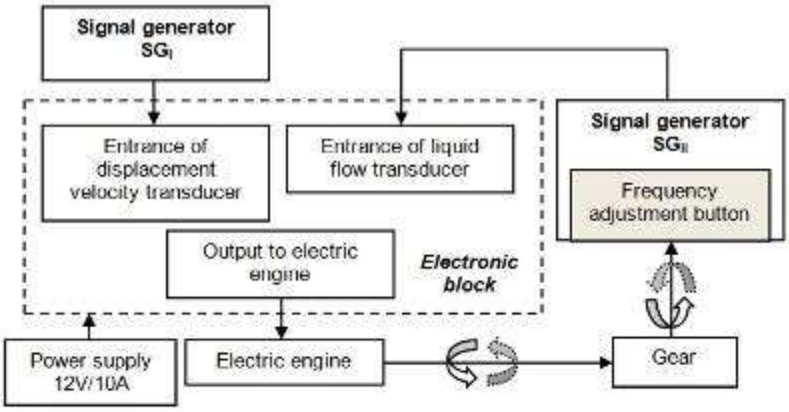

Fig. 7 - Stand for verification the adjustment feature of the automatic adjusting system of liquid flow with displacement velocity

For the experimental research on stand was used a method which involves the application of signals at the entrance of the system. The frequency of these signals go through a range of values, for which is measured (with adequate transducers) the output signal. Amplitude and phase of the output signal determines the dynamic characteristics of the adjusting system *(Brânduşa et al., 2006; Glodeanu et al., 2016)*. The control function of the electronic block is performed by the reaction circuit. In practice this circuit consists of: the control valve of liquid flow; the flow sensor through which is controlled the compliance value of the prescribed liquid rate.

The stand is equipped with two signal generators: SG_I (that simulates the information concerning the displacement velocity), which is coupled at the entrance of the speed transducer; SG_{II} (that simulates the information from the liquid flow transducer), which is actuated by the electric engine of the control valve (through the gear unit). In this manner the information concerning the displacement velocity it is automatically correlated with the information concerning the liquid flow (SG_{II} being coupled at the entrance of the flow transducer) *(Brânduşa et al., 2006; Glodeanu et al., 2017; Grigorescu et al., 2001)*.

During the tests it was found that actuation of the adjustment button of the frequency from the signal generator SG_I (corresponding to displacement velocity–f_v), automatically determine the actuation of the adjustment button of the frequency, from the signal generator SG_{II} (corresponding to liquid flow–f_Q). Actuation of the second adjustment button of the frequency is done through the engine–gear group. In this way the ratio of the two frequencies, f_v and f_Q is maintained permanently constant. It means that the electronic block performs correctly the adjusting function, on the basis of information concerning the displacement velocity (SG_I) and liquid flow (SG_{II}) *(Glodeanu et al., 2016; Glodeanu et al., 2017)*.

RESULTS

The obtained results concerning the determination of the characteristics of the used converters are presented in Tables 1 and 2.

Table 1

Results obtained for determining the characteristics of the liquid flow frequency-tension converter

f_Q [Hz]	10	15	20	25	30	35	40
U_Q [mV]	833,0	1249,0	1666,0	2082,5	2499,0	2915,5	3333,0

f_Q [Hz]	45	50	55	60
U_Q [mV]	3748,5	4166,5	4581,5	4998,0

Table 2

Results obtained for determining the characteristics of the displacement velocity frequency-tension converter

f_Q [Hz]	20	40	60	80	100	120	140
U_Q [mV]	941.17	1882.34	2823.48	3764.64	4705.80	5646.96	6588.12

f_Q [Hz]	160	180	200
U_Q [mV]	7529.28	4705.44	9411.70

On the above data base from Table 1 and Table 2 it could rise specific features of the converters, as in Figure 8.

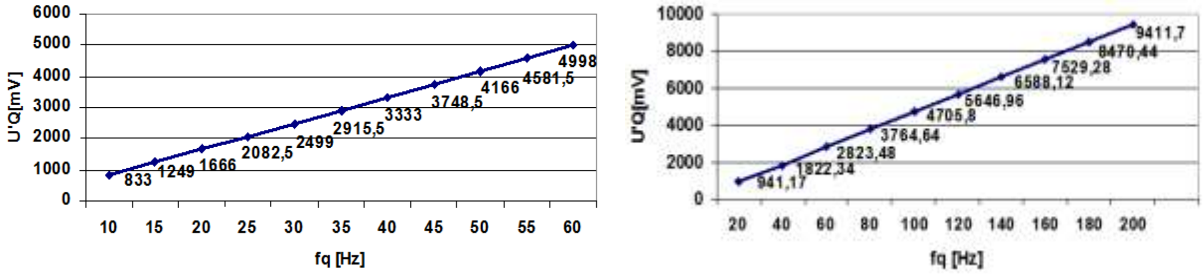

Fig. 8 - The graphic representation of the functions $U_V=f(f_V)$ and $U_Q=f(f_Q)$

The graphic representation shows that these functions are perfectly linear for the working areas, indicating the correct operation both converters.

The tensions measured at the output of integrated the circuit IC_2 (equal with tensions of the output of K_N switch), for m=1 are presented in Table 3. The graphical representation show that for each value of m (m_1=1; m_2=0,85; m_3=0,60) can get a family of straight lines passing through the origin. In Figure 9 is presented the family of straight lines obtained for m=1 (suitable for those 12 positions of the K_N switch).

Table 3

Values of the tension measured at the output of the integrator circuit IC_2

U_Q' [V] (m=1)	Tension at output of K_N divisor circuit											
	Position of K_N switch											
	1	2	3	4	5	6	7	8	9	10	11	12
500	500	400	320	256	204	163	131	104	83	67	53	42
1000	1000	640	512	409	327	262	209	167	134	107	86	68
1500	1500	1200	960	768	614	491	393	314	251	201	161	128
2000	2000	1600	1280	1024	819	655	524	419	335	268	214	171
2500	2500	2000	1600	1280	1024	819	655	524	419	335	268	214
3000	3000	2400	1920	1536	1228	983	786	629	503	402	322	257
3500	3500	2800	2240	1792	1433	1146	917	734	587	469	375	300
4000	4000	3200	2560	2048	1638	1310	1048	838	671	536	429	343
4500	4500	3600	2880	2304	1843	1474	1179	943	754	603	483	386
5000	5000	4000	3200	2560	2048	1638	1310	1048	838	671	536	430
5500	5500	4400	3520	2816	2253	1802	1441	1153	922	738	590	472
6000	6000	4800	38420	3072	2457	1966	1572	1258	1006	805	644	515
6500	6500	5200	4160	3328	2662	2129	1703	1363	1090	872	697	558
7000	7000	5600	4480	3584	2867	2293	1835	1468	1174	939	751	601
7500	7500	6000	4800	3840	3072	2457	1966	1572	1258	1006	805	644
8000	8000	6400	5120	4096	3276	2621	2097	1677	1342	1073	858	687

The checking of the functional characteristics of the programming circuit of liquid rate N and working width B (through measurements on stand) has shown that the selection function of both work parameters is performed in optimal conditions.

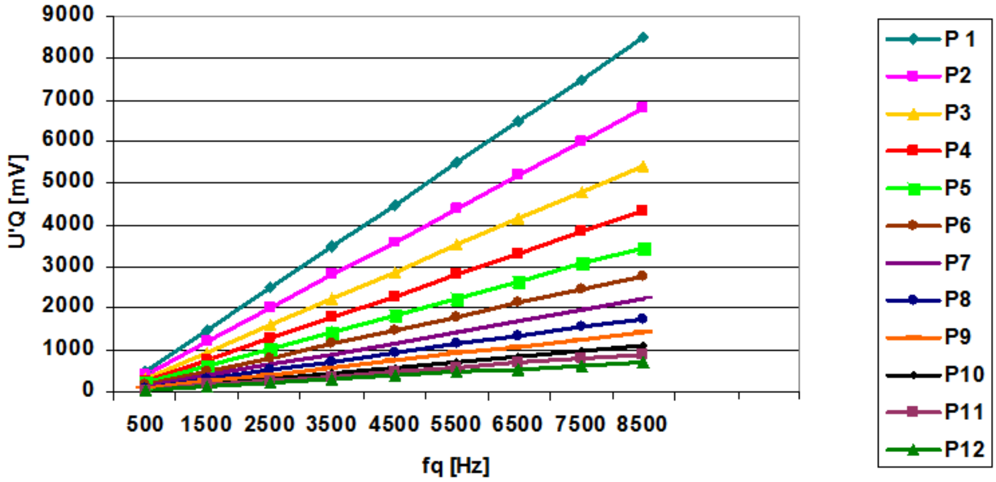

Fig. 9 - Graphical representation of family of straight lines (m=1) for the 12 positions of K_N switch

Results of laboratory tests have established that the outputs of the comparator circuit may have the following states:
- if $U'_Q=U_V+5$ mV: the output 1 pass into state UP (9 V), output 2 remain in DOWN state (0 V); if the frequency value is modified in the opposite way, the output 1 returns to the state DOWN (0 V) when $U_V=U'_Q$;
- if it $U'_Q=U_V-5$ mV: the output 2 pass into state UP (9 V), output 1 remain in DOWN state (0 V); switching of the output 2 in DOWN state (0 V) occurs if the frequency value is modified in the opposite way, also when $U_V=U'_Q$.
The results of these determinations are presented in Table 4.

Table 4

The results obtained for checking the functioning of the comparator circuit

U_V=700 mV													
U'_Q [mV]	700	701	702	703	704	705	706	702	700	699	698	697	696
U_{out1} [V]	0	0	0	0	0	**9**	**9**	**9**	**9**	0	0	0	0
U_{out2} [V]	0	0	0	0	0	0	0	0	0	0	0	0	0

U'_Q [mV]	695	696	694	692	691	700
U_{out1} [V]	0	0	0	0	0	0
U_{out2} [V]	9	9	9	9	9	0

U_V=4000 mV											
U'_Q [mV]	4000	4001	4002	4003	4004	4005	4006	4005	4002	4000	3999
U_{out1} [V]	0	0	0	0	0	**9**	**9**	**9**	**9**	0	0
U_{out2} [V]	0	0	0	0	0	0	0	0	0	0	0

U'_Q [mV]	3998	3997	3996	3995	3996	3998	3999	4000
U_{out1} [V]	0	0	0	0	0	9	9	9
U_{out2} [V]	0	0	0	**9**	**9**	**9**	**9**	0

U_V=8000 mV											
U'_Q [mV]	8000	8001	8002	8003	8004	8005	8006	8003	8000	7999	7998
U_{out1} [V]	0	0	0	0	0	**9**	**9**	**9**	**9**	0	0
U_{out2} [V]	0	0	0	0	0	0	0	0	0	0	0

U'_Q [mV]	7997	7996	7995	7996	7998	7999	8000
U_{out1} [V]	0	0	0	0	0	0	0
U_{out2} [V]	0	9	**9**	**9**	**9**	**9**	0

The obtained results indicate that the comparator circuit operates ensure an hysteresis area (of 10 mV) around the values of the voltages to compare. This hysteresis eliminates the phenomenon of overriding, as well as unnecessary drives of the adjustment tap.

The results obtained for checking the functioning of the power amplifier are presented in Table 5. These demonstrate that the motor operation is accurate. The motor is stopped promptly when the control command is canceled.

Table 5

The results obtained for checking the functioning of the power amplifier

Outputs status of the comparator circuit		Electric motor
Output 1	**Output 2**	
DOWN (0 V)	DOWN (0 V)	**is not rotating**
UP (9 V)	DOWN (0 V)	**is rotating to the left**
DOWN (0 V)	UP (9 V)	**is rotating to the right**

Experimental results demonstrate the optimum operation of the power amplifier (the electric motor rotates in both directions and switching it off at the cancellation of commands is performed promptly).

Test results concerning the adjusting characteristic ensured by the automatic system are presented in Table 6.

Table 6

Test results on stand of the electronic adjusting system

f_V [Hz]	16,00	20,00	24,00	28,00	32,00	36,00	40,00
v [km/h]	4,01	5,02	6,02	7,03	8,03	9,04	10,04
f_Q [Hz]	28,30	35,40	42,48	49,58	56,60	63,70	71,00
Q [L·min^{-1}]	16,98	21,24	25,48	29,74	33,96	38,22	42,60
Q/v	**4,230**	**4,230**	**4,230**	**4,230**	**4,229**	**4,228**	**4,240**

Analysis of the results reveal that the report (Q/v) is approximately constant, deviation for the considered example being insignificant (0,2%). This indicates that the adjustment function is ensured in good conditions.

CONCLUSIONS

1. The characteristic of the frequency-tension convertor for displacement velocity $U_V=f(f_V)$ is linear in the range of working frequencies, this aspect being respected also for input frequencies of 10 Hz (v=2.5 km/h); this ensures good stability in operation, for a wide range of working speeds; the slope of the characteristic of the converter is K_{1V}=83.30 mV/Hz.

2. The characteristic of the frequency-tension convertor for liquid flow $U_Q=f(f_Q)$ is linear in the range 17-170 Hz (10-100 l/min), having the slope K_{2Q}=47.05 mV/Hz.

3. Check of dividers circuits also has shown a linear operation thereof, obtaining for each division factor a family of 12 straight lines passing through the origin.

4. The obtained results indicate that the comparator circuit operates in accordance with the established transfer functions, for the two separate regimes of work: transitive and stationary; within the adjusting block, the comparator circuit (of hysteresis type) eliminates the phenomenon of over-adjustment, which has not occurred during the determinations.

5. The power amplifier achieves a proper amplification of the signals generated by the specific transducers, allowing an adequate reversal of the sense of rotation of the actuating electric motor; placing the motor rotor under short circuit regime (when the control command is canceled) allows quickly stopping and the phenomenon of over-adjustment is prevented.

6. Experiments under laboratory conditions performed on the electronic adjusting system showed a good sensitivity and stable behavior during operation.

7. The adjustment feature of the automatic adjusting system of liquid flow with displacement velocity highlights that the adjustment function is performed correctly, the deviation from the prescribed adjustment report (Q/v) being just 0.2%; The performance of the adjusting system is primarily due to the linear operation of equipment components.

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SLOSHING SIMULATION OF THE LIQUID FROM THE TRUCK TANKER
/
SIMULAREA COMPORTAMENTULUI LICHIDULUI DINTR-O CISTERNA DE CAMION

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Keywords: *liquid sloshing, tanker, SPH particles, baffles*

ABSTRACT
In this paper it is studied the liquid behaviour on the tank used for road transports. The first part of the paper present the most recent research of liquids behavior in tank during the transportation. Using advanced tehniques of CAD design in the second part of the paper it is modeled a base tank structure with two baffles, for liquids transportation. Using the SPH graphic simulation techniques it is simulateded the modeled structure of the tank with the fill level of 60 % at the imposed velocity that decreas at 13-0 m/s in 2.5 sec. In this case the deceleration simulate a sudden braking and the stop of the truck. The inside of the tank structure it is redesigned by adding modification of the baffles with the purpose of decreasing the force impact of the water on the tank. The new structure it is tested in the same work conditions like the base structure. The obtained results are compared with the results obtain for the base variant.

REZUMAT
În această lucrare se studiază comportamentul lichidului dintr-o cisternă folosită pentru transport. Prima parte prezintă cele mai recente cercetări ale comportării lichidelor în timpul transportului. Utilizând tehnici de modelare CAD, în partea a doua a lucrării se modelază structura de bază a unei cisterne pentru tranportat lichide, cu doi pereți despărțitori perforați. Folosind tehnicile de simulare grafică SPH se simulează structura de cisternă încărcată la o capacitate de 60% de lichid și la o viteza impusă care descrește de la 13-0 m/s în 2,5 sec. În acest caz, decelerarea simulează o frânare bruscă și oprirea camionului. Interiorul cisternei este reproiectat aducând modificări pereților interiori cu scopul reducerii forței de impact a apei asupra cisternei. Cea de-a doua structură este testată în aceleași condiții ca și structura de bază. Rezultatele obținute în ambele studii sunt comparate.

INTRODUCTION
Nowadays the numerical simulation of the dynamic and liquid flow using specialized software, it is more and more important in the design of liquid transport equipment. The dynamics of the liquids in tank while moving trucks is an important research topic in order to reduce the impact force of the fluid that influences the stability of the truck on the road. The better visualizations of the slosh movement can be seen during the acceleration or sudden deceleration of the truck. A study of the slosh effect is made by *Diaconu (2013),* where he studied and numerically simulated the compressible two phase model in a LNG tank that has a 3.790 m and a height of 2.590 m. For sloshing calculation, a grid of 8100 cells that were simulated numerically using ComFLOW software. The sloshing response of the containers model it is studied in (*Kermani et. al., 2016*). The numerical simulation is solved by using the SPH method in Abaqus/Explicit software. The first model it is designed without baffles, with a level of 63 %. The container has a longitudinal deceleration magnitude of 0.76 g. The effect of deceleration magnitude on sloshing are presented by comparing two containers without baffles, with a fill level of 63 %. The container is decelerated with two different magnitudes, 0.38 g and 0.76 g. A new container geometry with baffles was designed and simulated. After analysis it is observed that the container with the baffles had the lowest maximum stress. For solving the flows problems of the viscous and incompressible liquids can be used the Arbitrary Lagrangian–Eulerian (ALE) method (*Chandan et. al., 2013*).

A review on tankers cargo is presented in (*Chandan, 2014*), where is described the technical specification of the commercial tankers by different capacity. Another CFD compare study of the cargo truck carrying kerosene is designed and meshed in Ansys ICEM CFD software. Two cases are studied: without baffles and with baffles. The tank accelerated constantly at 10 m/s for 2 sec and then stops suddenly. The simulations of the kerosene behavior is carried out in Ansys Fluent at the 40% volume using VOF (volume of fluid) multiphase model and two simulation phases (primary phase is air and secondary phases is kerosene) (*Roshan and Rajesh, 2017*). The sloshing behavior of the LNG tanker used by ship transportation of the kerosene was studied (*Patil et. al., 2015*). The size of the tank model is taken from the commercial containers. The design and simulation volume of fraction are done using Geometry and Fluent module from Ansys Workbench. The effect of slosh is analyzed with 60% and 70% from the container and the volume of fluid was designed to view the interface between air and kerosene. Application of sloshing phenomenon into rectangular aircraft tank was simulated in Ansys Fluent (*Shriharsha et. al., 2017*). The tank is filled with 60% water and is subjected to 30 g peak acceleration at 40 ms. This study was solved in two cases: without baffles and with baffles. Simulation results show that the tank with one baffle reduce the peak pressure by 11.25 % as comparted with the base model without baffles. The model with two baffles reduce pressure by 2 % as compared with one baffle case.

Through the interaction between fluid and structure, this study shows fluid dynamics in the event of sudden deceleration from a medium capacity tank and the realization of a new model with partition walls whit the purpose to reduce the impact force of the fluid. The slosh movement refers to the movement of the liquid inside a tank and the dynamic force exerted by the liquid on the tank walls while traveling on the road. It is desired to reduce the slosh movement because this movement produces noise and great impact on the walls of the tank.

SPH approach

The simulation between fluid structure interaction are used four formulation: Lagrangian formulation, Eulerian formulation, Arbitrary Lagrangian-Eulerian formulation and Smooth Hydrodynamic Particles (SPH). For simulate the sloshing behavior of the liquid from the tank the SPH method is chosen. This method getting an accurate results and require less CPU resources compared with other formulations. SPH method uses the particles generated that contain the mechanical properties and the fluid behavior. In the folowing equations are presented the mass, volum and the distance between any particles (*Prashant et. al., 2010*).

Mass of the particle is presented in next equation:

$$m_p = \rho \cdot V / n \tag{1}$$

where:

m_p= mass of particle
V= total volume of the SPH particles
ρ= density of fluid
n= number of SPH particles.

The distance between particles is presented in following equation:

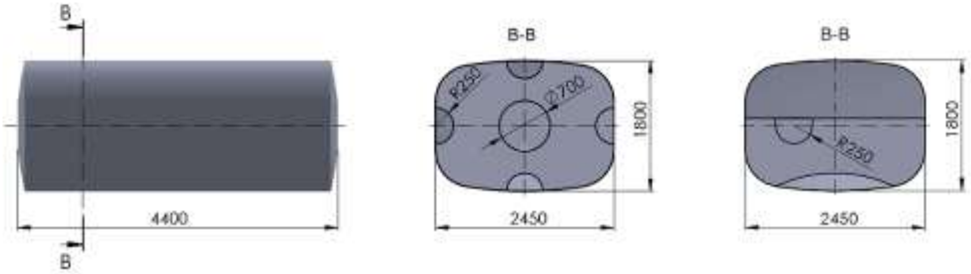
$$h_0^3 \approx \frac{\left(\sqrt{2} \cdot m_p\right)}{\rho} \tag{2}$$

From relation 1 and 2, the volume of the particle result:

$$V_p \approx \frac{h_0^3}{\sqrt{2}} \ \text{[mm]} \tag{3}$$

Geometrical design

The start point of this study is given by the CAD design of the tanker. Using advanced modelling techniques the basic model of a tank is modelled in SolidWorks software.



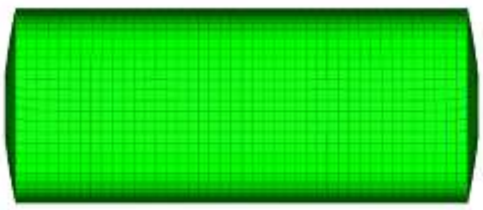
a) Longitudinal view
b) Baffles shape for the first model
c) Baffles shape for the second model

Fig. 1 – CAD model of the tank

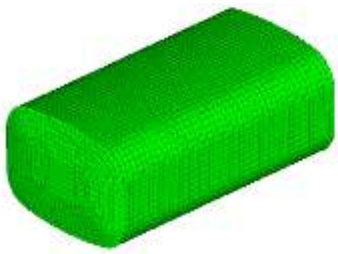
In Figure 1a is presented the longitudinal view of the tank basic model. This two baffles of the model are placed at a distance of 1600 mm. The approximate volume of the tank is 17.38 m^3. The tank model with baffles shape presented in Figure 1b is first model prepared for simulation and the Figure 1c present the second model for simulation. The baffles shape is changed to reduce the impact force of the fluid on the tank walls.

FEA setup

The process of the finite element analysis involves the following steps: preprocessing of the model, processing and postprocessing. The geometry resulted from CAD software is imported and prepared into Hypermesh. The first model of the tank is prepared for Radioss Block 140 solver and is meshed into 4882-shell elements whit a thickness 10 mm, shows in Figure 2, and the second model of tank is meshed into 4488 shell elements.

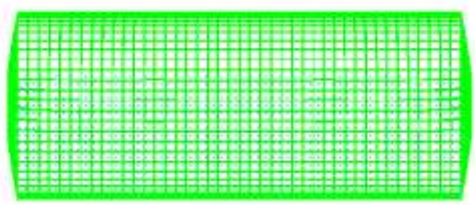


a) Longitudinal view of the meshed tank

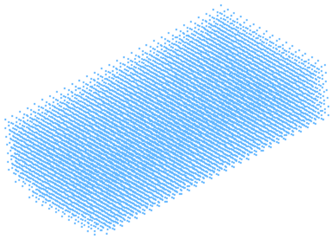


b) Isometric view

Fig. 2 – Tank meshed into shell elements



a) Level of SPH particles



b) SPH particles volume

Fig. 3 – Volume of the SPH particles

The tanker is filled with a level at 60% liquid using 15431 of SPH particle at 100 mm distance, presented in Figure 3. Interface between SPH particles that imitate the liquid and the tanker is realized using Type 7 interface available in software. The liquid volume defines the primary surface and the slave surface is defined by the shell tanker elements. The tanker surface and the baffles are made from the aluminum alloy by type M2_PLAS_JOHNS_ZERIL, which have the mechanical properties presented bellow in Table 1 (*Radioss theory manual*). The liquid assigned material is water and has hydrodynamic behavior by MLAW6 card image that have mechanical properties presented in Table 2 (*https://altairuniversity.com*). After creating the material of the water collector, when the SPH particles volume is generated for each particles is calculated the mass, in this case the mass of one particles is 0.6772389 kg.

Table 1

Mechanical properties of the aluminium alloy		
ρ	Initial density	2730 [kg/m^3]
E	Young's modulus	68.900 [GPa]
nu	Poisson's ratio	0.3
a	Yield Stress	0.0414 [GPa]
b	Hardening Parameter	0.110 [GPa]
n	Hardening Exponent	0.4

Table 2

Mechanical properties of the water		
ρ	Initial density	1000 [kg/m^3]
ν	Kinematic viscosity	0.0 [m^2/s]
C_1	Constant parameter coefficient	2.2 [GPa]
P_{min}	Pressure cutoff	-0.0001 [GPa]

To simulate a sudden break of the truck, the velocity decrease according to the chart presented in Figure 4. Truck braking decreases from 13 m/s and after 1.9 seconds the truck is stopped. The time from 1.9 to 2.5 seconds is simulated further to observe the water's behavior from the tank after stopping the truck. The gravity force is applied of the fluid and tank to view results that are more accurate.

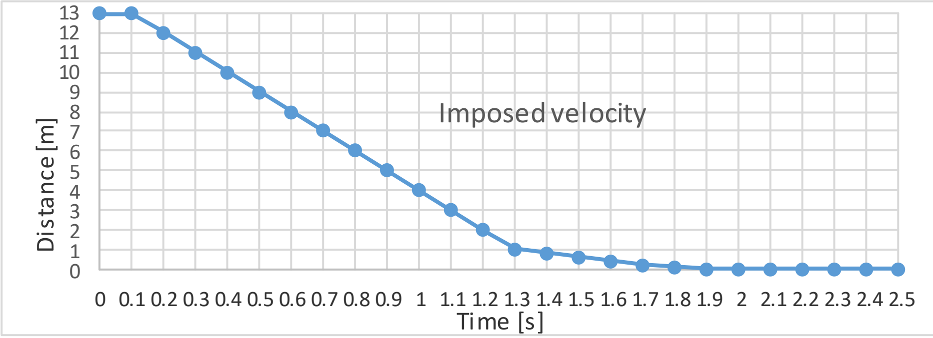
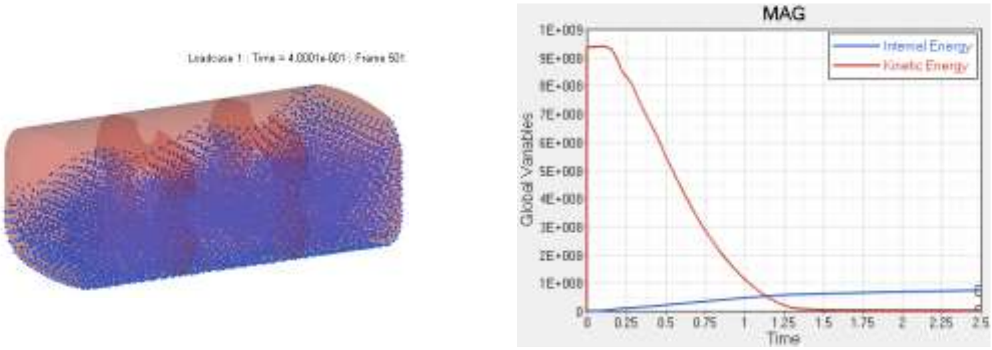


Fig. 4 – Decreasing speed due to sudden braking

The sloshing simulation are solved on a HP Z400 graphic workstation, with a frequency 3000 Hz Intel Xeon processor, 16 GB RAM memory and NVidia Graphical card 1 GB. First simulation of the tank is done after 25177.43 seconds and the second tank model is solved after 21419.74 seconds.

RESULTS

The results of the simulations are interpreted by Hyper View and HyperGraph module. After the sudden break sloshing analysis is performed the internal and kinetic energy curves, plotted in Figure 5. The kinetic energy curve starts 9.3599E+008 joules and increase up to 9.3926E+008, then as a result of the impact of the water with the tank it suddenly falls down at 2.8248E+006 at time 1.5635 second. When the water mass get in contact with the tanker at the sudden break kinetic energy is absorbed and is converted into internal energy at 1.1382 seconds and 5.1889E+007.



a) Isometric view at 0.4 sec. b) Energy balance

Fig. 5 – Energy balance during slosh simulation

In Figure 6 is presented the plot and magnitude value of the displacement. Measurement units for displacement is milimeter and for time is second.

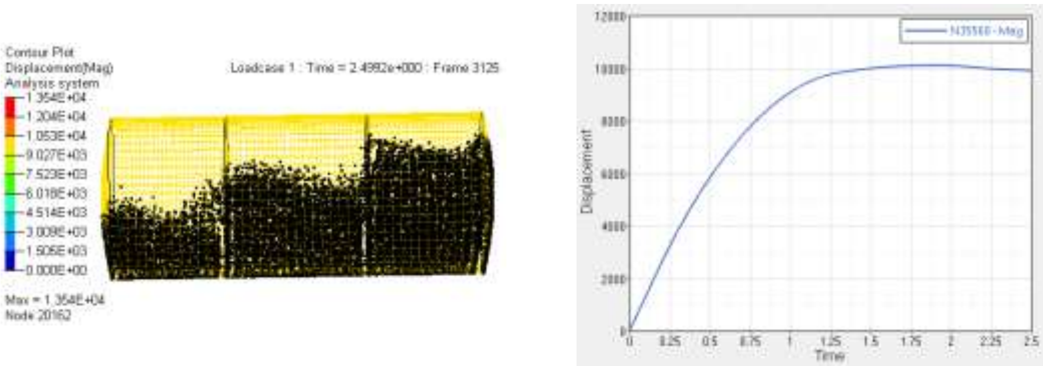
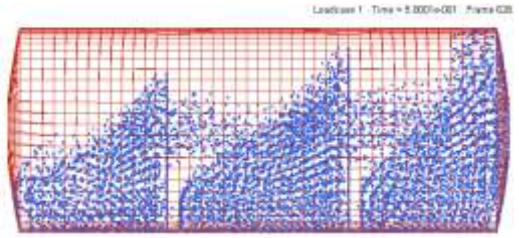
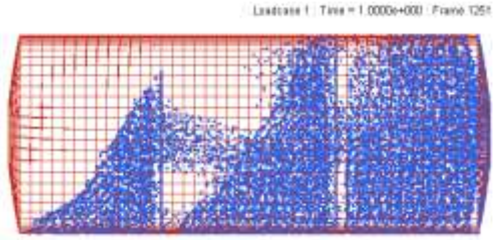


Fig. 6 – Displacement magnitude during slosh simulation

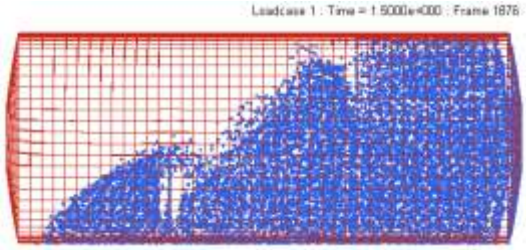
For a better view a water behaviour in first model of the tank model in Figure 6 are presented four simulation phase at the different time. It can be observed that at 0.5 sec. the liquid hits the front of the tank, and after 1.9 sec. the liquid start to stabilize after the tank it's stopped.



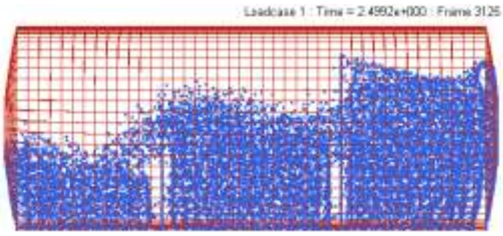
a) 0.5 sec



b) 1.0 sec



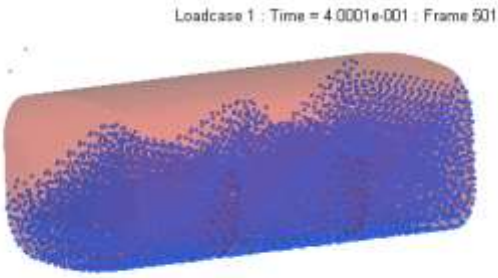
c) 1.5 sec



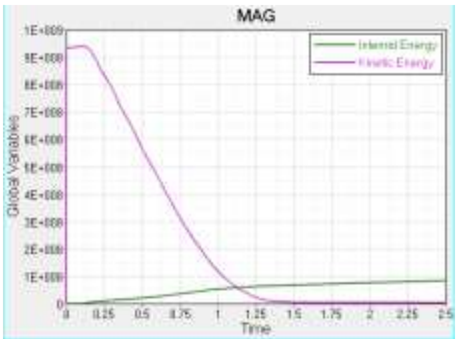
d) 2.5 sec

Fig. 7 – Water behaviour – first tank model

The results of the second simulation are presented in pictures below. Figure 8 presents the energy balance during the slosh simulation. By comparing the obtained results it is observed that the second tank model does not have a better efficiency than the first model.



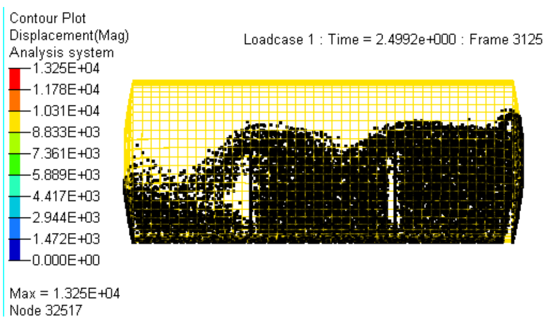
a) Isometric view at 0.4 sec.



b) Energy balance

Fig. 8 – Energy balance during slosh simulation

Displacement values and plot curve are presented bellow in Figure 9.



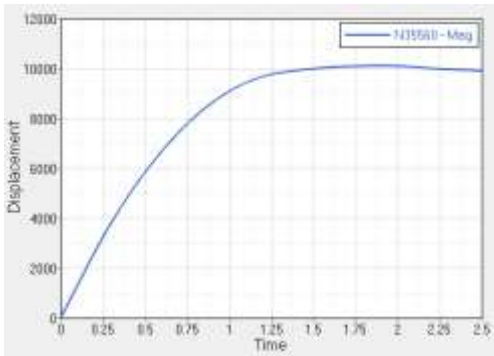
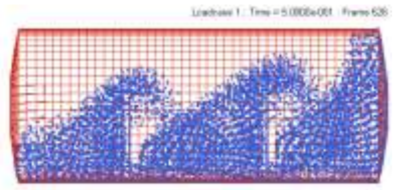
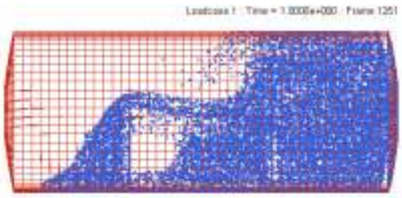


Fig. 9 – Displacement magnitude during slosh simulation

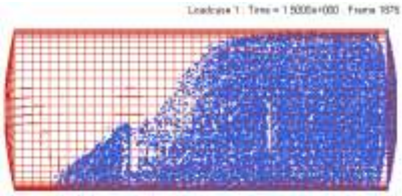
The sloshing of the water for second tank model simulation can be observed in Figure 10. By visually comparing the obtained results it is observed that after the tank stops the water stabilizes faster in the second model.



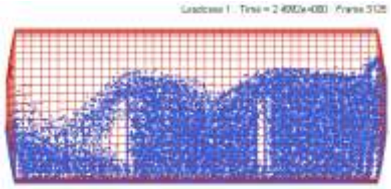
a) 0.5 sec



b) 1.0 sec



c) 1.5 sec



d) 2.5 sec

Fig. 10 – Water behaviour – second tank model

CONCLUSIONS

This study may be a starting point for determining the dynamic behaviour of liquids in tanks. The obtained results for both simulations give a complete view of the water slosh phenomena. Using the SPH method for simulation of the liquid behaviour shorten the simulation timing. To stabilize the liquid and reduce the sloshing phenomena for this type of tank it would be necessary to install three transverse baffles with small holes, or install the straggled baffles between the conventional baffles.

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CFD STUDY OF THE EXHAUST GASES DISTRIBUTION FOR TRACTORS WITHOUT CAB
/
STUDIUL CFD A DISTRIBUTIEI GAZELOR EVACUATE PENTRU TRACTOARELE FĂRĂ CABINĂ

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Keywords: *CFD simulation, exhaust muffler, tractor, streamline distribution*

ABSTRACT

In this paper are studied aspects on the distribution of the flow streamline of exhaust gases especially at tractors without cab. Considering that the majority of the tractors exhaust muffler it is positioned in the front side of driver and have a negative effect on his health. There are studied methods of improving the exhaust gases distribution. In the first part, are presented actual numerical methods of computational fluid dynamics and the geometrical models of existent gases exhaust muffler from agricultural tractors. The second part presents the CAD modelling of a tractor without cab with a driver and the CFD simulation is achieved. After the running of the CFD simulation and analyzing of the exhaust gases distribution it is proposed a new position of the exhaust system adapted for reducing the gases distribution on the driver.

REZUMAT

În această lucrare sunt studiate aspecte despre distribuția și curgerea gazelor de evacuare în special la tractoarele fară cabină. Se consideră că majoritatea dispozitivelor de evacuare a gazelor sunt poziționate în partea frontală a șoferului, având un efect negativ asupra sănătății lui. Sunt studiate metode de îmbunătățire a distribuției gazelor de eșapament. În prima parte se prezintă metodele numerice actuale de calcul dinamic al fluidelor și modele geometrice a dispozitivelor de evacuare a gazelor pentru tractoare agricole. A doua parte prezintă modelarea CAD a unui tractor fără cabină cu șoferul și se realizează simularea CFD. După rularea simulării CFD și analizarea distribuției gazelor evacuate se propune o nouă poziție de amplasare a sistemului de evacuare adaptat pentru reducerea distribuției gazelor la șofer.

INTRODUCTION

Nowadays, an important research subject is the improvement of operators ccomfort in agricultural environment. The main harmful aspects during the operation and use of agricultural tractors are: exhaust gases, vibrations and engine noise or auxiliary equipment. The reduction of vibrations produced by agricultural tractors on the driver can be achieved by using a suspension seat, which reduces vibrations up to 45%. An overview of the current technologies applied in the construction of the seats for tractors is presented in (*Drakopoulos D., 2008*), where is presented the ergonomic and comfort features of these types of seats.

Tractors noise can be generated by the thermal engine, auxiliary equipment and exhaust gas evacuation. Redesigning the exhaust muffler using computational methods can greatly reduce the noise and transmissions loss can be improved (*Piana et al., 2018*). The exhaust gas pressure has a major impact on noise reduction; the modification of the exhaust design can reduce noise by up to 3.5 dB (*Mohit et al., 2015*) proved exhaust design generates a pressure of 60 mm Hg compared to 70 mm of Hg that is generated by the commercial version. Improved geometry of the muffler to reduce noise is made easier by specialized software such as Solidworks, Ansys, Comsol, etc. A comparative noise reduction study between an existing evacuation geometry and a proposed one is simulated in Comsol, where new geometry is found to be improved (*Verma et al., 2016*).

In (*Samoilenko, 2013*) a new muffler design is realized, aiming to reduce the exhaust diameter to improve aerodynamic characteristics. The evacuation pressure value of the redesigned model is low by 686 Pa compared to the commercial model.

MATERIAL AND METHOD

The optimal position of the exhaust system for medium tractors types that do not have cabin is studied in this paper. This type of tractors belongs to the older tractors category that do not have filters to reduce exhaust emissions. In order to carry out the exhaust gas distribution CFD study, it is necessary to follow the steps: CAD modeling of the equipment, impose of the working conditions, compute, visualize and interpret the results. In the follows paragraphs is detailed the required steps to apply the CFD method.

CAD design

Using advanced modeling techniques, the structure of a tractor and the driver are generated. The overall dimensions of the tractor are approximated in accordance with a true average size tractor model (*http://agripak.com.pk*). The three-dimensional tractor model is modeled in the SolidWorks software (*http://www.solidworks.com*).

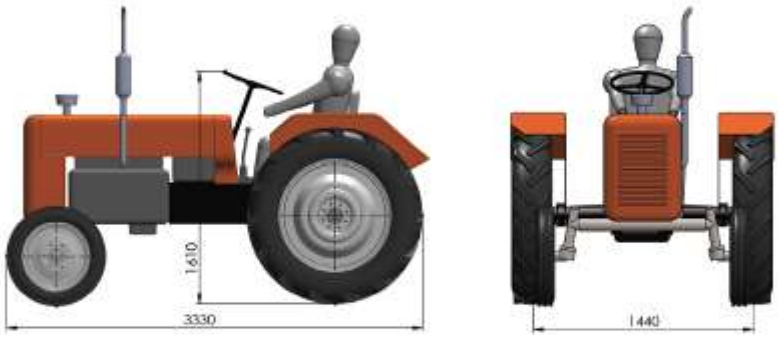

Fig. 1 – Overall dimensions of the base tractor and driver

In Figure 1 are presented the front and lateral views of the base tractor model without cab and the driver sitting in the work position. The tractor geometry is simplified to reduce the computer simulation time, are respected just the overall dimensions.

Computational fluid dynamic

The CFD method is an increasingly popular iterative method for determining the flow of gasses or fluids, is used in almost all areas of study, from the determination of optimal mechanical geometries in operation to the study of animal comfort in livestock (*Sousa Junior et. al., 2018*), dispersion of exhaust gases into the atmosphere in order to reduce pollution (*Akhatova et al., 2015*), or in simulation and analysis of airplanes used for herbicidal purposes in agriculture (*Dziubiński et al., 2014*). In the agricultural environment this method is used especially for atmospheric modeling, simulation of odor dispersion, air pollution or climate calculation (*Lee et al., 2013*).

To achieve the CFD study, follow the steps presented in Figure 2. The starting point is the CAD drawing of the proposed geometry, in the present case of the tractor and the driver. The definition of the computational volume in which the streamlines distribution of the gases or fluid and the simulation conditions can be observed is the second step. In this step, can be defined the required speed of the model, pressure, speed, fluid or gas flow, atmospheric pressure, etc. After imposing the working conditions follows the model's running simulation. The results are analyzed and if they do not meet the objectives, the process resumes from the first step, modifying the geometry of the model. If the results obtained meet the objectives, the final form of the model results.

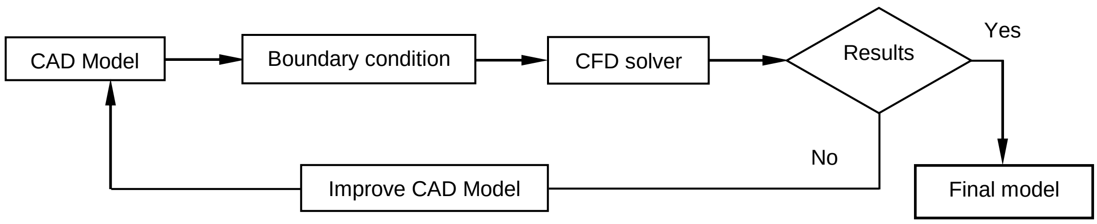

Fig. 2 - Flowchart of the iterative CFD simulation process

Two types of gas were used to determine the flow lines, one is the atmospheric air, and the second is carbon monoxide, which has the role of exhaust gas in this study. The volume of the defined computational domain is approximate of 9.1256 m^3 and is located on the top side of the tractor, only in the area of interest, in order to reduce the simulation time. The required simulation conditions are applied following the several CFD simulations study (*Puneetha et al., 2015*).

In the first simulation case, the distribution of air and carbon monoxide is affected by the left side winds and the speed of the tractor during the work, for example during the tillage operation. In Table 1 is presented the boundary conditions imposed.

Table 1

Inlet boundary conditions – first case

Mass flow rate of exhaust gas [kg/s]	0.00514
Exhaust gas temperature [°C]	226
Tractor initial velocity [m/s]	1.1
Left side wind velocity [m/s]	0.8

In the second case, the simulation is carried out at a front wind velocity and the forward velocity of the tractor when driving on the road. The required parameters for the simulation are shown in the Table 2, presented below.

Table 2

Inlet boundary conditions – second case

Mass flow rate of exhaust gas [kg/s]	0.00514
Exhaust gas temperature [°C]	226
Tractor initial velocity [m/s]	2.8
Frontal wind velocity [m/s]	8.34

RESULTS

After the simulation of both cases, the results can be observed in pictures presented below. In Figure 3 is presented a longitudinal and front planar view from the middle of the tractor and driver, can be seen that the volume fraction of the exhaust gas affects the driver.

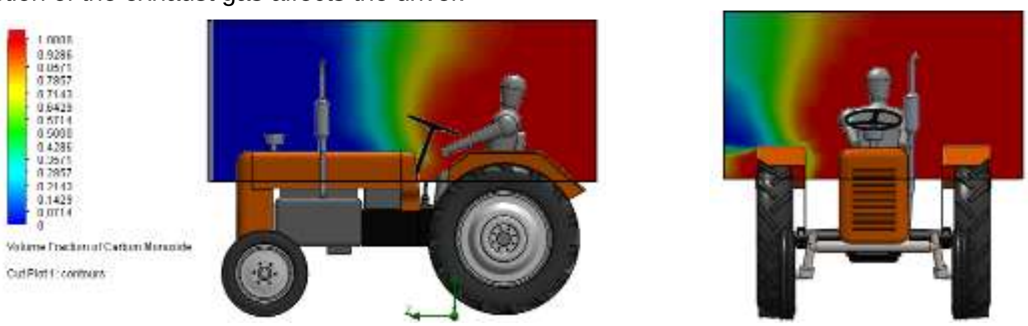

Fig. 3 – Plot of volume fraction of carbon monoxide – first case

The results of the second case is presented in Figure 4, it can be observed that the exhaust gas does not affect the driver.

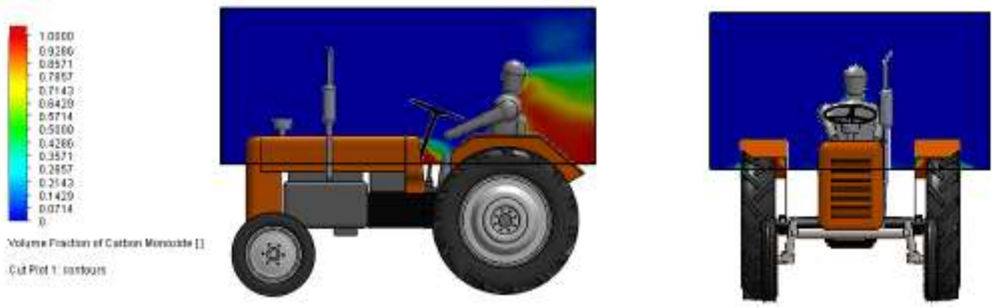

Fig. 4 – Plot of volume fraction of carbon monoxide – second case

Analyzing the results of these two simulations, it can be observed that in the first simulation case the exhaust gases affects the driver. The exhaust muffler will be positioned in the rear side of the tractor. For a better view and the validate this chosen of the distribution of the exhaust gas a new simulation is prepared. For this simulation are used the boundary condition from first simulation case. The results of the simulation are presented in Figure 5.

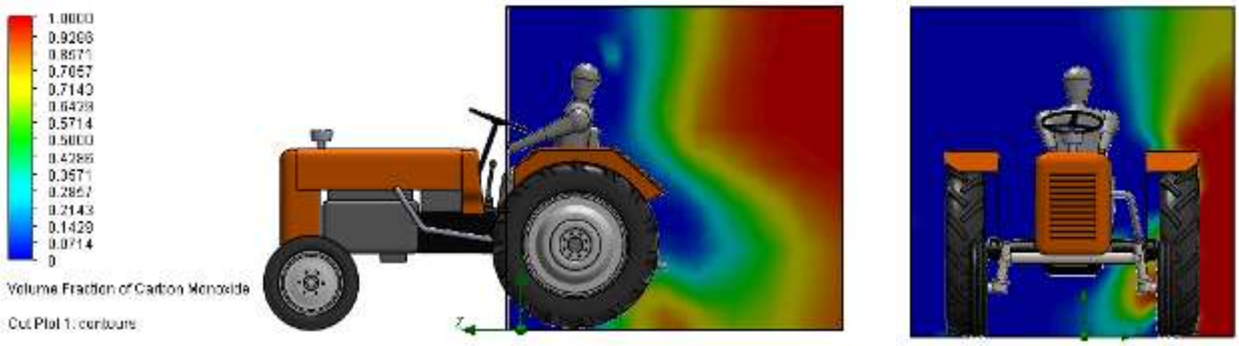

Fig. 5 – Plot of volume fraction of carbon monoxide – third case

CONCLUSIONS

This study achieved improving the working conditions for drivers of medium-sized tractors without cabs. The CFD simulation method used shows a clear view of the exhaust gas distribution, allowing drawing up multiple work scenarios without including additional material costs. The case with the muffler located at the rear side of the tractor eliminates the exhaust gases that affect the driver. The disadvantage of this variant is that in the case of the transport of flammable materials these may be fire risk due to temperature of the exhaust gases.

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THE NITRATES NUTRITION STATUS ASSESSMENT AND MANAGEMENT OF THE HORTICULTURAL CROPS IN THE STEPPE ZONE OF UKRAINE
/
ОЦІНКА ТА РЕГУЛЮВАННЯ ВМІСТУ НІТРАТІВ У ПЛОДО-ОВОЧЕВИХ КУЛЬТУРАХ В СТЕПОВІЙ ЗОНІ УКРАЇНИ

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Keywords: *vegetables, fruits, berries, nitrates, norm, maximum permissible concentration, yield, vermicomposting extract.*

ABSTRACT
The main aims were: a) to prepare a database of the determination of nitrate in vegetable and fruit production; b) identify plants – accumulators of nitrates and determine the number of samples exceeding maximum permissible concentration (MPC); c) to compare trials and doses of artificial nitrogen fertilizers and vermicomposting extract application in the field experiments with some vegetable and fruit plants. The results of the determination of nitrates in vegetables, fruits and berries, which are most often used in the human diet in steppe zone of Ukraine are presented. Two foliar spraying with vermicomposting extract gives the best results for cabbage cultivation then drip fertigation. The best result for pumpkin cultivation was recorded after vermicomposting extract treatment with a dilution of 1:150. The same trend was observed when determining the optimal doses for the greatest number of seeds and lowest NO_3 content. The lowest level of nitrate in pepper fruits determined in trial with vermicomposting extract foliar spraying with a dilution of 1:100. The best dose-effect response for apple tree yield was fixed for trial with vermicomposting extract two time drip fertigation with dilution 1:50.

ТЕЗИ
Головні цілі: a) сформувати базу даних визначення вмісту нітратів у продукції овочівництва і плодівництва; b) ідентифікувати рослини – акумулятори нітратів і визначити частку проб з перевищенням рівню ГДК.; c) порівняти варіанти і дози внесення мінеральних азотних добрив і вермикомпостного екстракту у польових дослідах з деякими овочевими і плодовими культурами. Наведено результати визначення нітратів в овочах, плодах і ягодах, що найчастіше використовують у раціоні харчування людини в степовій зоні України. Дворазове оприскування капусти вермікомпостним екстрактом призводило до отримання кращих результатів ніж за умов введення під час крапельного зрошення. Кращий ефект при вирощуванні кабаку був відмічений при фертигації розчином вермикомпостного екстракту з розведенням 1:150. Та ж тенденція спостерігається у збільшенні кількості насіння та зменшенні вмсту нітратів. Найнижчий рівень нітратів у плодах перцю зафіксований за умов дворазового оприскування вермикомпостним екстрактом з розведенням 1:100. Кращий відгук доза-ефект пов'язаний із підвищенням врожаю яблуні за умов дворазового введення розчину вермікомпостного екстракту з розведенням 1:50 з крапельним зрошенням.

INTRODUCTION
Approximately 80% of dietary nitrates are derived from vegetable consumption. Sources of nitrites include vegetables, fruit, and processed meats, which means that human exposure to nitrate is usually associated with intake through vegetables, and to a lesser extent, with other foods and water (*Temme, 2011*). Nitrates are, besides being used as food additives, found in nature as part of the nitrogen cycle, and play an important role during nutrition, growth and development of plants. Because of their cumulative properties, they are an important part of vegetables (*Lucarini et al., 2012*). Nitrates serve as a source for the production of nitrite and nitric oxide as well as other metabolic products. Nitrites are also produced endogenously through the oxidation of nitric oxide and through a reduction of nitrate by commensal bacteria

in the mouth and gastrointestinal tract (*Norman, 2009*). Long-term use of contaminated with nitrates vegetables, fruits and water leads to development of chronic intoxication. In the case when foods have a high content of nitrates, both nitrate and their metabolites (nitrite and nitro-compounds) enter the human body. Thus, a precise balance between nitrates income and outcome in the human body has not yet succeeded. Nitrates are not only entering to the body from outside, but also formed therein. Regarding to the rules by of nitrates – 5 mg nitrates per 1 kg of body weight of a person for an adult person is allowed, i.e. 0.25 g – for a person with weight 60 kg (*Ganchuk et al, 2012; Menard et al., 2008*).

Acceptable standard for child is less than 50 mg. A person takes easy the daily dose of nitrates in 15–200 mg. The 500 mg is the maximum permissible dose, and 600 mg is toxic dose for an adult person. Nitrogen – an essential element for all life forms. In the process of the nitrogen cycle in nature during the breakdown of proteins and other nitrogen-containing substances excreted ammonia. Nitrification bacteria substances make oxidation to nitrates, and those, in turn, are converted to nitrites. Under the action denitrification bacteria last turned back into nitrogen, which is released to the atmosphere.

The nitrogen is supplied in the soil with various kinds of fertilizers, residues of plants, amonium and nitrogen nitrates salts, which are contained in rain water (*Temme, 2011*). Nitrates – are natural products of metabolism of all plants. They are vital to plants, because of it is impossible without them to provide their normal growth and development. However, uncontrolled use of nitrogen fertilizers has led to the accumulation of unlimited level in their products of plant origin (*Berova and Karanatsidis, 2008*).

The main factors that cause the accumulation of nitrates in vegetables, fruits and berries include meteorological and agronomic conditions of cultivation, the level of soil fertility, varietal characters of plants (*Iammarino et al, 2014*) The fruit and vegetables grown in the south - eastern part of Ukraine, on the content of toxic substances, depending on their species and varietal facilities (carrots, beets, pumpkin, peppers, tomatoes, rhubarb, gooseberry, etc.), as well as in their anatomical parts.

These studies allowed identifying the safest crops and their varieties. The study of patterns of income and accumulation in plants nitrates is necessary for the proper reasoning for the development of activities to reduce their content in the finished product. Studies have shown that vermicompost plays a major role in improving growth and yield of different field crops, including vegetables and fruit crops. For example, the application of vermicompost gave higher germination, growth and yield of horticultural crops (*Vigna radiate L*.) compared with the control (*Gutiérrez-Miceli et al., 2007; Sallaku et al., 2009*).

Plants fertilized with vermicompost have shown greater ability to assimilate essential macro and micro nutrients, and resulted into improved root development (*Atiyeh et al., 2001; Arancon et al., 2006*). Nutrients in vermicompost are present in readily available forms for plant uptake; e.g. NO_3, exchangeable P, K, Ca and Mg (*Edwards and Burrows, 1988*). Better plant growth and yield of different crops have been reported when vermicompost was combined with artificial fertilizer in a certain ratio. The main *aims* were: a) to prepare a database of the determination of nitrate in vegetable and fruit production; b) identify plants – accumulators of nitrates and determine the number of samples exceeding maximum permissible concentration (MPC); c) to compare trials and doses of artificial nitrogen fertilizers and vermicomposting extract application in the field experiments with some vegetable and fruit plants.

MATERIAL AND METHOD

Monitoring of nitrates was conducted in field experiments with species and varieties of vegetable and fruit crops grown in the Steppe zone of Ukraine. Field experiments were laid out in 4-fold repetition in terms of vegetable and orchards variety testing stations of Dnipropetrovsk region in 2000–2004 and 2015-2016 years. Average samples of vegetables, fruits and berries were crushed and homogeneous. Then they were weighed to 10 g of powdered sample or squeezed juice, was added 50 ml of a 1 % solution of potassium alum to extract nitrate for 15 min. The control of nitrates content was carried out applying the potentiometric method with nitrate selective electrode (*Products of fruits and vegetables, 1995*). Assessment of cases of exceeding maximum permissible concentrations (MPC) has been done taking into account several references (*Ganchuk et al., 2012; Menard et al., 2008; Mitek et al, 2013*).

The contents of readily soluble proteins of sweet pepper tissue withdrawn by the buffer 0.05 M tris-HCl and pH 7.4 were defined according to the Bradford method (*Bradford, 1976*). The activity of peroxidase was determined right after the secretion (*Boyarkin, 1956*). Protein spectra in the sweet pepper tissue were determined with SDS electrophoresis. Pepper, cabbage, pumpkin and apple were selected as test plants to examine the effectiveness of different forms of fertilizers. Scheme of field experiments with vegetables included the following options: foliar spraying with nitrogen fertilizer (50 g NH_4NO_3 per 10 liters of water) and vermicomposting extract (dilution 1:100). Ratio of fertilizer and water in case of drip irrigation using were: 1:200, 1:150 and 1:100. Two apple varieties (*Gala Red and Pinova*) were evaluated in field experiments with drip irrigation. Vermicomposting extract with ratio of fertilizer and water: 1:100 and 1:50 was applied after time of drip fertigation. Vermicomposting extract technology includes the following stages: mechanical decomposition of wastes to the certain parameters; crushing of crops wastes to certain fractions, fermentation of the ground raw material under the proper humidity and temperature, bioprocessing of the fermentated husk (sunflower, buckwheat or rice) by worms *Eisenia foetid*a on the special shelves, extracting of biohumus with water (*Kharytonov et al., 2009*).

RESULTS

The results of determining the concentration of nitrates in fruits and berries are shown in Table 1.

Table 1

Nitrate concentration in fruit and berries

Fruits, berries	Number of samples	Average meaning	Min – Max
Plum	7	50.4	23.9–81.9
Cherries	24	15.8	8.05–27.6
Apricot	6	45.6	20.3–82.0
Plum	4	40.7	28.9–51.7
Strawberry	5	42.0	34.9–50.5
Raspberry	7	33.3	16.2–91.4
Blackberry	17	22.8	14.4–28.7

The average value of nitrates in fruits and berries were in the range of 20–50 mg/kg. The content of nitrates was studied in our work fruits and berries belong to the group of low concentration. The results of nitrate assessment in vegetable crops are given in Table 2.

Table 2

Nitrates concentration in vegetable crops, mg/kg

Vegetable crop	Number of samples	Average meaning	Min – Max	MPC	Number of samples, which exceed MPC
Radish	5	2727.6	2022–3596	1500	5
Beet	6	2886.5	1276–4527	1400	5
Carrot	6	485.0	161–1137	250	5
Pumpkins	6	669	291–1157	400	5
Potatoes	46	138.2	23–639	250	12
Cabbage	12	584.33	103–1833	900	2
Pepper	9	228.75	73–580	200	2
Tomatoes	19	44.1	16,5–82,0	150	0
Sugar pea	9	4.6	3,6–6,4	-	-

The data in Table 2 shows that 36 of the 111 samples tested for nitrate content exceed the maximum permissible concentration. The largest share of the maximum permissible concentration is observed in the vegetables: radishes, beets, carrots and pumpkin. In the determination of nitrate content in potatoes 12 samples from 46 exceeded the 1MPC, in cabbage 2 samples of 12, and pepper in 2 samples of 9 exceeded the 1MPC. The results of measuring of content of nitrates in of pepper fruits treated with solutions of mineral nitrogen fertilizers and vermicomposting extract shown in Figure 1.

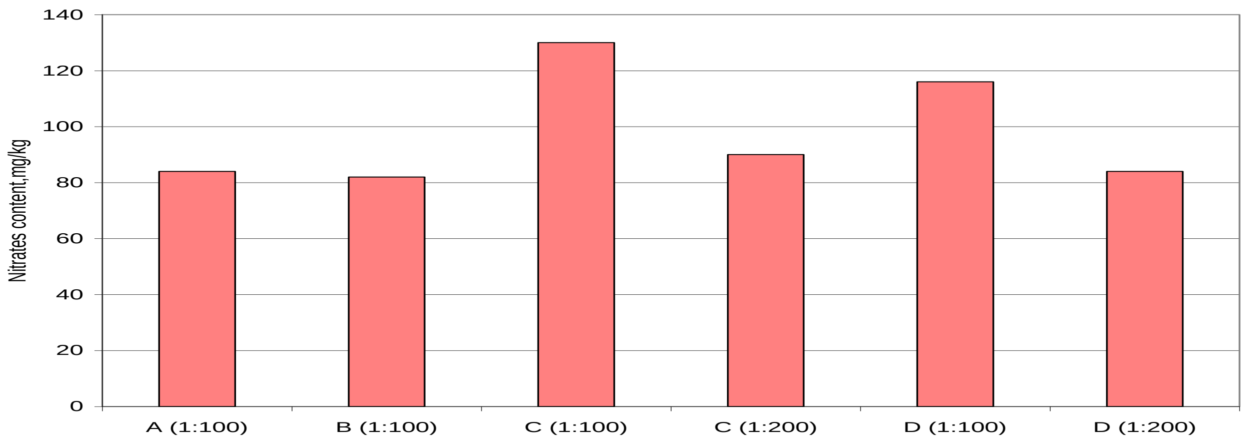

Fig. 1 - The content of nitrates in fruits of pepper in different variants of the field experiment:
A -foliar spraying with nitrogen fertilizer (1:100) ; B - foliar spraying with vermicomposting extract (1:100);
C – drip fertigation with nitrogen fertilizer (1:100; 1:200); D - drip fertigation with vermicomposting extract (1:100; 1:200)

The highest level of nitrates was recorded in the cultivation of pepper drip irrigation in the cultivation of nitrogen fertilizers in the ratio 1:100. The same pattern is recorded, and when vermicomposting extract has been applied. The lowest level of nitrate determined in trial with vermicomposting extract spraying (B 1:100). In other words, these options provide higher environmental quality of the pepper fruits.

The results of the electrophoresis of peroxidase protein of sweet pepper tissue are given in Table 3.

Table 3

Isoelectric points (PI) of isoenzymes of peroxidase tissues of sweet pepper grown under different conditions

№	pI	Treatment					
		A (1:100)	B (1:100)	C (1:100)	C (1:200)	D (1:100)	D (1:200)
1	4,00	+	+	+	+	+	+
2	4,05	++	++	++	++	++	++
3	4,07	+++	+++	+++	+++	+++	+++
4	4,09	+	++	++	++	++	++
5	4,12	-	+	+	+	+	+
6	4,20	-	-	+	+	-	-
7	4,25	+	+	+	+	+	-
8	4,30	-	+	+	-	+	-
9	4,40	-	-	+	-	+	+
10	4,50	-	-	-		+	+
11	5,25	-	-	-		+	+
12	6,40	-	-	-		+	-

The highest number of protein fractions and enzyme concentration is noted for the variant *D* - drip fertigation with vermicomposting extract (1:100).

The data obtained in field experiments with cabbage variety "Langedijk" in research vegetable variety testing station are shown in Table 4.

Table 4

Vermicomposting extract application in field plots of cabbage

Trials	Average yield, ton/ha	Additionally, %
Control (water)	35.7	-
Drip irrigation (1:100)	43.4	21.5
Drip irrigation (1:200)	46.9	31.2
Foliar spraying (1:100)	48.8	36.6
LSD_{05}	5.1	

It was found that two foliar spraying with vermicomposting extract gives the best results in terms of yields comparatively to control. The vermicomposting extract drip fertigation with a dilution of 1:200 gives higher application yield than trial with a dilution of 1:100.

The results of the experiments with the pumpkin variety “Valok” for the study of optimal dose of the vermicomposting extract are given in Table 5.

Table 5

Vermicomposting extract influence on pumpkin yield and NO_3 content

Trial	Average fruit weight, kg	Seeds weight, g (in average of 3 fruits)	NO_3 content, mg/kg
Control	9. 45	263	225
1:200	10.30	272	158
1:150	11.00	294	164
1:100	10.00	264	172
LSD_{05}	0.84	50	

The best result was recorded after vermicomposting extract treatment with a dilution of 1:150. The same trend was observed when determining the optimal doses for the greatest number of seeds and lowest NO_3 content.

The results of the field experiments with vermicomposting extract (VCE) application in apple orchard based on two varieties testing are presented in Figure 2.

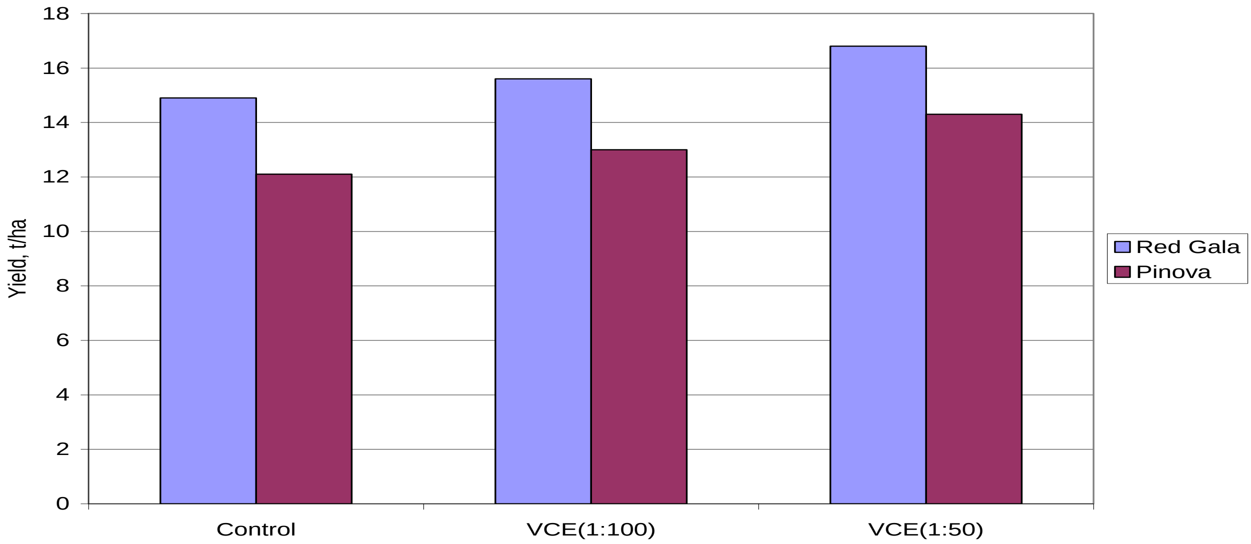

Fig. 2 - The vermicomposting extract dose-effect search in apple orchard

The best dose-effect response for apple tree was fixed for trial with vermicomposting extract dilution at 1:50.

CONCLUSIONS

The data obtained shows that 36 of the 111 vegetable samples tested for nitrate content exceed the maximum permissible concentration. The content of nitrates was studied in our work fruits and berries belong to the group of low concentration to 100 mg/kg. The lowest nitrate content we found in green peas.

The field experiments data showed the best result in case of vermicomposting extract application both from productive and ecological points of view. Thus, the application of the bioconversion products can provide reliable ways to environmentally friendly agriculture.

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MATHEMATICAL MODELING AND NUMERICAL SIMULATION OF THE DRYING PROCESS OF SEEDS IN A PILOT PLANT
/
MODELAREA MATEMATICĂ ȘI SIMULAREA NUMERICĂ A PROCESULUI DE USCARE A SEMINȚELOR ÎNTR-O INSTALAȚIE PILOT

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Keywords: *mathematical modeling, numerical simulation, seed drying*

ABSTRACT
The artificial drying of grain seeds is widespread to ensure that they are preserved, as reducing the water content allows products to be stored for long periods of time without the need for complex storage facilities. The proposed drying installation is a low-capacity pilot one, which can change and monitor in real time a series of important parameters of the drying process. By means of the CFD simulation was optimized the construction of the cylindrical box and of the deflectors. This leads to reaching a uniform drying and to reducing the energy consumptions.

REZUMAT
Uscarea artificială a semințelor de cereale este larg răspândită pentru a asigura condiții de conservare a acestora, deoarece prin reducerea conținutului de apă se permite păstrarea produselor pe perioade lungi de timp fără a fi nevoie de instalații complexe de depozitare. Instalația de uscare propusă este una pilot, de capacitate mică, prin care se pot modifica și monitoriza în timp real o serie de parametri importanți ai procesului de uscare. Cu ajutorul simulării CFD a fost optimizată construcția casetei cilindrice și a deflectoarelor. Aceasta conduce la obținerea unei uniformități a uscării și la o reducere a consumurilor energetice.

INTRODUCTION
The experimental laboratory investigations of cereal seed drying precede the CFD simulation process, because the simulation involves the use of physical parameters (porosity, volume mass, specific heat, conductivity) for both the product and the air used as drying agent.

By CFD simulation of the cereal seed drying process, it is possible to graphically visualize the evolution of temperature and humidity fields at any point in the product layer. Calibration of the simulation is performed by comparison with the experimentally obtained data, measured in the median area of each product layer.

The degree of precision of the mathematical model, obtained by CFD simulation, is given by the differences in temperature and humidity of grain seeds determined under laboratory conditions. Also, an important weight in these differences is also the simplifying assumptions on which the mathematical model of convective drying was built, considering that this process is complex by the large number of physical parameters, as dependent variables, which vary simultaneously over short time.

The concept of a model has many meanings that can refer to a machine, a concept, an equation, a person, etc. In the most general sense, the model is a material or spiritual construction which, depending on the purpose pursued, has a similarity or similar behaviour to the patterned object. The model is a representation of reality, used to analyse the behaviour of the original under different conditions. The model is, in most cases, a simplification of the original, keeping only the essential, significant elements. There must be an analogy between the original or model object and model. This analogy may be structural or functional.

Structural or isomorphic analogy is characterized in that the elements of the original are found in the model. The structure and functionality of the prototype and model are the same. If geometry is preserved, the pattern and the prototype are geometrically similar.

Functional analogy corresponds to simplified models that reproduce only input-output functions from the prototype. For engineering and machine design in the agro-food industry, two types of models are important: mathematical and physical scale.

The use of the Computational Fluid Dynamics technology has made it possible to design and simulate a drying baffled unit for agricultural seed, to achieve uniform seed temperature distribution and to reduce the energy demand.

Franks shows that mathematical models are based on three rules: for physical processes, there must be a number of independent equations equal to the number of unknown sizes; from any equation, the solution leads to the value of an unknown; equations are systematized so that each one obtains one of the most significant quantities (*Franks, 1961*).

Many mathematical models have been developed to simulate the heat and the moisture transfer in the aerated bulk stored grains. A lot of them were obtained at low temperatures and low seed humidity.

Iguaz et al. (2004) developed a model for the storage of rough rice during periods with aeration. *Andra* (2001) and *Devilla* (2002) simulated the temperature changes in a wheat storage bin, but, without moisture changes.

Chang et al. (1993) and *Sinicio et al.* (1997) also developed a rigorous model to predict the temperature and the moisture content of wheat seeds during storage with aeration.

The aim of this paper is to propose the mathematical model of mass and heat transfer and to simulate the air flow in a cylindrical drying unit with deflectors, using the FLUENT software.

MATERIAL AND METHOD

CFD analyses can provide complex information on the drying phenomenon that cannot be obtained under experimental conditions. Table 1 presents the capability and limits of the experiment and the CFD numerical simulation by comparative analysis.

Table 1

Comparative analysis between experiment and simulation

Elements	**Experiment**	**CFD Numerical Simulation**
	Quantitative description of the drying phenomenon using measurements	Quantitative prediction of the drying phenomenon using mathematical models and CFD simulation programs
Number of analyzed parameters	1	>1
Number of analyzed points	1	>1
Model scale	reduced	real
Number of analyzed problems	limited	unlimited (depending on software)
Conditions of deployment	laboratory	real conditions
Sources of errors	measurements errors	modeling, meshing, implementation

The mathematical model of the convective drying process is based on fluid dynamics, mass balance and energy dynamics theory.

The equations of the mathematical model of the air flow are: the differential equation of continuity, Navier – Stockes equations, mass transfer equation, heat transfer equation and moment transfer equation.

The system of the equations described above is the general mathematical model. This system is solved by numerical procedures, using solving algorithms. Numerical solving by CFD simulation of the equation system in the mathematical model is accomplished by the iterative method using the Gauss-Seidel model. The iterative method of solving the equation system is performed by successive iterations, so based on the previous solutions each iteration calculates a new solution.

The iterative Gauss-Seidel method aims to increase the convergence speed and reduce the memory needed to store the solution in one memory space, not two.

CFD simulation, based on the proposed mathematical model, involves following steps:

- numerical meshing of the calculation area by the finite volume method (centered difference approximation) in the pre-processing stage;

- imposing boundary conditions to obtain a determined system of equations, which is done in the pre-processing stage for geometry and in the processing stage for parameters of speed, temperature, humidity;

- solving the system of equations in each domain node by the interactive method until obtaining the convergence in the processing stage;

- graphical representation of the solutions obtained at each node in the studied field, for parameters of speed, temperature, humidity and current lines, in the post-processing stage.

During the pre-processing stage are presented the numerical meshing techniques and the limit conditions for obtaining a determined system of equations.

Approximation by meshing is a fundamental concept based on several numerical methods such as finite difference method, finite volume method, finite element method and spectral method.

The numerical discretization of the computation domain in this simulation is done by the finite volume method (centric approximation). Control volume discretization applies to a three-dimensional domain divided into a finite number of adjacent volumes of parallelepipedal shape chosen to contain a single node of the network represented by the coordinates i, j, k and side faces intersecting the lines of the network in points located halfway between two neighboring nodes (Figure 1).

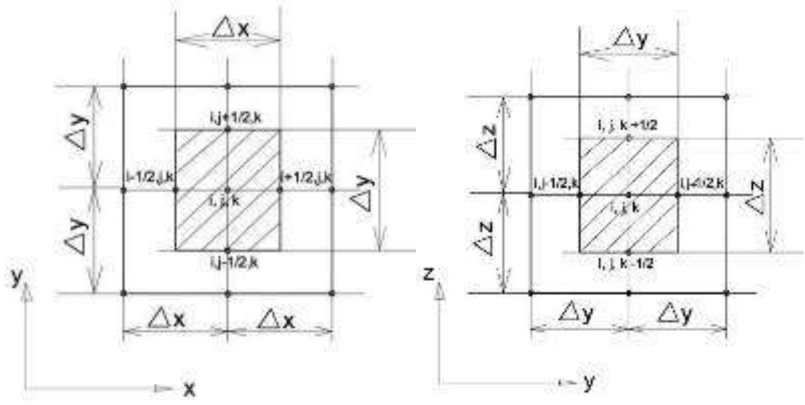


Fig. 1 - Defining the control volume

At the basis of this method are the solutions for the integration of an equation on each volume, by choosing a certain distribution law of *u* (*u* may be a function of temperature, humidity, displacement of a fluid or product) so that it can be evaluated integrally. The meshed form of the equation contains the function values for a group of nodes of the network, adjacent to the central node.

The areas of separation between the adjacent control volumes are in this case discontinuous surfaces. The values of the function *u* on these surfaces are considered equal to the arithmetic mean of the values corresponding to the volumes placed on one side and the other, being represented by the relations:

$$u_{i+\frac{1}{2},j.k} = \frac{u_{i+1,j,k} + u_{i,j,k}}{2} \; ; \; u_{i-\frac{1}{2},j.k} = \frac{u_{i,j,k} + u_{i-1,j,k}}{2} \qquad (1)$$

$$u_{i,j+\frac{1}{2}.k} = \frac{u_{i,j+1,k} + u_{i,j,k}}{2} \; ; \; u_{i,j,-\frac{1}{2}.k} = \frac{u_{i,j,k} + u_{i,j-1,k}}{2} \qquad (2)$$

$$u_{i,j,k+\frac{1}{2}} = \frac{u_{i,j,k+1} + u_{i,j,k}}{2} \; ; \; u_{i,j,k-\frac{1}{2}.} = \frac{u_{i,j,k} + u_{i,j,k-1}}{2} \qquad (3)$$

where: *i*, *j*, *k* as the index represents the natural number.

By integrating the partial derivative equations on the finite control volume V ($V=\Delta x \cdot \Delta y \cdot \Delta z$), the first and second order integrals appear, which will take a discretised form respecting the values of the function in the neighbouring volumes. The discretized form on the three directions will be:

$$\int_{\Delta V} \left(\frac{\partial u}{\partial x} \right) dxdydz = \left(\frac{u_{i+1,j,k} - u_{i-1,j,k}}{2\Delta x} \right) \Delta V \qquad (4)$$

$$\int_{\Delta V} \left(\frac{\partial u}{\partial y} \right) dxdydz = \left(\frac{u_{i,j+1,k} - u_{i,j-1,k}}{2\Delta y} \right) \Delta V \qquad (5)$$

$$\int_{\Delta V} \left(\frac{\partial u}{\partial z} \right) dxdydz = \left(\frac{u_{i,j,k+1} - u_{i,j,k-1}}{2\Delta z} \right) \Delta V \qquad (6)$$

where:

V represents the volume.

The expressions of the integrals of the mixed derivatives can be obtained using the integration of second-order mixed derivatives:

$$\int_{\Delta V}\left(\frac{\partial^2 u}{\partial x \partial y}\right)dxdydz = \frac{u_{i+1,j+1,k} - u_{i+1,j-1,k} + u_{i-1.j-1,k} - u_{i-1,j+1,k}}{4\Delta x \cdot \Delta y} \tag{7}$$

Finite volume discretization involves an analysis of the working range that is volumetric represented by the cylindrical unit. It has the form of a cylinder that has three slots where the cereal seeds are introduced for drying. The hot air enters this cylindrical box through the central region, being guided by a cylindrical tubing that connects to the dryer.

The geometry of the three-layer cylindrical unit and the introduction of the drying agent is shown in Figure 2, and the mesh geometry is shown in Figure 3.

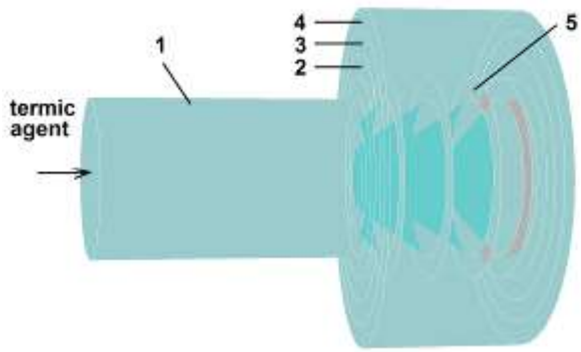


Fig. 2 - Defining the control volume
1 – heat duct, 2 – first seed layer, 3 – second layer, 4 – third layer, 5 – deflectors.

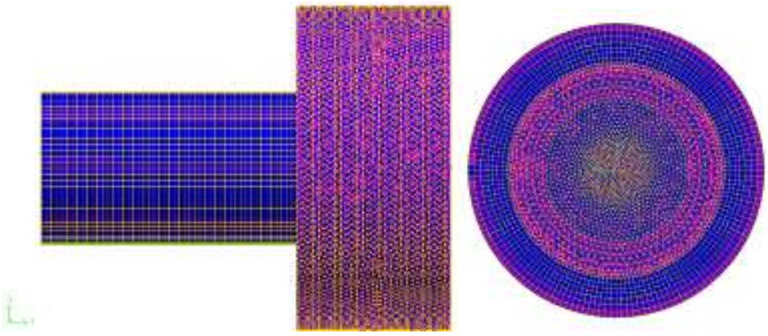


Fig. 3 - Cylindrical box meshing

The cylindrical unit geometry is hybridized. The displacement of the cylindrical introduction of the drying agent is structured, and in the region of the three slots where the seeds are introduced, the meshing is unstructured.

The air inlet and outlet area in the free volume and the four vertical surfaces define the free volume and are shown in Table 2.

Table 2

Cylindrical unit imposed outline conditions

Cylindrical box areas	Contour conditions
Entry	Speed
Exit	Pressure
Surfaces	Wall
Volume	Fluid

At the discretization of the pressure and other conservation equations, the upwind mesh scheme (the value of the velocity *u* is transported to the edge of the volume element relative to the local speed direction) of the first order (*Ansys-Fluent-User Guide, 2012*). A linear (first order) scheme was used to simulate the pressure equation in order to maintain the stability of the final solution. The quadratic scheme is more sensitive to pressure deformations, resulting in an instability of the calculation, the solution for the multiphase flow (air plus humidity) and the density (of nodes) imposed by the meshing. All the simulations were unstated. The flow regime for simulation is tested to obtain a convergent equilibrium state in the evolution of residues (Figure 4).

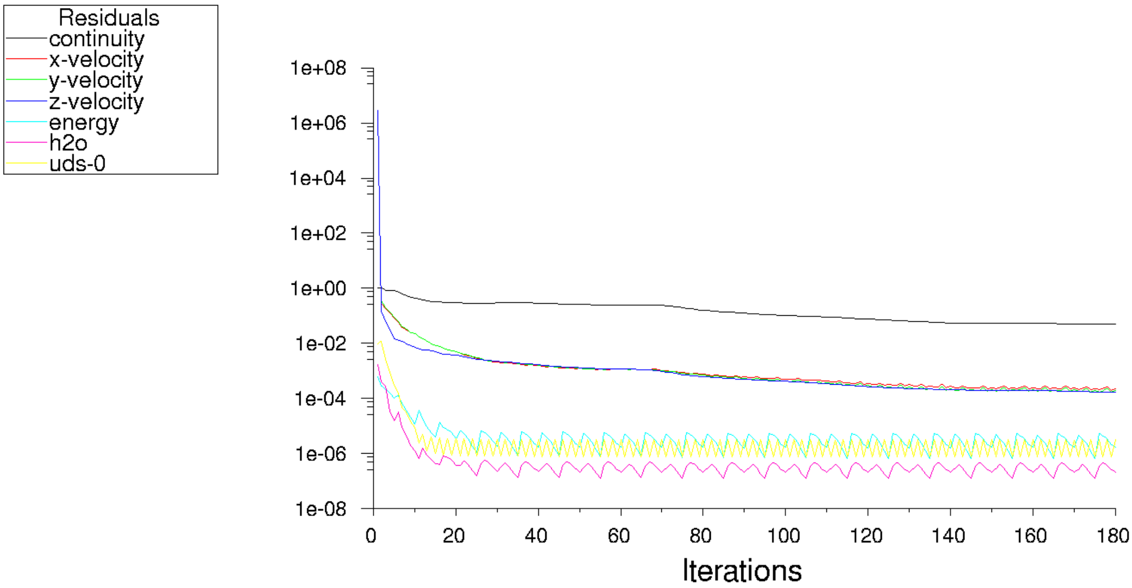


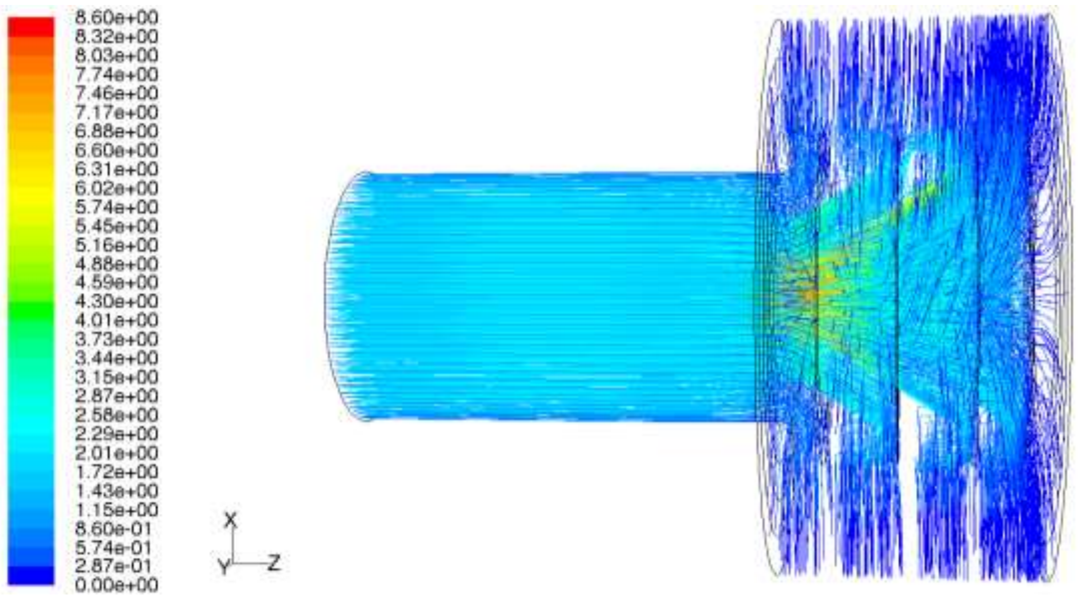
Fig. 4 - Developments in processing residues for non-steady state

Following the mathematical modeling of the drying process, CFD simulations were made in two variants for the three-layer cylindrical unit with corn seeds from the DKC 4751 hybrid.

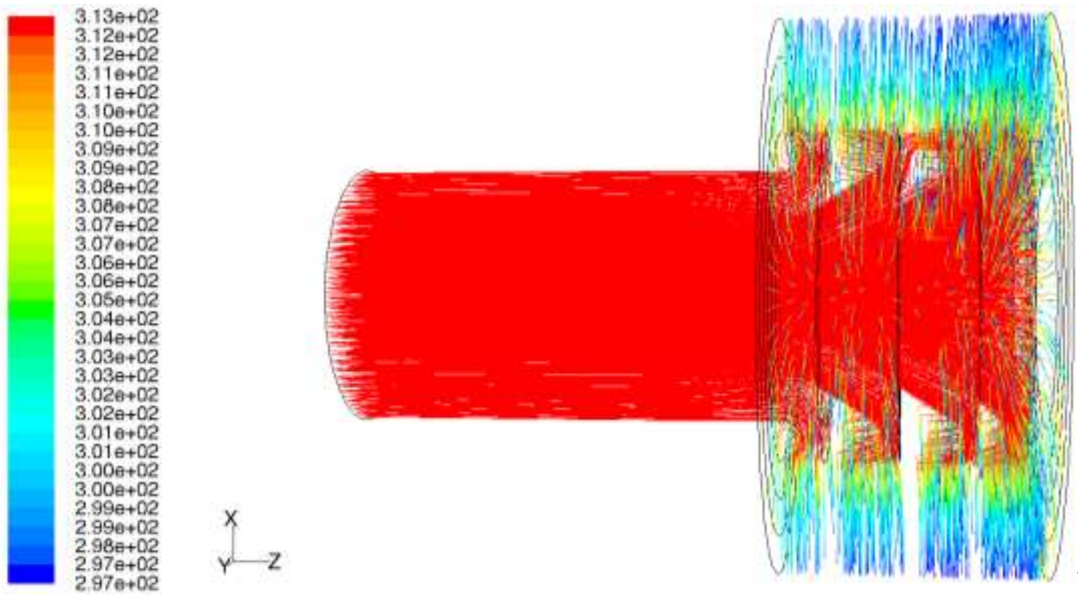
RESULTS

The field of the current lines obtained in the three-layered cylindrical unit has a laminar flow of the drying agent at the unit entrance, and in the region of the baffles, one can see a uniform distribution of the hot air over the entire surface of the corn seeds to be dried. In the simulation version I, with a thermal velocity of 2 m/s and its inlet temperature of 313 K (40 °C), a speed increase of up to almost 8 m/s is observed in the deflector region as a result of the reduction of the section and afterwards it reaches uniformly again the value of 2 m/s on the surface of the first seed bed. Passing the three layers of corn seeds, the speed of the current lines drops to 0.3 m/s at the exit of the last layer (Figure 5a). The surface temperature of the first seed coat is 313 K (40 °C) with a uniform distribution of current lines, and in the seed layers the temperature decreases, yielding heat for drying and lowering to the last layer up to 300 K (27 °C) Figure 5b).

In the CFD simulation variant II at an air velocity of 2 m/s and its inlet temperature of 343 K (70 °C), the same speed increase in the deflector region is observed as a result of the section reduction, which will be uniformly reached again at 2 m/s on the surface of the first grain seed bed. Passing the three layers of corn seed, the current line speed drops to 0.3 m/s at the exit of the last layer. The distribution of air velocity in the three-layer cylindrical box is preserved as in variant I, with very small variations, as the geometry remains unchanged (Figure 6a).



a



b

Fig. 5 - The current lines field inside the cylindrical box with baffles and three layers for the first version (temperature of 313 K = 40ºC):
a – velocity (m/s); b – temperature (K).

The temperature at the surface of the first seed bed is 343 K (70 °C) with a uniform distribution of the current lines, and in the seed layers, the temperature decreases giving off their heat for drying and lowering to the last layer to 311 K (38 °C). As shown in Figure 5 and Figure 6, regardless of the working regime of the drying unit, the same uniformity of the current lines is maintained over the whole surface of the first layer of seeds. In the design phase of the three-layer cylindrical unit, the distance between the baffles and sections was optimized by repeated CFD simulations to achieve this uniformity of spreading of the drying agent at the layers of corn seeds. In order to obtain the seed temperature and humidity parameters CFD simulation was performed at two different temperatures of the hot air.

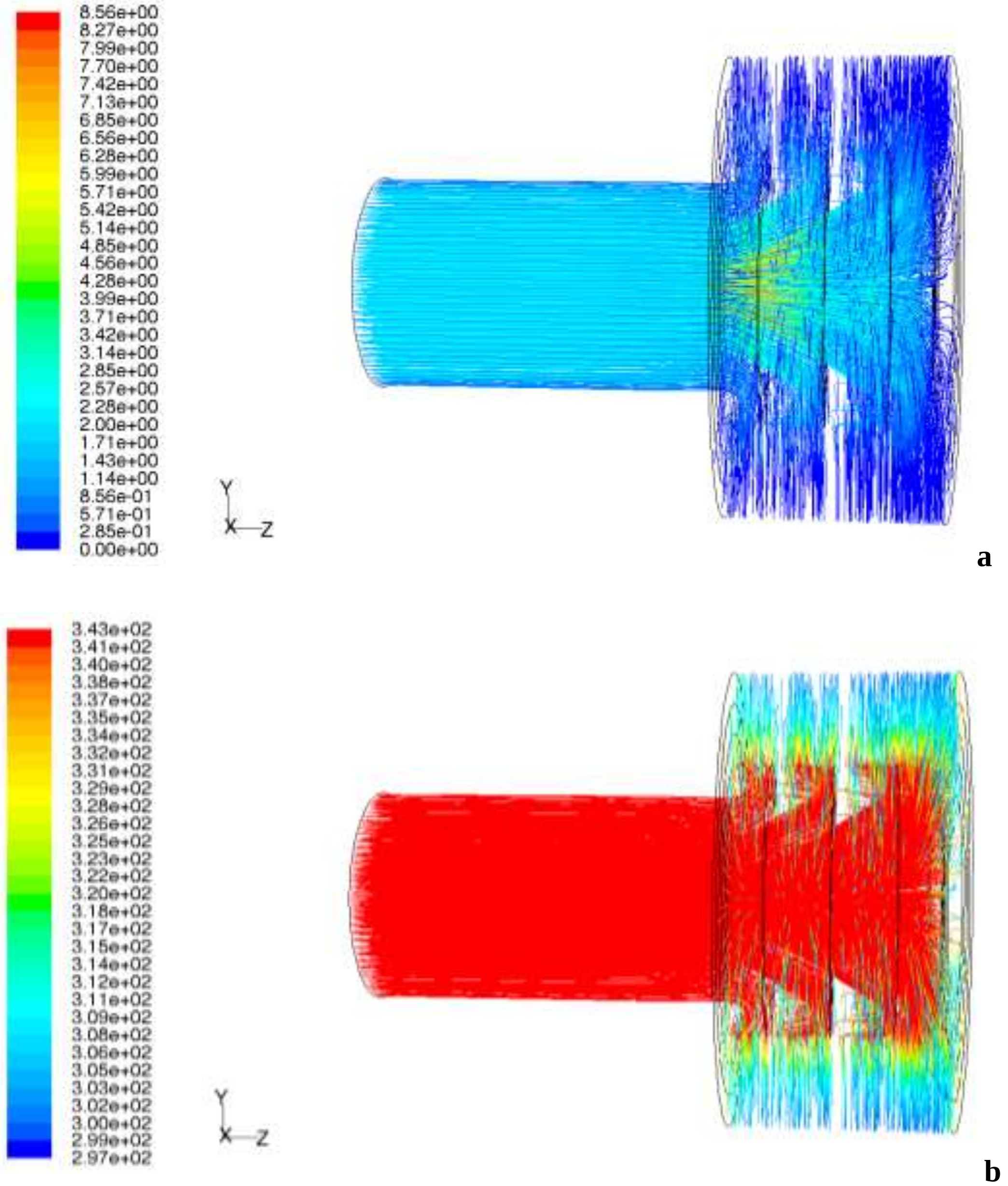


Fig. 6 - The current lines field inside the cylindrical box with baffles and three layers for the second version (temperature of 343 K = 70ºC):
a – velocity (m/s); b – temperature (K).

CONCLUSIONS

After the drying process mathematical modeling, CFD simulations have been made in two variants for the cylindrical box with three corn seeds layers.

The results regarding the distribution of the corn seed humidity, in the three layers of the cylindrical box in the second variant, had medium values that varied from the first to the last layer as it follows: the medium value reached was 11.5% in the first layer, 17% in the second, and 21% in the third one.

By means of these CFD simulations calibrated with the experiment, one can make a sufficiently exact model, so that it could be used for other types of seeds too. The main condition is that the entry data introduced in the simulation and obtained experimentally should be as exact as possible. By means of the CFD simulation one can optimize the working process in the cereal seed drying.

Also, by means of the CFD simulation was optimized the construction of the cylindrical box and of the deflectors so that one could obtain a uniform distribution of the air currents and of the temperature fields in the three cereal seed layers. This leads to reaching a uniform drying and to reducing the energy demand.

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STUDIES ON THE INFLUENCE OF LIGHT ON THE DEVELOPMENT OF WHEAT
/
STUDII PRIVIND INFLUENȚA LUMINII ASUPRA DEZVOLTĂRII GRÂULUI

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Keywords: *Influence of light, red light, blue light, development of wheat.*

ABSTRACT

This paper presents the influence of light on plant development and the effects of red and blue light on wheat. A comparative analysis of germination and wheat growth is performed, depending on the color of the light. The purpose of the present research was to conduct studies on the influence of light color-coded pet-colored crops on seed germination and plant growth from their embryos. Studies have as their starting point the seed stage and have considered the response of each organ plant growth during plant growth, for each species under study.

REZUMAT

Această lucrare prezintă influența luminii asupra dezvoltării plantelor, precum și efectele luminii roșii și albastre asupra grâului. Se realizează o analiză comparativă a germinației și creșterii grâului, în funcție de culoarea luminii. Scopul prezentelor cercetări a fost efectuarea de studii privind influenţa luminii colorate produsă de culoarea PET-urilor in care au stat plantele asupra germinaţiei seminţelor şi creşterii plantelor rezultate din embrionii acestora. Studiile au avut ca punct de plecare stadiul de sămânţă şi au luat în considerare reacţia fiecărui organ vegetal pe parcursul creşterii plantelor, în cazul fiecărei specii supuse studiului.

INTRODUCTION

The structure and physiology of plants are particularly regulated by light signals from the environment, as the primary response of plants during photosynthesis completely depends on light conditions (*Bercea V., 2008*).

Plant growth and productivity depends on the light conditions and photosynthetic metabolism is detrimentally affected by light intensity. Plants have developed a sophisticated mechanism to adapt their structure and physiology to the light environment (*Bercea V., 2008*).

Light is an energy source for plant life is known to effect plants dually. Light affects photosynthetic rate and assimilate accumulation, thereby playing a substrate role and also controls plant growth and development (*Avercheva et al, 2009; Samuoliene et el, 2010*).

Plants are using the light as an energy source for photosynthesis and as an environmental signal, and they respond to its intensity, wavelength, and direction. Light is perceived by plant photoreceptors that include phytochromes, cryptochromes and phototropins and plants generate a wide range of specific physiological responses through these receptors (*Bercea V., 2008; Shewry, 2009; Samuoliene et el, 2010)*.

Plant development and physiology are strongly influenced by the light spectrum of the growth environment among which blue light is involved in a wide range of plant processes such as phototropism, photo-morphogenesis, stomatal opening, and leaf photosynthetic functioning (*Bercea V., 2008; Kroeze D., 2005)*.

Plants are sensitive to red light spectrum, the plant having a red light photoreceptor. The receptor is a blue-green pigment termed a phytochrome present in the cells of a plant. Red light impacts a plant in many ways. The plants that are grown in red light are often large and tall with plenty of branches (*Cachiţă C.D., Ardelean A., 2009).* If the photoreceptor picks up a large quantity of natural red light, for example in the summer when there's plenty of natural red light, production of a plant hormone (meta-topolin) is increased.

This hormone prevents the chlorophyll in the plant being broken down, so that it stays green in the spring and summer (*Cachiţă C.D., Ardelean A., 2009*).

If there is plenty of blue light, as in nature during the autumn and winter, this receptor dampens the operation of a plant hormone called auxin (*Cachiţă C.D., Ardelean A., 2009*).

This hormone is responsible for the plant's stem growth. Auxin is also responsible for what is referred to as 'apical dominance', the phenomenon whereby growth points ensure that buds do not get entwined and create subsidiary branches. This causes the plant to create more side stems when exposed to bluish light and the plant stays a little shorter (*Cachiţă C.D., Ardelean A., 2009*).

The blue light is also responsible for directing leaves and growth points toward the light. Blue light also avoids the multiplication of leaves around the fruits and fertilised plants give more seeds (if applicable to the crop – more female seeds) (*Cachiţă C.D., Ardelean A., 2009*).

Wheat (*Triticum aestivum L*) is the most extensively grown cereal crop in the world, covering about 237 million hectares annually, accounting for a total of 420 million tonnes and for at least one-fifth of man's calorie intake, is counted among the 'big three' cereal crops, with over 600 million tonnes being harvested annually (*Dobrotă C., Yamashita M., 1999*).

The quality of agricultural seedlings is important to crop growth and yield and the quality seedlings exhibit characteristics such as thick stems, thick leaves, dark green leaves, and large white roots. The plant development and physiology are strongly influenced by the light spectrum, which affects seedling structure (*Bercea V., 2008*).

Raising seedlings irradiated with blue light has been shown to increase crop yield after planting because of the high accumulation of phenolic compounds. Although most studies with blue light only or blue mixed with red light have indicated that blue light-containing irradiation produces higher plant biomass, recent research has suggested that yield and crop quality could be improved by controlling light quality (*Bercea V., 2008*).

MATERIAL AND METHOD

The aim of this study was to investigate the effect of red, blue and natural light on the development of wheat over a seven-day period.

The biological material used consisted of seeds, or the plants from their embryos - with which we studied the germination and growth process in the colored light produced by the colored glasses in which the plants stood.

The method used to grain wheat was by using a piece of wet cotton. Deep glasses were used, the bottom was padded with a piece of cotton wool soaked in water, and wheat was placed on top. It was watered daily and kept in a bright place, more precisely beside the window sill.

Wheat requires a moist, warm and bright environment to germinate.

We used the wheat plant to determine how it influences its growth. For this study we used three plastic glasses: a transparent one, a red one and a blue one. In each glass, fifty grains of wheat were placed over a piece of cotton.

The natural light should give the wheat a normal increase, while the red light will give it a sharp increase in height. Blue light will also provide faster growth but not as dramatic as the red one.

The plants that are grown in red light are large and tall with plenty of branches. The blue light causes the plant to create more side stems and the plant will stay a little shorter in length.

All plants were watered with the same source of water, they were left in the same place and received the same amount of natural light. No fertilizers were used during the study.

Figure 1 shows the red glass, the transparent one and the blue one.

Fig. 1 - Wheat seeds in plastic glasses

RESULTS

On the second day we can see how wheat germinated (Figure 2 a - red glass, b – transparent glass, c – blue glass).

a) b) c)

Fig. 2 - Wheat seeds in plastic glasses

Four days after planting the wheat, we can see a difference in growth. The wheat found in the red glass developed much faster than the one in the transparent glass. In Figure 3 we can see that wheat in the middle has reached a much larger size than the other two, and the wheat from the transparent glass seems to develop just like the one in the blue glass. The one in the red cup is larger and has several branches.

Fig. 3 - Wheat – four days after planting

On the seventh day it can be very clear that wheat in the red glass grew about 20 percent more than the wheat in the transparent or blue glass (Figure 4). Instead, there is not a big difference between the blue and the transparent glass (the two glasses look almost the same). A slight difference can be seen in the flower pigment. The plant from the blue glass is slightly more pigmented than the one in the transparent glass that is more discolored.

Following this study we can say that red light is much better in terms of plant development.

Fig. 4 - Day 7 - the final day of the study

CONCLUSIONS

The study presents the effects of red and far-red lights on germination, aerial architectural development and plant nutrition.

Plant growth and productivity depends on the light conditions but also of the color. Many plants grown under only red light, have a stretched, elongated appearance; the leaves are thin and large and plants become tall. Red light is among the best colors of light to stimulate plant growth.

The wheat in the red glass has developed much faster, and it became larger and taller, with plenty of branches.

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AGROTEXTILES - SUSTAINABLE STRATEGIC DEVELOPMENT STRATEGY OF THE CONVERGING ECONOMIC SECTORS
/
AGROTEXTILE - STRATEGIE SUSTENABILĂ PENTRU SECTOARELE ECONOMICE CONVERGENTE

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ABSTRACT

The overall objective of sustainable development is to find a balance of interaction between the four systems: economic, human, environmental and technological, in a dynamic and flexible process. It is an answer to the current global challenges of climate change, atmospheric pollution, the danger of resource depletion and the threat to biodiversity, but also to the problem of economic growth, which is in contrast to the idea of protecting the environment and resources.

In this context, the textile sector is an example of a "traditional sector", able to "redefine its identity" according to a new, fully adapted business model - the needs of the new industrial revolution (smarter, more inclusive and more sustainable).

Agrotextile sector includes the application of textile products in agriculture, forestry, horticulture, floriculture, segments of fishing, landscape, gardening, animal husbandry, aquaculture, agro-engineering. Agrotextile products could be of any structural type, and offer multidimensional solutions, due to the advantages of textile structures (flexibility, strength, low weight, etc.). In the agricultural sector, textile materials have always been used for the purpose of protecting, harvesting and storing agricultural products. The diversification of the range of raw materials and modern techniques has allowed the relaunching or maintaining of classical uses and especially the opening to new applications that correspond to the concerns and desires of the farmers.

Technical textiles, "agrotextile", through the potential of functionalities, can make a special contribution to achieving a level of coherence between agriculture, the environment and rural development through the intelligent capitalization of knowledge and innovation.

REZUMAT

Obiectivul general al dezvoltării durabile este de a găsi un echilibru de interacțiune între cele patru sisteme: economic, uman, mediu și tehnologic, într-un proces dinamic și flexibil. Este un răspuns la provocările globale actuale legate de schimbările climatice, poluarea atmosferică, pericolul epuizării resurselor și amenințarea la adresa biodiversității, dar și problema creșterii economice, care este în contrast cu ideea protejării mediului și a resurselor.

În acest context, sectorul textil este un exemplu de "sector tradițional", capabil să-și "redefinească identitatea" în conformitate cu un nou model de afaceri complet adaptat - nevoile noii revoluții industriale (mai inteligente, mai incluzive și mai durabile).

Sectorul agrotextil include aplicarea produselor textile în agricultură, silvicultură, horticultură, florărie, segmente de pescuit, peisaj, grădinărit, zootehnie, acvacultură, agroindustrie. Produsele agrotextile pot fi de orice tip structural și oferă soluții multidimensionale, datorită avantajelor structurilor textile (flexibilitate, rezistență, greutate redusă, etc.). În sectorul agricol, materialele textile au fost întotdeauna utilizate în scopul protejării, recoltării și depozitării produselor agricole. Diversificarea gamei de materii prime și a tehnicilor moderne a permis relansarea sau menținerea utilizărilor clasice și, în special, deschiderea spre noi aplicații care corespund preocupărilor și dorințelor fermierilor.

Textilele tehnice, "agrotextile", prin potențialul funcționalităților, pot aduce o contribuție specială la atingerea unui nivel de coerență între agricultură, mediu și dezvoltare rurală prin valorificarea inteligentă a cunoștințelor și a inovării.

INTRODUCTION

Agriculture is one of the areas of action in which the European countries have agreed to share their responsibility and public funding. Romania needs to make full use of favorable global and European trends as well as its own competitive advantages. The magnitude and complexity of the socio-economic context in the agricultural sector requires additional ways to adapt. Agriculture is considered the "backbone of a country" and agrotextiles can be considered the "backbone of agriculture" (*Agrawal Sunil, 2013*).

The management of the agricultural production process is a particularly complicated activity, differentiated in relation to the production area where the agricultural process materializes and requires a double approach, namely:

- reducing greenhouse gas emissions (GHGs);
- adapting to the anticipated effects of climate change.

In this respect, the management of the sustainable development of agriculture includes the implementation of techniques/methods/technologies/unconventional tools, which having regard to the requirements of the field of use, are the result of the activity of converging fields (mechanical, processing of fibers/wires, materials science, IT, etc.)

MATERIAL AND METHOD

Textile product groups are various, and product ranges start from the traditional textile and clothing products, to the technical applications of building and construction; technical components of footwear and clothing; geotextiles and civil engineering; technical components of furniture, household textiles and floor coverings; filtration, conveying, cleaning and other industrial uses; hygiene and medical; automobiles, shipping, railways and aerospace; environmental protection; packaging; personal and property protection; and sport and leisure

Messe Frankfurt divides technical textiles into following twelve categories:

- AgroTech
- HomeTech
- OekoTech
- BuildTech
- InduTech
- PackTech
- ClothTech
- MediTech
- ProTech
- GeoTech
- MobiTech
- SporTech

EU-28 technical textiles represent (*Annual Report, 2016, Euratex*):

- 15% of total textile employment
- 8% of the companies active in the textile sector
-23% of the turnover of the sector – this varies strongly according to country (Figure 1)

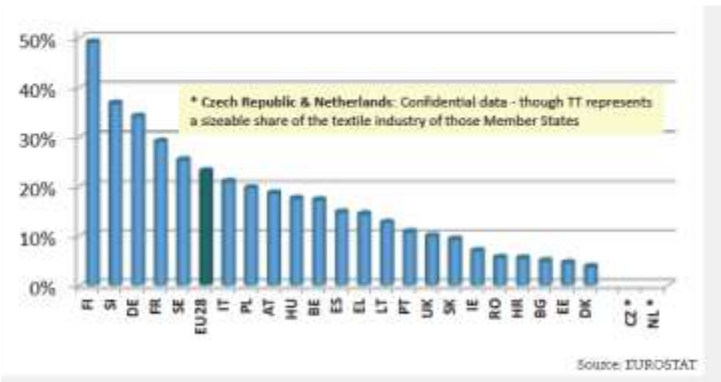


Fig. 1 - EU Technical textile consummation and turnover.
Weight of technical textiles in turnover in the EU-28 Source: EUROSTAT

The Agro textiles sector is one of the forerunners within technical textiles, one of the main tools by which agriculture grows sustainably, occupies a well-established place and has a wide sale market, including a generous supply of knitted, woven and non-woven products that convey the outcome of more systematic, in-depth, multidisciplinary research.

The multifunctionality of textile systems used in agriculture takes into account that the main functions of agriculture in the national economy are: food function; socio-economic function, participation in the process of growth and development; the function of environmental protection and sustainable socio-economic development.

To support this idea, the concept of economy circulating proposes to improve product design processes (so that their value, quality and sustainability is increased), creating ways to reuse and repair them, or rebuilding them by using raw materials that have been at the base of the initial products.

A wide range of textile structures are available for a wide variety of technical applications. An understanding of the dynamic interactions between textile structures and the field of use is essential for the design and selection of textile materials for applications in potential fields of use

RESULTS

A key factor for the agro-industrial sector is to increase productivity by increasing crop yields, and improving land, water, resource and land management, and environmental conservation (*Bharamkar, 2013*). The adoption of high-tech agricultural technology, when using textile structures, improves the quality and overall yield of agri-food products.

Agrotextile - a crucial and emerging sector in the twelve textile textile sectors - have a great significance for everyone. The market value of agrotextiles is projected to reach US $ 16.3 billion in 2020 (*Budholiya, 2015*).

According to the report by Credence Research, "Agro Textile Market - Growth, Future Prospects and Competitive Analysis, 2016-2024, the agro-industry market is projected to increase over US $ 14,363.2 million by 2025, with an average annual growth rate (CAGR - compound annual growth rate of 5.5% from 2017 to 2025.

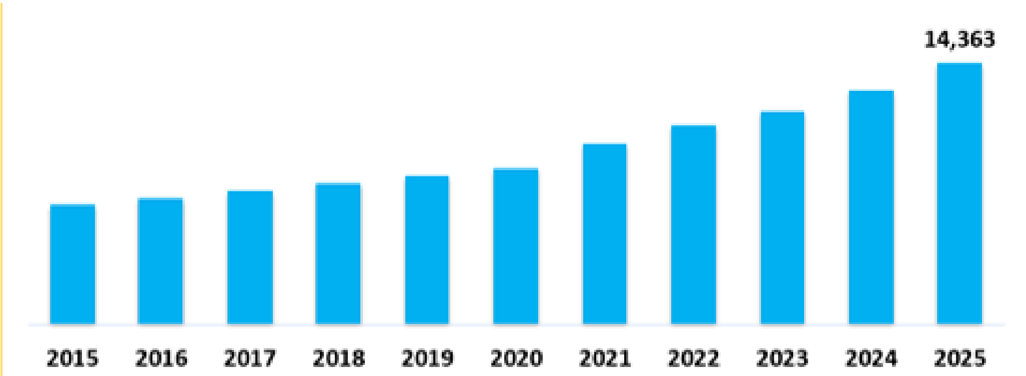


Fig. 2 - Global agrotextile market (dollars) (*Kumar G., 2016*)

Advantage of textiles used in agriculture are: increase crop production; avoid the soil from drying out, decrease the requirement of fertilizers pesticides and water, they Make Product Quality Better, increase the early maturing of crops and non-seasonal plants , protects from climatic changes and its effect

Various types of mono or multifilament chemicals (nylon, polyester, polyethylene, and polypropylene) or natural fibers (jute, wool, sisal, hemp, hemp, coconut) are used to make agrotextiles (Table 1). Of yarn assortments takes into account the functionality of agrotextil, the conditions imposed by the field of use and protection of the environment and human health. Manmade textile fibers are mostly used in continues filament form, and natural fibers are used in long staple yarn form at Agro textiles surface production processes.

Table 1

Types of fibers / yarn used in agrotextile

Jute	**Viscose**	**LDPE, HDPE**
Cotton	Polypropylene	Hemp, Coconut
Wool, sisal fibers	mono / multifilament Polyethylene	Polyester
Cotton-polyester blend	mono / multifilament Polyamide	HMPE

Legend: LDPE low density polyethylene; HDPE high density polyethylene; HMPE high-module polyethylene

Mainly desired fiber properties (*Palamutcu S. and Devrent N., 2017*), are listed in Table 2.

Table 2

Desired fiber properties in agro textile products

Desired fiber property	**Expected product property**
Tensile strength and elongation	long term durability and service life
Solar radiation withstanding	long term durability and service life
Ultraviolet radiation withstanding	light permeability 80 to 90%
Bio degradability	bio-degradation in the nature
Abrasion Resistance	long term durability and service life
High potential to retain water	capable of 15 to 60 g/m2 / 100 and 500 g/m2 water carry
Protection property	protection from wind and creation of a micro-climate
Resistance to microorganisms	resistant to microorganism to protect the living being
Stable construction	be stable for any application
Lightweight	fabric should be such that it will bare by the plant
Resistance to toxic environment	long term durability and service life

The key functional properties of agro-textile products are (*Bharamkar, 2013*):
- Weather resistance
- Resistance to micro-organisms
- Light Weight
- Resistant to solar radiation
- Resistant to ultraviolet radiation
- Long service life
- Biodegradability
- Water conservation
- Stable construction
- Tensile strength
- Abrasion resistance
- Protection

Depending on their use, the agro-textile can be classified as (*Palamutcu and Devrent, 2017*; *Technical Textiles Market Forecast to Grow Rapidly*):
- *Agro-textile products for crop production and packing*
- *Agro-textile products for horticulture and floriculture*
- *Agro-textile products for forestry*
- *Agro-textile products for animal husbandry*
- *Agro-textile products for fishing and aquaculture*

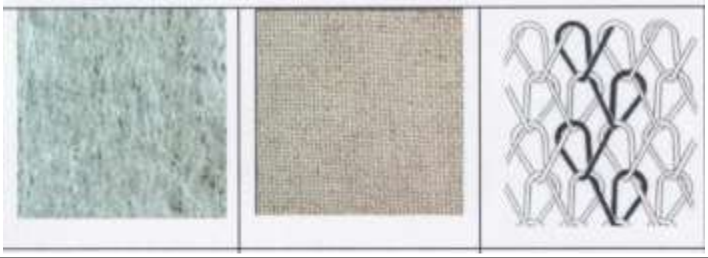
The most important functional requirements of agrotextile products are resistance to weathering and resistance to microorganisms. Therefore, for the design of agrotextile, the polypropylene and polyethylene fibers are the most commonly used and from the category of natural fibers, jute, due to both functional properties and biodegradability (serving as a fertilizer for soil) (Table 3) (*Chowdhury, Nasrin, 2017*).

Table 3

Types of fibers / yarns recommended for agrotextile with different functionalities

Purpose of using agrotextile	Type of fiber / yarn	Purpose of using agrotextiles	Type of fiber / yarn
Protection against solar radiation	polyethylene	Support for roots	cotton, polyester, cotton-polyester blend
Packaging for transport, storage, (flexible consoles)	jute, plastic, polypropylene FIBC	Covering pallets	polypropylene, jute
Insect protection	mono / multifilament polyethylene, polyamide	Anti fouling nets	polyethylene, polyamide, polyester,
Low temperature and frost protection	polypropylene	Monofilament nets	polyamide, HDPE
Protection against weeds	polyethylene	Milking filters	cellulose, viscose, cotton, polyester
Tape nets	polypropylene	Plant protection	polyolefin fibers
Mulching	HDPE, LDPE, polypropylene, wool	Protection against birds	polyamide copolymer, polyethylene, polypropylene
Hail protection	multifilament polyethylene	Shading	polyethylena
Harvest	HDPE, polyamide, cotton	Protection of uggs	Cotton, cotton-polyester blend
Support	polyamide	Fishing (nets)	monofilament / multifilament polyamide, HDPE
Round	polypropylene, sisal fibers	Fishing (yarns)	HMPE (Dyneema and Spectra type), HDPE, polypropylene, polyamide
Aquaculture	polyamide, HDE	Belts	polyamide, polyester
Soil protection	Polypropylene, jute	Ultraviolet radiation Protection sheets	cotton, cotton-polyester blend, polypropylene
Protection of cherry crops	polypropylene polyethylene	Localized irrigations	
Rain protection	polyethylene	Greenhouses	Polyethylene

Woven, knitted, knotted, twine, and braided textile surfaces (Figure 2) (*Palamutcu and Devrent, 2017*) are basic fabric types applied for agrotextiles and they can be used for various applications.



nonwoven **wovewn** **knitted**

knotted **braided** **twine**

Fig. 3 - Textile surface types, used in agro textiles

Agricultural textile product groups, agro textiles, are innovative products that are designed specially for the agricultural applications and practices. Factors that determine the stress biotic or abiotic environment of agricultural crops are basic elements in the determination of the structure and the fiber composition and technology.

CONCLUSIONS

Scientific research in the field of agriculture and implicitly in the related fields has been and remains topical to the multiple demands of agriculture as a result of the widening of the knowledge horizon and the necessity of achieving biological, ecological and sustainable productions.

Agro-textile sector includes application of textiles in agriculture, forestry, horticulture, floriculture, fishing segments, landscape, gardening, animal husbandry, aquaculture and agro-engineering. Agro-textile products can be woven, non-woven or knitted and they are used in various agricultural applications.

Multifunctional agrotextile systems are the result of multidisciplinary activity in the field of material science, fiber / textile yarns, textiles engineering, agriculture.

Textiles and agriculture, areas of convergence activity, in the context of sustainable development of Romania, have a strategic role to play in: rural development; sustainable and ecological agriculture, conservation and sustainable management of biodiversity; preventing and combating desertification, the impact of global and regional climate change; development of new technologies, new technical equipment adapted to climate change; protection of the environment and human health.

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BIOENERGETIC ASSESMENT OF SWEET SORGHUM GROWN ON RECLAIMED LANDS
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БІОЕНЕРГЕТИЧНА ОЦІНКА ЦУКРОВОГО СОРГО ВИРОЩЕНОГО НА РЕКУЛЬТИВОВАНИХ ЗЕМЛЯХ

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Keywords: *reclaimed lands, sweet sorghum, sewage sludge, biomass yield, conservative sugar yield, ethanol yield potential, kinetic characteristics of biomass*

ABSTRACT

Sweet sorghum varieties of domestic breeding are the priority for studying their bioenergy potential, when they cultivated on reclaimed lands. Medove is a promising cultivar for growing on such sites in areas with insufficient water supply. The energetic characteristics of sorghum were studied on four types of mining substrates: loess-like loam (LLL), red-brown clay (RBC), green-grey clay (GGC), and piled up black soil mass (BS). Under such conditions, at the plots without fertilizer, Medove produced above-ground biomass from 38 to 82 ta ha^{-1}. The highest yield was recorded on loess-like loam. The sewage sludge application has promoted the increase of productivity by 4-44%. Although the sewage sludge introduction reduced the content of fermentable sugars in stem juice by 5.3-6.7%, the theoretical ethanol yield increased by 8-48%, except for the plot with loess-like loam. Thermal destruction of dry biomass proceeded in a similar way on all studied substrates. Nevertheless, it was revealed that the sewage sludge application shifts the process of thermolysis into the region of lower temperatures on BS and GGC, increases the stage of lignin decomposition on LLL, and affects the rates of the reactions, as well as slightly (LLL) and significantly (BS) augments the share of the incombustible residue.

ТЕЗИ

Різновиди цукрового сорго вітчизняної селекції є пріоритетними для дослідження біоенергетичного потенціалу за умов вирощування на рекультивованих землях. Медове – це перспективний сорт для вирощування на таких ділянках у районах з нестачею водозабезпечення. Енергетичні характеристики сорго були досліджені на чотирьох типах гірничих ґрунтів: лесоподібний суглинок (ЛС), червоно-бура глина (ЧБГ), сіро-зелена глина (СЗГ) та насипний шар чорнозему (НШЧ). У таких умовах, на ділянках без застосування добрив, врожай надземної біомаси сорту Медове сягав від 38 до 82 т/га. Найвищий врожай був отриманий на лесоподібному суглинку. Застосування осаду стічних вод забезпечило збільшення продуктивності на 4-44%. Хоча осад стічних вод зменшував концентрацію розчинних цукрів стеблового соку на 5,3-6,7%, вихід теоретичного етанолу збільшився на 8-48%, за виключенням ділянки з лесоподібним суглинком. Процес термічної деструкція сухої біомаси сорго був схожим на усіх досліджених субстратах. Однак, було з'ясовано, що застосування осаду стічних вод зміщує термоліз в область більш низьких температур на НСШ та СЗГ, збільшує стадію розкладання лігніну на ЛС, змінює швидкості термічних реакцій, а також злегка (ЛС) та значно (НШЧ) збільшує частку неспаленного залишку.

INTRODUCTION

Rapid depletion of natural resources and environmental degradation all over the world bring up the issue of creating environmentally friendly renewable energy sources. Biofuels are sustainable and renewable source of energy derived from organic matter in the form of biomass. In this connection, in recent decades, sorghum arouses particular interest as a multipurpose bioenergetic crop. The interest in sweet sorghum as an alternative energy crop is associated with the shortage and increase in the cost of non-renewable fossil energy products, and the use of ethanol as fuel (*Rooney et al., 2007; Goff et al., 2010; Mathur et al., 2017*).

Sweet sorghum belongs to the *Sorghum bicolor* (L.) Moench species, numerous cultivars and hybrids of which contain a large amount of fermentable sugars in stem juice. The ability of sweet sorghum to accumulate a lot of soluble sugars makes it a potential source of raw materials for the production of bioethanol. The biological features of this crop allow obtaining a good yield of green mass even on marginal lands and under insufficient water supply conditions. The most intense sugar in the stems accumulates after flowering. The maximum amount of sugars in plants is contained in the phase of wax and full ripeness of grain. The main components of extracted juice are sucrose, glucose, and fructose, which can be directly fermented into ethanol with efficiencies of more than 90% (*Ratnavathi et al., 2010; Wu et al., 2010; Regassa & Wortmann, 2014*). Lignocellulosic dry biomass can be used for the production of solid fuel (briquettes, granules) and for the making of biocomposite materials (*Yu et al., 2012; Yin et al., 2013*).

Due to its physiological traits and unique mechanism of moisture regulation, sorghum is highly resistant to soil and air drought, insects, diseases, salinity, and soil alkalinity (*Reddy et al., 2007; Dalla Marta et al., 2014*). In addition, this crop has one of the best rates of carbon assimilation (*Prasad et al., 2007; Schmer et al., 2014*).

Despite the unpretentiousness and resistance, if sorghum is grown on marginal lands, there is a risk of obtaining low yields due to the combined effect of multiple unfavorable factors. In this case, it seems expedient to apply fertilizers. Given the current economic situation and the deficiency of mineral and organic fertilizers promising direction is the use composted sewage sludge in agriculture, fodder production, landscaping, for soil fertility restoration. Recently, the advantages and disadvantages of applying sewage sludge are widely discussed (*Jamali et al., 2007; Wang et al., 2008; Singh and Agrawal, 2008; Hossain et al., 2010*). Composted sewage sludge contains large amounts organic and inorganic elements essential to plants. Its effectiveness does not yielding to traditional organic and mineral fertilizers, but availability of potential toxic metals often restricts its uses. At the same time, using sewage sludge which does not contain toxic impurities indicates a promising way of its use as a fertilizer.

MATERIAL AND METHOD

This study was carried out at Pokrov land reclamation station of Dnipro State Agrarian and Economic University which located in the Nikopol manganese ore deposit. The rocks of this ore basin are presented the holocene, postpliocene, neogen and paleogen deposits. These mining rocks are brought to the surface during process of manganese ore mining. The soil mass was taken off, piled up and heaped onto the land after the rock was replaced. Substrates formed in this way can be attributed to the category of Technosol which are soils strongly influenced by human activities, and as a result, their properties and pedogenesis are dominated by technical origin (*De Kimpe and Morel, 2000*).

Geographically, the land reclamation station is located in the Dnipropetrovsk region in the steppe zone of Ukraine with moderately continental climate: dry and hot summer and moderate winter. The average long-term air temperature is +8.5°C. The hottest month is July with the average temperature +22.0°C, the coldest is January with the average temperature -4.1°C. The site is located in the zone of unstable water supply with often prolonged droughts in the summer. The average hydrothermal coefficient is 0.9. In recent years, there has been a gradual increase in the average monthly air temperature with a simultaneous decrease in the amount of precipitation during the vegetation period. Seasonal precipitation and mean temperatures are shown in Figure 1.

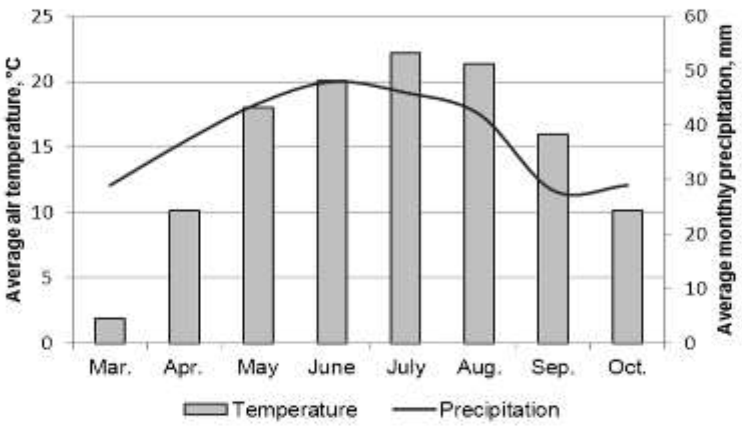

Fig.1 - **Average monthly temperature and precipitation amount at the reclamation station district (long-term data)**

The sweet sorghum cultivar Medove was studied. This first generation hybrid was breeding at the Odessa Institute of genetics and breeding. This cultivar is mainly grown for silage and green mass, as well as for the sweet juice production and products of its processing (syrup, ethanol). Its potential productivity is 50-100 t ha^{-1}. The vegetative period before the milk-wax ripeness of grain is 90-100 days. The Medove is not affected by diseases and slightly damaged by aphids, resistant to lodging and is well suited for mechanized harvesting. Its main morphological characteristics are shown in Table 1.

Table 1

Morphological characteristics of sweet sorghum cultivar Medove

Height, cm	Number leaves per stem, pieces	Stem diameter, mm	Number stem per plant, pieces	Panicle form	Seed features
270-290	12-13	20-25	4-5	ellipsoid	brown, closed 3/4

The plants were sown on four types of mining substrates. Loess-like loam, (LLL), red-brown clay (RBC), and green-grey clay (GGC) were taken from the board of the quarry and exposed to long-term soil stabilization. Piled up black soil mass (BS) was taken in the soil stockpiling area. The humus content in these substrates is low (1.05- 1.25%), except black soil (3.29%). The ratio of humic and fulvic acids is 1.36 for BS and 0.62-0.69 for others substrates. The hygroscopic level varies from 7.6% (LLL) to 20.5% (GGC). To study the effect of sewage sludge, it was introduced into substrates in a dose of 30 ton ha^{-1}.

Biometric parameters, biomass productivity, brix, conservative sugar yield, theoretical ethanol yield, and dry biomass thermal characteristics were studied. The plant height was measured using a measuring line. To determine the yield of above-ground biomass, plants were harvested after the grain reached hard dough stage by cutting at the height of 10 cm from the ground level and weighed. After that, the biomass was dried to constant weight, and then weighed again. Brix was determined using a hand-held refractometer "RHBO–50ATC". Conservative sugar yield (t ha^{-1}) was calculated based on an approach assuming that the sugar concentration is 75% of Brix expressed in g kg^{-1} sugar juice (*Wortmann et al., 2010; Ekefre et al., 2017*).

Theoretical ethanol yield was calculated as sugar yield multiplied by a conversion factor: 0.58 L ethanol per kg of sugar (*Rutto et al., 2013; Ekefre et al., 2017*). The thermal analysis of plant biomass was carried out using the derivatograph Q-1500D of the "F. Paulik-J. Paulik-L. Erdey" system. Differential mass loss and heating effects were recorded. The results of the measurements were processed with the software package supplied with the device. Samples of biomass were analyzed dynamically at a heating rate of 10°C/min in an air atmosphere. The mass of samples was 100 mg. The reference substance was aluminum oxide. To hande the results obtained, the statistical analysis was applied using the StatGraphics Plus5 software package at significance level of 0.95 % (P-value < 0.05).

RESULTS

Cultivar Medove grown on mining substrates mainly conformed to the varietal characteristics. However, the plants grown on red brown clay, green-grey clay, and black soil were slightly lower (Table 2). Fresh biomass yield on these substrates was also lower than on loess-like loam. Thus, the lowest yield was recorded on green-grey clay (38.05±0.13 t ha^{-1}), and highest on loess-like loam (82.5±0.36 t ha^{-1}). The sewage sludge application on loess-like loam had no effect on biometric parameters and biomass yield. At the same time, the positive effect was observed on others substrates (Figure 2). The growth and productivity indicators have increased by 4-16% and by 14.5-44.5% respectively.

Table 2

Effect of the sewage sludge application on the height of cultivar Medove

	Black Soil	Loess-like loam	Red brown clay	Grey-green clay
Without fertilizer	255.2±3.03	295.3±4.92	250.1±1.15	235.3±1.99
With the sludge application	295.3±2.31	300.0±2.70	260.2±1.66	250.4±1.65

Due to the low biomass productivity on green-grey clay the conservative sugar yield was also small (2.75 t ha^{-1}). The highest yield was obtained on loess-like loam (5.91 t ha^{-1}). The same trend persisted in determining the theoretical ethanol yield, which was from 1611.4 L ha^{-1} to 3455.4 L ha^{-1}.

The sewage sludge introduction has reduced the content of fermentable sugars in stem juice by 5.3-6.7%, except plants grown on green-grey clay. Brix values on the plots without fertilizer varied between 19.0-19.3%, and on the plots with sludge application between 18.0-18.1%. Only on green-grey clay this index was 19.6%. Considering that in both variants on loess-like loam the amount of juice in the stems was practically the same, the yield of potential sugar and ethanol decreased by 4% in the version with the use of sewage sludge. On the other experimental plots, an increase in the theoretical ethanol yield was observed, especially on green-grey clay (Figure 3).

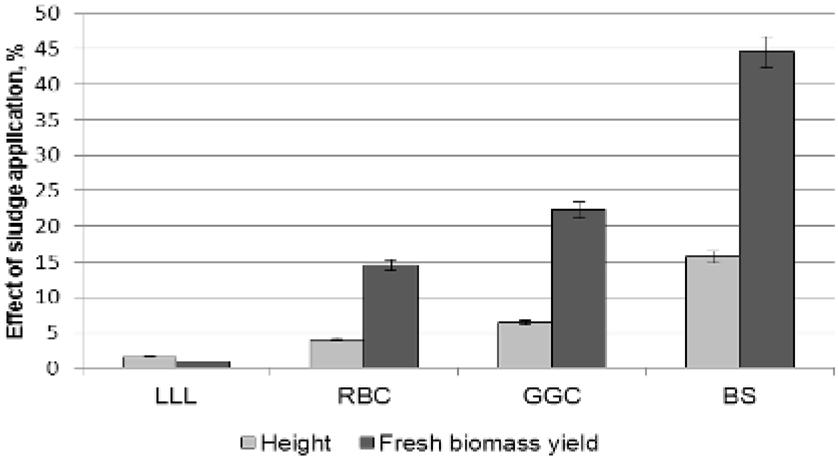

Fig. 2 - Effect of sewage sludge application on growth and productivity of sorghum Medove grown on mining substrates

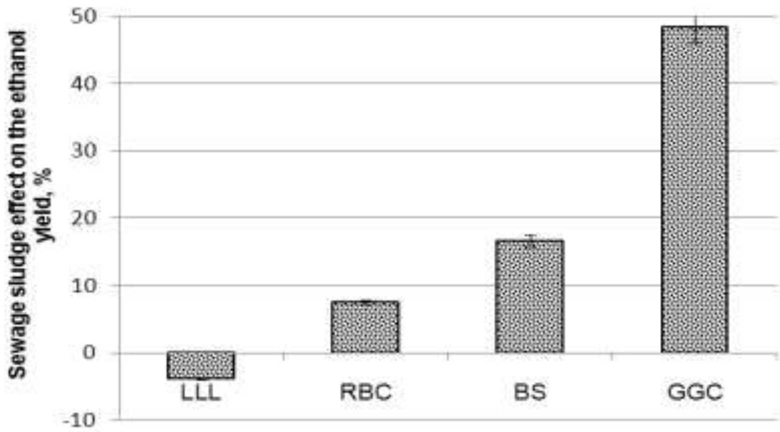

Fig. 3 - Effect of sewage sludge application on theoretical ethanol yield of sorghum Medove grown on mining substrates

One of the most universal methods of treatment biomass for effective use as solid fuel is pyrolysis. Biomass is a highly reactive and thermally unstable raw material, so the low-temperature pyrolysis type is used for its processing (*Fisher et al., 2002; Kumar et al., 2008*). Conducted thermogravimetric analysis showed that thermolysis of Medove biomass passes in the temperature range from 30-40ºC to 540-560ºC. The water evaporation and the active removal of volatile components took place in the first stage within a temperature of 30°C-140°C (Table 3). The analysis of the rate of change in mass showed a single peak in this region. The mass loss was insignificant and varied within 5.2-8.6%.

In the second stage, the removal of volatile components was completed and the hemicellulose decomposition began. The mass loss was 13.6-14.2% (BS and LLL) and 17.4-19.6% (GGC and RBC). The highest rate of thermal reaction was observed at a temperature of 180-190ºC. However, this rate was 14.0-14.4% / min for the samples taken on black soil and loess-like loam, and was almost twice as high on green-grey and red-brown clay (26.0%/min and 27.2%/min, respectively).

The main process of hemicellulose and cellulose decomposition was similar in all studied samples and took place in the temperature range 220°C-390°C (third stage). In this range, a small fraction of lignin decomposed as well. This phase was accompanied by the greatest mass loss (44.2-50.2%). The maximal rate of biomass destruction was 23.6-28.0%/min. During the last stage of thermolysis (390ºC-560ºC) thermal decomposition of cellulose and lignin was completed. In addition, the oxidation of formed at the previous stage char residue was occurred. At this stage, there were also no significant differences in the thermal behavior of biomass samples taken from different substrates. On the whole, the most complete combustion of biomass was observed on black soil.

Table 3

Data of Medove biomass thermal degradation on mining substrates

Stage of biomass destruction	Temperature interval, °C		Mass loss, %		The share of residual mass, %	
Black soil						
	without fertilizer	with sludge application	without fertilizer	with sludge application	without fertilizer	with sludge application
I	40–140	30–120	8.6	6.0		
II	140–220	120–180	13.6	9.6		
III	220–380	180–360	47.4	50.8		
IV	380–550	360–550	24.0	22.2	8.8	11.4
Loess-like loam						
Stage of biomass destruction	Temperature interval, °C		Mass loss, %		The share of residual mass, %	
	without fertilizer	with sludge application	without fertilizer	with sludge application	without fertilizer	with sludge application
I	30–130	40–130	6.4	4.2		
II	130–210	130–210	14.2	19.0		
III	210–390	210–380	50.2	44.0		
IV	390–540	380–570	20.4	22.4	6.4	10.4
Red-brown clay						
Stage of biomass destruction	Temperature interval, °C		Mass loss, %		The share of residual mass, %	
	without fertilizer	with sludge application	without fertilizer	with sludge application	without fertilizer	with sludge application
I	30–130	50–140	5.2	4.0		
II	130–220	140–220	19.6	16.0		
III	220–390	220–370	44.2	43.2		
IV	390–560	370–570	22.6	28.8	8.4	8.0
Green-grey clay						
Stage of biomass destruction	Temperature interval, °C		Mass loss, %		The share of residual mass, %	
	without fertilizer	with sludge application	without fertilizer	with sludge application	without fertilizer	with sludge application
I	30–140	30–130	6.6	7.6		
II	140–220	130–200	17.4	13.8		
III	220–390	200–370	44.2	43.0		
IV	390–540	370–550	22.2	26.0	9.6	9.6

The use of various amendments can affect the absorption of different elements from the soil and change the chemical composition of the biomass. This, in turn, can influence the process of thermal destruction. In our case, the sewage sludge application did not have any significant effect on the pyrolysis of sorghum biomass.

Nevertheless, some changes were noted in this process (Table 3, Figure 4). Thus, in the samples taken from black soil and green-grey clay, the first three stages of thermolysis passed in zones of lower temperatures. On loess-like loam the last stage was longer. Also, there were small variations in the rates at different stages of the biomass destruction. Moreover, on black soil the share of residual mass was 78% bigger than on the plot without fertilizer.

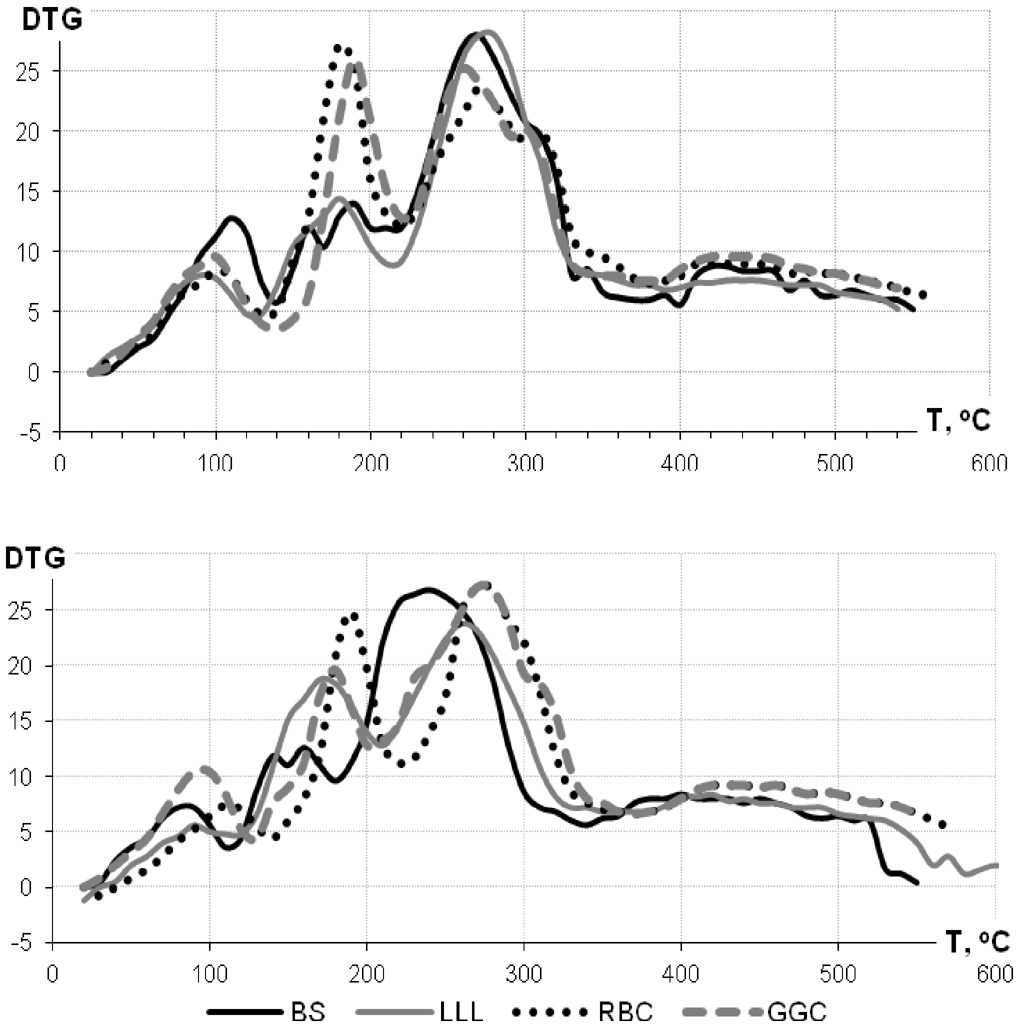

Fig. 4 - DTG curves of biomass thermal destruction of sorghum cultivar Medove; variants without fertilizer (up) and with sewage sludge application (below)

CONCLUSIONS

Medove is a promising cultivar of sweet sorghum for growing on mining lands in areas of insufficient water supply. Under such conditions it can produce above-ground biomass from 38 to 82 ta ha^{-1}. The sewage sludge application can promote increase of productivity by 4-44%. Although the sewage sludge introduction reduced the content of fermentable sugars in stem juice by 5.3-6.7% the theoretical ethanol yield was increased by 8-48%, except for the plot with loess-like loam.

Thermal destruction of dry biomass proceeded in a similar way on all studied substrates. It was revealed that the sewage sludge application shifts the process of thermolysis into the region of lower temperatures (for BS and GGC), increases the stage of lignin decomposition (for LLL), and affects the rates of the reactions, as well as slightly (LLL) and significantly (BS) augments the share of the incombustible residue.

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AGROPHYSICAL AND BIOTIC FACTORS OF REGULATION OF BIOLOGICAL ACTIVITY OF SOIL IN THE CROP ROTATION
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АГРОФІЗИЧНІ І БІОТИЧНІ ФАКТОРИ РЕГУЛЮВАННЯ БІОЛОГІЧНОЇ АКТИВНОСТІ ҐРУНТУ В СІВОЗМІНІ

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Keywords: *crop rotation, soil tillage, biological activity, plant residues, soil hardness, volume mass, field crops.*

ABSTRACTS
In the field stationary experiment, the dynamics of the general biological activity of chernozem, depending on the biomass of plant residues, methods of the basic soil tillage under different hydrothermal conditions was studied. It was established, that the release of carbon dioxide by microorganisms from the soil more intensively occurred on the background of deep tillage, where the best conditions for aeration and distribution of plant residues in the profile of the arable layer were found. Minimization of soil tillage, in consequence of the compaction of the arable layer by more than 1.3 g/cm³ limited the volume of active zone of biotic activity and growth processes of field crops in crop rotation while inhibiting the overall biological activity and reducing the amount of carbon dioxide released. However, small soil tillage contributed to the enhancement of the anti-erosion resistance of the chernozem surface from the shock energy of rain drops, and also provided more favorable conditions for the humification of organic residues instead of undesirable intensive mineralization, especially humus.

ТЕЗИ
В польовому стаціонарному досліді вивчено динаміку загальної біологічної активності чорнозему залежно від біомаси рослинних решток, способів основного обробітку ґрунту за різних гідротермічних умов. Встановлено, що виділення вуглекислого газу мікроорганізмами з ґрунту більш інтенсивно відбувалося на фоні глибокої полицевої оранки, де виявлені кращі умови аерації і розподілу рослинних залишків в профілі орного шару. Мінімалізація обробітку ґрунту, внаслідок ущільнення орного шару більше за 1,3 г/см³ обмежувала об'єм активної зони біотичної діяльності і ростових процесів польових культур у сівозміні, гальмуючи при цьому загальну біологічну активність та зменшуючи кількість виділеного вуглекислого газу. Але, мілкий обробіток сприяв посиленню протиерозійної стійкості поверхні чорнозему від ударної енергії дощових крапель, а також забезпечував більш сприятливі умови для гуміфікації органічних решток замість небажаної інтенсивної мінералізації, особливо гумусу.

INTRODUCTION
The issue of arable layer differentiation at different methods of the basic soil tillage in the crop rotation on fertility and biological activity and dynamics of these parameters depending on the intensity of mechanical action on the soil and the cycle of organic matter is a very important aspect for the theoretical study of innovative soil protecting technologies of growing of field crops (*Tsyliuryk et al. , 2015, 2017, 2018, Chumak et al., 2011; Tsyliuryk and Kozechko, 2017, Tsyliuryk and Sudak, 2014, 2016, Tsyliuiryk, Desyatnik, 2016, Tsyliuryk, Sudak, Shapka, 2015; Hadzalo, 2017 et al.*).

By numerous investigations on the study of the nutrient regime of the soil during the transition to mouldboard-free methods of soil tillage in different zones has been established an actual increase of the concentration of basic nutrients (phosphorus and potassium) in the upper layer, decrease the biogenesity and effective fertility of the lower layers, with its long application (*Tanchyk, 1999; Pabat, Shevchenko 2000; Tsyliuryk et al., 2017; Sayko, 2007*). At the same time, in some cases, the localization of the elements of fertility is considered as a satisfactory fact, since near the weakly developed root system of plants in the beginning of the vegetation there is an increased content of elements of nutrition (*Tsyliuryk and Shapka, 2016, 2017*), in others - as negative, so long as in the conditions of drought, the elements of nutrition in the upper layer become positionally and physiologically unavailable to plants (*Shevchenko and Rybka, 2002, 2003*).

Mineralization and immobilization processes in the soil have a cyclic nature, reflecting the dynamic equilibrium between them at a certain point in time. The nitrogen of the soil substrate is constantly transformed from inorganic to organic form by means of assimilation processes, from organic to inorganic form - by decomposition and mineralization (*Tsyliuryk, 2014, 2016; Lebid and Tsyliuryk, 2014*). It is also established, that the increased amount of plant residues (mulch) leads to the decrease in the availability of nitrogen.

At the decomposition of plant residues, which have the broad correlation of carbon to nitrogen, there is a biological absorption of the latter by rapidly developing microorganisms for the synthesis of their own proteinic bodies (*Desyatnik, 2017*).

The intensification of mineralization processes to a certain level can be considered as positive phenomenon, because in parallel with such agrocenosis there is an increase in the productivity of field crops. Excessive activity of soil microorganisms can lead to rapid mineralization of humus and the growth of unproductive losses of gaseous nitrogen in the processes of denitrification and nitrification, accumulation of nitrates in the soil and further their washing with groundwater. At the same time, the coefficient of use of field crops of nitrogen from fertilizers is reduced whose content in the soil is not sufficiently high (*Hordiyenko et al., 1991*).

MATERIAL AND METHOD

The research was carried out at the State Enterprise "Experimental Farm of Dnipro" of the State Institution of the Institute of Grain Cultures of the National Academy of Sciences of Ukraine in the stationary field experiment of laboratory of the crop rotation and environmental protection systems of soil tillage in five-year crop rotation: peas - winter wheat - sunflower - barley spring - corn according to generally accepted techniques of experimental work (*Yeshchenko, 2005*), during 2010-2017.

The scheme of the experiment also consisted of three radically different systems of basic soil tillage, namely, moldboard soil tillage (for all crops of crop rotation, a moldboard soil tillage is executed), differentiated soil tillage (a combination of different methods of moldboard-free soil tillage (disking, subsurface cultivation, chiseling) and moldboard cultivation in the crop rotation), and zero cultivation (direct sowing). Soil cultivation was carried out by the following implements: 1. Moldboard soil tillage - by a plough PO-3-35 at a depth of 20-22 cm for spring barley and sunflower, 23-25 cm for corn, 25-27 cm for bare fallow (in autumn) 2. Chiseling – by Chisel Plow at the depth of 14-16 cm for sunflower and spring barley (in autumn);

3. Harrowing – by disc harrow BDVP (БДВП) - 6.3 at the depth of 10-12 cm for barley spring and bare fallow (in autumn); 4. Subsurface cultivation by subsurface cultivator – by means of combined unit KSHN (КШН)-5.6 “Resident” or KR (КР) -4.5 at the depth 14-16 cm in corn and 12-14 cm in sunflower (in autumn) in the early fallow (in the spring).

As organic soil fertilizers were used the post-harvest residues of predecessors, which, after mineralization, are known, return to the soil epy significant part of previously alienated elements of plant nutrition (N-NO_3, P_2O_5, K_2O). In view of this, the experimental scheme included three fertilizer systems from the calculation per hectare of crop rotation: 1) without fertilizers + after harvest residues; 2) $N_{24}P_{18}K_{18}$ + after harvest residues; 3) $N_{48}P_{18}K_{18}$ + after harvest residues. Mineral fertilizers were applicated in the spring by means of broadcasting for pre-sowing cultivation.

The conventional generally accepted techniques of experimental work have been used in the process of carrying out of research by B.A. Dospekhov. As well as special methods of research have been used, in particular, the hardness of the soil was determined by the Revayakin hardness gauge, the density - by the cutting ring method, the surface coating of the plant residues and their mass by Shyiatyi, the biological activity of the soil by the method of Shtatnov, and others like that.

The soil of the experimental site is common chernozem heavy-clayey loam with content in the arable layer: humus – 4.2%, nitrate nitrogen – 13.2 mg/kg, mobile phosphorus and potassium compounds (according to Chirikov), respectively 145 and 115 mg/kg.

Weather conditions during the research years were sufficiently favorable for the growth and development of field crops, except for the abnormally arid 2012, when the hydrothermal coefficient during the period of the largest water consumption of plants (May-July) was 0.6.

The hydrothermal coefficient less than 0.7 indicates the presence of soil drought and air drought, which have bad influence on the formation and swelling of grain and seeds. In all other years, the hydrothermal coefficient did not decrease below the indicated figure and was 0.8-0.9.

The purpose of the work is to establish the biological activity of the soil in accordance with volume of the release of CO2 in crop rotation, depending on the amount of plant residues left under the influence of soil tillage due to changes in agrophysical parameters and soil moisture.

RESULTS

According to the results of the research, the minimization of soil tillage causes the significant changes in the differentiation of the arable layer (0-30 cm) relative to the positional disposition of nutrients, the concentration of potential humus substances in the aerobic zone and the intensification of microbiological activity, as evidenced by the volumes of carbon dioxide releases.

The transformation of the mulch coverage of surface of the soil with plant residues was carried out under the influence of mechanical mixing with soil by means of soil tillage implements and decomposing by microorganisms (Table 1).

Table 1

Dynamics of biomass of mulching coverage of the field surface for different systems of basic soil tillage, on average for 2010-2017, t / ha

Cultures of crop rotation	Terms of definition	Soil tillage system		
		Mouldboard	differentiated	zero
Peas	in autumn	0.30	2.10	3.21
	in the spring	0.11	1.62	2.41
Winter wheat	in autumn	0.39	2.48	3.91
	in the spring	0.23	2.01	3.36
Sunflower	in autumn	0.28	1.87	2.24
	in the spring	0.21	1.42	2.03
Barley spring	in autumn	0.24	1.96	2.60
	in the spring	0.10	1.58	1.85
Corn	in autumn	0.61	3.12	4.34
	in the spring	0.35	2.88	4.05

The largest organic mass in crop rotation naturally left itself corn, and the minimum - barley spring and sunflower. Substantial redistribution of the projective coverage of the surface of the field with plant residues and their mixing with the soil in the profile of the arable layer was carried out by various methods and systems of basic soil tillage. For example, after harvesting of corn and carrying out of soil tillage on the surface of the field, the minimum number of plant residues remains for the moldboard soil tillage system - 0.61 t/ha. The intermediate position was occupied by the differentiated (disking) cultivation system – 3.12 t/ha, and the maximum amount of vegetative substrate was logically marked for zero soil tillage – 4.34 t/ha.

According to the results of studies, soil tillage minimization contributes to the greater localization of plant residues in the upper layers of the arable layer (0-20 cm) and on its surface, while the application of moldboard soil tillage system leads to the wrapping of almost the entire biomass in the lower layers of the soil (20-27 cm).

As is known from literary sources (*Hordiyenko et al., 1991*), the degree of decomposition of plant residues largely depends on the microbiological activity of the rhizosphere zone, which in its turn is changed under the influence of agrophysical parameters (density and hardness of the soil) which are regulated by methods of basic soil tillage. The conducted agrophysical monitoring of soil condition showed that at growing of different crops in crop rotation, the arable layer was heterogeneous according to indicators of density and hardness in a vertical section.

In all fields of crop rotation in the spring, a clear pattern of differentiation of zone distribution have been appeared between the upper less hard pan of 10-15 kg/cm^2 and the deeper packed horizon with mechanical counteraction for plant roots at 25-30 kg/cm^2. That is, the depth of occurrence of a hard pan of soil significantly depends on the methods of basic soil tillage and biological peculiarities of crop rotation crops (Table 2).

During the vegetative period there was the gradual compaction of the arable layer, but the tendency continued to be characteristic for the spring determination. So and in the beginning of June, the deepest occurrence of the compacted layer was by the mouldboard system of soil tillage - 24 cm especially in the fields of sunflower and corn, while at the differentiated system of soil tillage (especially for discing - 8 cm) the compaction was detected at the depth of 8-16 cm in the sowings of peas, spring barley and winter wheat. For zero soil tillage system, there was no significant differentiation of the arable layer on density indicators, where it was maximum and was 1.35 g/cm³.

Table 2

Depth of occurence of compacted layer of soil under different systems of basic soil tillage in crop rotation for 2010-2017

Field cultures of crop rotation	Phase of development of plants of field crops	Soil moisture in arable layer (0-30 cm) %	Soil tillage system		
			mouldboard	differentiated	zero
Peas	Formation and ripening of grain	15.3	14/66	9/60	8/55
Winter wheat	Formation and ripening of grain	13.4	14/94	10/90	8/87
Sunflower	4 pairs of leaves	19.4	24/42	14/38	12/32
Barley spring	Formation and ripening of grain	13.5	14/73	10/67	8/62
Corn	6-7 leaves	20.3	24/61	12/50	9/43

Note: Numerator - the depth of the compacted, hard pan of soil, see.
Denominator – the height of plants of field crops, cm.

In general, the minimization of the soil tillage was accompanied by the compaction of the arable layer of soil (0-30 cm) deeper than 8-16 cm, while in the background of the mouldboard ploughing more favorable conditions for growth and development of the root system up to 27 cm were noted.

On zero backgrounds, as well as the decrease in the depth of the main soil tillage to 8-16 cm after the small soil tillage, with leaving the compacted layer in the lower horizons, all crops of crop rotation slowed the linear increase. In particular, for example, winter wheat plants had the lower height for zero soil cultivation, not exceeding 87 cm in comparison with the mouldboard soil tillage system, where the plant height was 94 cm. In the cotn sowings at the 6-7 leaf phase, the above indicators were 43 cm and 61 cm accordingly.

One of the most powerful levelling factors for reduction of soil hardness is the level of soil and plant water supply. So, the hardness of the soil was in the inverse multiple correlation dependence with the soil moisture, that is, with increase of soil moisture the hardness decreased and the height of the plants of field crops increased. The correlation coefficient here was quite high and was 0.85.

After intensive heavy showers at the level of 45 mm of rainfall in the summer, at the time of harvesting of early cereal crops, as well as in the phase of milky-waxy ripeness of corn and flowering of sunflower, the most favorable layer of soil with respect to its hardness for plants significantly expanded to the depth of its aspiration. After heavy rains, the depth of the line of differentiation of the separation of the hard and loosening layers in the early cereal crops was deepened to 16-23 cm, and in fields of tilled crops (sunflower, corn) up to 21-27 cm, which was on 3-9 cm deeper, and than before rainfalls.

However, even in spite of the substantial moisture of the arable layer of soil, the advantage of the mouldboard soil tillage system over the differentiated and zero soil cultivation in terms of the ability to loosen the arable layer at the expense of a better soil digestion function was also manifested after the intense rainfall (Table 2). These processes are especially intensive in the autumn-winter period due to maximum moisture of the soil, as well as mutually opposite processes of its freezing and thawing, when the destruction of coarse fractions is > 10 mm to the most valuable aggregates of smaller sizes (from 0.25 to 10.0 mm) .

The methods of basic soil tillage also had the significant influence on the indications of projective coverage of the soil surface with plant residues after each field crop in the crop rotation, which is of paramount importance in control of erosion processes (water and wind erosion) during the absence of vegetative cover.

The dynamics of the projective coverage of the surface of the field with plant residues showed that the methods of basic soil tillage differed significantly in the nature of anti-erosion efficiency and microbiological destruction of straw under the influence of moisture, temperature and mechanical action. At the same time, the methods of minimal soil cultivation contributed to the enhancement of the anti-erosion stability of the chernozem surface from the shock energy of rain drops, and also provided more favorable conditions for the humification of organic residues instead of undesirable intensive mineralization.

During the winter period, plant residues also undergone a slow stage of destruction and decomposition. In particular, for the differentiated system of cultivation on the background of small discing before the beginning of spring field operations, the reduction of biomass residues in different fields of crop rotation was within the range of 0.24-0.48 tons / ha, and in the case of zero cultivation and direct sowing 0.21-0.80 t / ha.

The intensity of the decomposition of organic matter in the soil is a heterogeneous process, which primarily depends on the determining factors - moisture, temperature and aeration level of the treated layer of chernozem. The intensity of the processes of breathing of soil microorganisms makes it possible to estimate the total biological activity of the soil, which is based on the amount of carbon dioxide released, depending on the different methods of soil tillage per unit area of the field surface (Table 3).

Table 3

Influence of crop rotation and soil tillage on the general biological activity, mg CO_2 / kg soil / day on average for 2010-2017

Field cultures of crop rotation	Terms of definition (number, month)	Soil tillage system		
		mouldboard	differentiated	zero
Peas	01.05	37.1	34.7	32.0
	01.06	50.3	46.3	40.5
Winter wheat	01.05	31.7	30.2	28.9
	01.06	40.9	38.0	35.1
Sunflower	01.05	35.0	34.7	29.5
	01.06	49.2	43.9	42.0
Barley spring	01.05	32.8	31.3	29.6
	01.06	43.3	39.7	36.0
Corn	01.05	33.1	31.4	28.2
	01.06	47.5	45.8	41.1

As these studies have shown, the biological activity of the soil depended on the phases of development of plants of field crops and had a sufficiently wide amplitude of variation. Thus, as an example of the mouldboard plowing, it is evident that insufficient soil warming at normal humidification at the time of corn sowing has led to the decrease in biological activity to 33.1 mg CO_2 / kg of soil / day.

The maximum intensity of soil respiration (47.5 mg CO_2 /kg of soil / day) occurred at 30 days after corn sowing, when the optimal combination of temperature and humidity of the soil was noted. Similar regularities and tendencies in the release of CO_2 from the soil during certain phases of maize development are also noted for differentiated and zero cultivation systems, but with somewhat lower overall CO_2 release, respectively, by 1.7-5.3 mg CO_2 / kg ha / day (10-12%) and 5.8-9.8 mg CO_2 / kg ha / day (12-22%) compared to the mouldboard soil tillage system. Generally, this tendency took place both in the maximum and at the minimum amplitude of the activity of respiration processes, that is, the indicators of the general biological activity of the soil were higher in the background of plowing and prevailed other systems of mechanical cultivation of chernozem (differentiated, zero system).

One of the reasons for reduction the biological activity of the soil, depending on the methods of basic soil tillage, is the different profile dislocation of plant residues. That is why, the availability of oxygen, moisture, optimal agrophysical properties of the soil and the presence of a significant amount of plant residues in the profile of the arable layer over the mouldboard soil tillage system creates the most favorable medium for microorganisms. At the same time, when at zero soil cultivation, all plant residues are located on the soil surface and are isolated from the zone of vigorous activity of the soil biota.

CONCLUSIONS

Thus, the biological activity of the soil is the derived indicator, which depends on the features of the technology of growing of cultures in the crop rotations, the presence of organic matter of plant residues in the chernozem, the level of compaction of arable layer and the methods of basic soil tillage.

The use of deep plowing due to the creation of favorable conditions for the expansion of the root system of crops with sufficient aeration and moisture absorbtion properties provides maximum biological activity under all crops of crop rotation, decomposition of residues and intensive mineralization processes.

However, methods of unploughed treatment of the soil contributed to increasing the anti-erosion stability of the surface of chernozem from the shock energy of rain drops, as well as providing more favorable conditions for the humification of organic residues instead of undesirable intensive mineralization.

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IMPACT OF VIBRO-COMBINATOR SOIL PROCESSING ON PHYSICO-MECHANICAL SOIL PROPERTIES
/
IMPACTUL PRELUCRĂRII SOLULUI CU UN VIBRO-COMBINATOR ASUPRA PROPRIETĂŢILOR FIZICO-MECANICE ALE SOLULUI

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ABSTRACT

The research carried out in this paper observes the changes in the soil as a result of processing it with a modernized vibro-combinator, equipped with vibro-elastic active parts, which contribute to obtaining the most favourable living environment for plants, reducing the negative effects of soil structure degradation, respectively reducing fuel consumption. Vibro-combinator experiments were performed on autumn ploughed land (frozen) and in summer-autumn, on fresh ploughed land / scarified land, which was harrowed/disked in advance. In order to determine the impact of soil processing with vibro-combinator on soil physico-mechanical properties, soil properties were determined before the machine passed (in its initial state), respectively after it passed on the parcels established for experiments within private agricultural farms in Arad County (between April-August 2015), obtaining superior agro-pedological indices, corresponding to the qualitative and energetic indexes established for this equipment. The yields of crops established in the spring of 2015 on the soil worked with this vibro-combinator have been superior to those obtained by applying the classic system, the costs being lower by approximately 15%.

REZUMAT

Cercetările realizate în cadrul prezentei lucrări urmăresc modificările la nivelul solului, ca urmare a prelucrării cu un vibro-combinator modernizat, dotat cu organe active vibro-elastice care contribuie la obţinerea unui mediu de viaţă cât mai favorabil plantelor, reducerea efectelor negative de degradare a structurii solului, respectiv reducerea consumului de combustibil. Experimentările vibro-combinatorului s-au realizat pe arături de toamnă (degerate) şi vara-toamna, pe arături proaspete / teren scarificat, care au fost grapate / discuite în prealabil. Pentru a putea determina impactul prelucrării solului, cu vibro-combinatorul asupra proprietăţilor fizico-mecanice ale solului, s-au determinant în prealabil proprietăţile acestuia înainte de trecerea utilajului (în stare iniţială), respectiv, după trecerea acestuia, pe parcelele stabilite pentru experimentări din cadrul unor ferme agricole particulare din Jud. Arad (între aprilie-august 2015), obţinându-se indici agropedologici superiori, corespunzător indicilor calitativi şi energetici stabiliţi pentru acest echipament Producţiile culturilor înfiinţate în primăvara anului 2015 pe sol lucrat cu acest vibro-combinator au fost superioare faţă de cele obţinute prin sistemul clasic, cu cheltuielile materiale mai mici cu aproximativ 15%.

INTRODUCTION

Soil works are operations performed with agricultural equipment being designed to modify the soil characteristics by achieving an optimum proportion between the capillary porosity and non-capillary porosity and a suitable regime of water, air and nourishment, in order to capitalize the biologic potential of culture plants (*Canarache A., 1990; Canarache A. et al, 1990*). Researches performed during the years on soil works led the way to new types of working parts and, at the same time, improved those already existing.

The economic efficiency of a crop is directly influenced by the performance and quality of soil processing systems. They first determine the physical changes, the characteristics influencing the chemical substances and then the biological properties of the soil (*Cârciu Gh., 2003*).

Among soil works when establishing a new crop, the preparation of the germinating bed has a forefront place. Through this operation, the land clods are broken, the soil is levelled and a high-quality germinating bed is achieved, thus ensuring the optimum conditions for sowing and uniform plants springing. Recently, conservative tillage technologies, using a new range of agricultural machines were promoted. The soil works of conservative type are achieved with aggregates consisting of different types of equipment that concomitantly perform several operations at a single passing in land (*Constantin N., 2012*). The equipment used performs both soil loosening and soil work without furrow overturning, thus the land is prepared for the classic sowing, but also for direct sowing.

Conservative tillage preserves soil humidity, reduces land compaction, ensures a good deep loosening by destroying the hardpan layer (the mark let by plough in the land), increases the water storing capacity of soil and reduces the costs comparing to conventional system. Therefore, implementing conservative soil works besides their diminished costs, can bring benefits on long term by maintaining and boosting the soil fertility (*Constantin N., 2012*).

According to sustainable farming principles, there is unanimously accepted that there is not any universal viable system of soil work, because of the local differences as climate and soil and also of different level of endowment. Soil humus content has registered a growing tendency by applying the minimum tillage. This is due on one hand, to large quantity of vegetal residues (minimum 30%) in different decay stages remained on soil in the first 10-20 cm, and on the other hand, to balance between mineralization/humification obtained by a specific physical, thermal and biological regime (*Gus P. and Rusu T., 2011*).

Soil minimum tillage systems with paraplow, chisel or rotary harrow represent useful alternatives for the basis process, germination bed preparing and sowing of cultures with average demands in terms of loosening, assuring and enhancing the rationalization and natural fertility of soil, reducing erosion, increasing the water holding capacity and giving the possibility to sow in the best period of time (*Constantinescu A., 2010*).

Current researches are aiming to improve the technologies of mechanization of soil works and increase the economic efficiency for obtaining a high quality work with positive effects on soil physical and mechanical properties (*Constantin N., et al., 2009*; *Constantin N. and Cojocaru I., 2008*).

MATERIAL AND METHOD

Experiments to determine the impact of soil processing on its physico-mechanical properties related to soil fertility were performed with a state-of-the-art agricultural equipment equipped with vibro-elastic working parts (Figure 1).

Soil vibro-combinator is an agricultural equipment that performs a complex operation: it slightly levels the soil crests with vibratory blades; it slightly levels by means of rollers with rods; basically, process the soil with active parts of Delta 2 type, mounted on elastic supports especially designed for obtaining vibrations suitable for a certain working speed; clods breaking and final levelling with the battery of rollers with rings of Crosskill type.

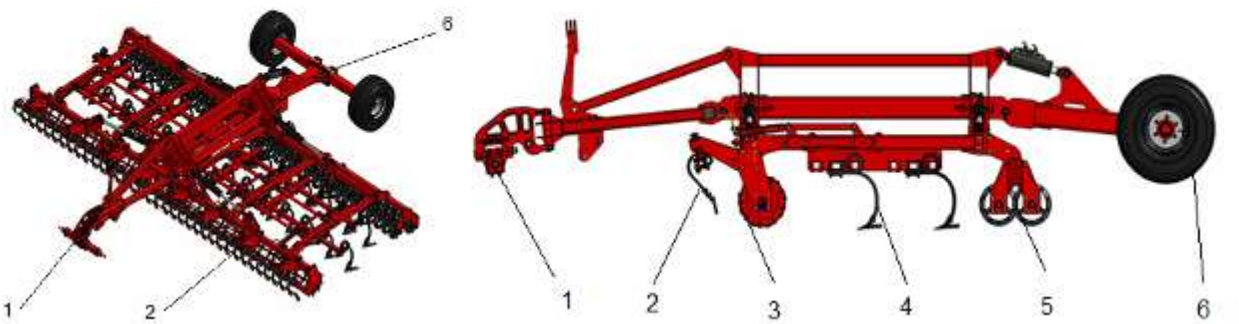

Fig. 1 - Vibro-combinator – working parts

1 – 2-point hitch traction bar and semi-traction frame; 2 – vibratory blades with variable height; 3 – roller with rods; 4 – vibratory acting parts placed on two rows adjustable in depth with Delta working parts 2; 5 – roller with Croskill rings for finishing; 6 - transport trucks

During the working process, the vibratory blades made of manganese sheet plates mounted on elastic supports hit the soil crests displacing them in the field gaps, this way performing a light levelling and the rod rollers make uniform and initially level all crests. After the work with pre-levelling and levelling parts, the Delta type active parts perform a complete cut of soil and roots on the whole width and a loosening of soil worked in a depth of max. 12 cm. These active parts are of arrow-knife type and are mounted on elastic supports for achieving a vibration able to ensure a high-quality work with reduced energy consumption.

The processed and dislodged soil is broken up by the rod rollers. Over the soil pre-levelled, cut, deep loosened and mixed with upper layer by vibro-combinator's working parts the battery of rollers with rings will pass, thus finalizing the working process by soil levelling and superior breaking. Once the working process finished, the processed soil properties will be improved in terms of structure comparing to that performed with classic equipment.

The dimensional and constructive characteristics of the equipment for soil processing are given in Table 1.

Table 1

Dimensional and constructive characteristics of the vibro-combinator

No.	Characteristic	UM	Values
1.	Working depth, soil processing, soil breaking and superior levelling	cm	10÷12 6÷10
2.	Working width	m	max. 7
3.	Working speed	km/h	max. 15
4.	Aggregate tractor	HP	200÷340
5.	Specific mass	kg/ml	max. 785
6.	Specific aggregate power	[HP/ml]	30÷50

Experiments were made on plots in Cermei and Curtici county. Soil samples, as natural structure, are taken with special probes and aim to determine the apparent density, porosity, permeability, water stocking capacity. Samples aiming to find out soil humidity are put in sealed metallic phials for avoiding the sample water evaporation. Soil samples were taken out of each profile for two depths, respectively 6 cm and 12 cm. For each sample were made six repetitions. Based on soil samples, the granulometric and chemical characteristics for the three relevant types of soil were determined.

Knowing the granulometric structure of soils of the land where tests were performed is rather compulsory because of different ratios existing between the granulometric fractions and other physico-mechanical characteristics (*Gus P. and Rusu T., 2011*). Granulometric composition of a soil is directly connected to easy processing by mechanical means. The coarse part of soil particles (sand) was determined by screening and the fine parts (dust, clay) by deposits. The tests were made within the agro-pedological laboratory of Arad Agricultural Centre and pedological laboratory of West University "Vasile Goldiş" in Arad.

The chemical features that influence the crop living and directly determine the fertility are the following: soil reaction, content of limestone, humus, ionic change, nutrients ensuring, etc (*Cârciu Gh., 2003*). Taking into account the great part detained by soil chemical characteristic in crops growing, 7 indexes have been studied: pH – soil pH, CaCO3 – carbonates, H – humus, Ntot – total nitrogen, N-NO3 – nitric nitrogen, P – mobile phosphorus and K – mobile potassium, each of them emphasizing a certain aspect of soil fertility-as a complex phenomenon. The probes sampled came from the three testing plots and all depth horizons.

At the same time, the environment conditions were determined by the field test with vibro-combinator. The lab-field tests have consisted of finding out the following indexes:

- agro-technical indexes: porosity, water holding capacity and soil compaction;
- qualitative working indexes: working depth, working width, soil breaking degree, level of destruction of vegetal residues;
- energetic indexes: working speed, traction force, driving necessary power, fuel consumption, motor wheels skidding.

RESULTS

Results obtained after determining the granulometric characteristics for the three types of soil are given in Table 2, and the granulometric curves are presented in Figure 2.

Table 2

Granulometric analysis for three types of soil

Probe sampling depth	Sand		Dust		Clay
	Coarse	Fine	I	II	
	>0.2	0.2-0.02	0.02-0.01	0.01-0.002	<0.0002
cm	%				
Plot P5- Cermei					
6	3.8	30.1	16.6	16.9	32.1
12	3.5	29.6	16.4	16.7	34.5
Profile average	**3.6**	**29.8**	**16.5**	**16.8**	**33.3**
Plot P6- Cermei					
6	3.6	29.8	17.4	17.8	31.5
12	3.3	29.6	17.2	17.6	32.8
Profile average	**3.5**	**29.3**	**17.3**	**17.7**	**32.2**
Plot P7- Curtici					
6	5.8	36.6	18.7	13.2	26.4
12	5.6	36.4	18.3	12.8	26.2
Profile average	**5.7**	**36.5**	**18.5**	**13.0**	**26.3**
	Sand (coarse + fine)		**Dust (I + II)**		**Clay**
P 5	33.4		33.3		33.3
P 6	32.8		35.0		32.2
P 7	42.2		31.5		26.3

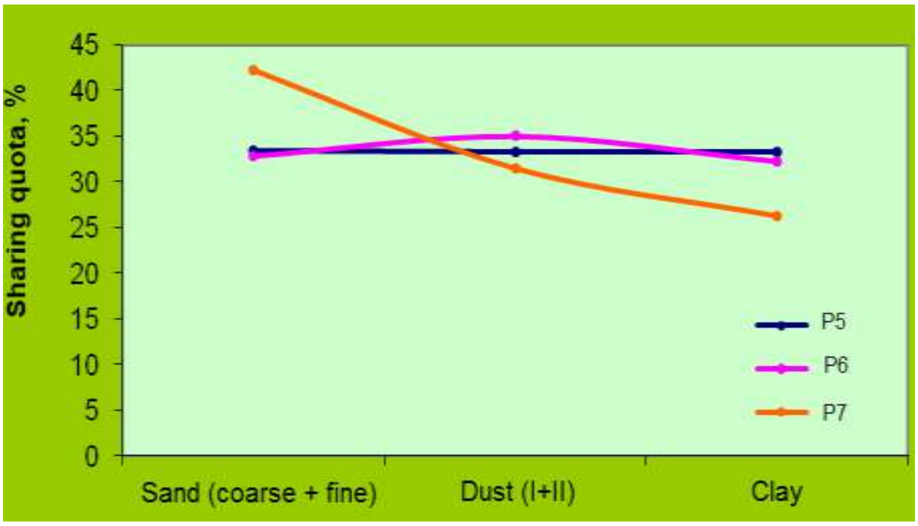

Fig. 2 - Granulometric curves of soil from testing plots

After analyzing the obtained values, the following have resulted:

All types of soil where vibro-combinator was tested are made of a relatively insignificant mixture of different shares of the three granulometric fractions;

Sand fraction (coarse+ fine) is predominant in plot P7 (42.2 %);

At dust fraction (I + II) differences between the three soils framed within 3.5 %, the highest value being found for plot P6 (35.0 %);

Sharing quotas of clay granulometric fraction are the biggest, varying within 26.3 % (soil 3) and 32.2 % (soil 2) reaching 33.3 % in plot P1; dust granulometric fraction is approximately constant for all the three types of soil.

The results obtained after determining the chemical characteristics for the three types of soil are given in Table 3.

Table 3

Soil chemical characteristics

Sampling depth	**pH**	**Carbonates**	**Humus**	**N tot**	**N-NO$_3$**	**P(AL)**	**K(AL)**
cm		%			ppm		
P 5- Cermei							
6	6.5	6.3	2.1	0.105	10.2	21.8	86
12	6.7	6.5	2.0	0.101	10.4	24.3	85
Profile average	**6.6**	**6.4**	**2.1**	**0.103**	**10.3**	**23.1**	**85.5**
P 6- Cermei							
6	6.6	6.2	2.1	0.102	9.4	20.5	84
12	6.8	6.4	1.8	0.095	9.8	22.8	86
Profile average	**6.7**	**6.3**	**1.95**	**0.099**	**9.6**	**21.65**	**85**
P 7- Curtici							
6	7.9	0.5	3.3	0.173	2.3	24	162
12	7.5	0.8	3.1	0.169	2.1	26	155
Profile average	**7.7**	**0.7**	**3.2**	**0.171**	**2.2**	**25**	**158.5**

Following the analysis of values contained in Table 3 the following have resulted:

- the soil from tested surfaces is less acid with values framing within 6.6 (P 5- Cermei). 6.7 (P 6- Cermei) and 7.7 (P 7- Curtici);
- pH values do not vary according to depth;
- carbonates, humus, total nitrogen, mobile phosphorus and potassium are more favourable in testing plots P 5- Cermei and P 6- Cermei than in P 7- Curtici;
- depending on granulometric composition and mineral characteristics, the humus content has average values in all depth horizons (0-12 cm) as well as in all the testing plots.

Environment conditions of field testing of vibro-combinator are shown in Table 4.

Table 4

Environment conditions of field testing

No.	**Characteristics**	**Plot**		
		P5	**P6**	**P7**
1.	Plot surface	25 ha	32 ha	50 ha
2.	Soil type	Gley soil	Gley soil	chernozem
3.	Previous operation anterioara	Scarification	Scarification	Plough
4.	Previous culture anterioara	Vetch	Vetch	Wheat
5.	State of land	Flat and smooth	Flat and smooth	Flat and smooth
6.	Land slope	1.3°	0.7°	0.7°
7.	Soil humidity	0 - 5cm - 18.5% 5 - 10cm - 19.1%	0 - 5cm - 20.6% 5 - 10cm - 24.3%	0 - 5cm - 14.9% 5 - 10cm - 19.1%
8.	Compaction of soil	0÷2.5cm - 523kPa 2.5÷5cm - 728kPa 5÷7.5cm - 974kPa 7.5÷10cm-1336kPa	0÷2.5cm - 472kPa 2.5÷5cm - 714kPa 5÷7.5cm - 925kPa 7.5÷10cm-1282kPa	0÷2.5cm - 574kPa 2.5÷5cm - 836kPa 5÷7.5cm - 978kPa 7.5÷10cm-1139kPa
9.	Soil temperature	11.2 °C	9.4 °C	10.3 °C

Within the lab-field tests of vibro-combinator the following indexes were determined: porosity, water stock, soil settlement, traction force, working depth, working width, soil breaking level, vegetal residues destruction degree, working speed, necessary driving power, fuel consumption and motor wheels skidding.

Soil porosity (factor that influences the permeability for air and water, aero-hydric soil regime, soil micro-organisms activity, respectively, soil fertility) has increased by 2.82 % within 47.34÷50.16% interval. Values registered are shown in graphic from Figure 3. Water stock (average values) in terms of depth is suitable to a high-quality germinating bed performed by vibro-combinator. Values registered are shown in graphic from Figure 4.

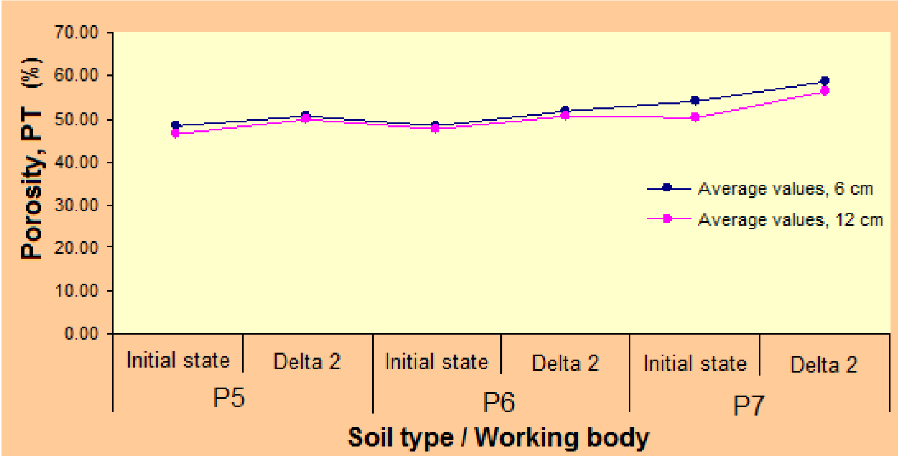

Fig. 3 - Variation of average values of porosity depending on sampling depth

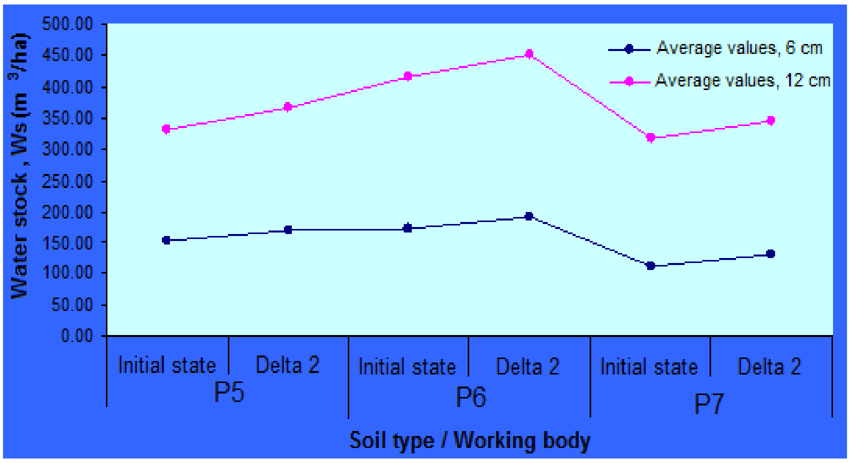

Fig. 4 - Variation of average values of water stock depending on sampling depth

Settlement level has values < 10% which means a medium settled soil (plot P5) with values framing between 3.65…5.56%, signifying a light settled soil (plot P6) and negative values within -17…-10% namely for an average settled soil (plot P7. with chernozem). Registered values are shown in graphic from Figure 5.

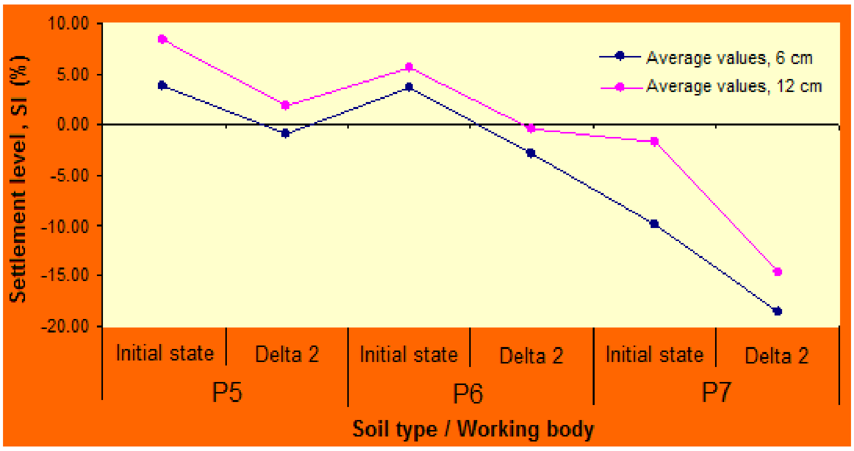

Fig. 5 - Variation of average values of settlement level according to sampling depth

Table 5

Traction force

Working part type	Minimum value of traction force (kN)	Maximum value of traction force (kN)	Average value of traction force (kN)
Delta2	15.89	103.5	**64.75**

Based on data obtained and processed during the experimental researches in lab-field conditions, a synthesis of working qualitative and energetic indexes values was achieved. These values are shown in Table 6.

Table 6

Working depth (average value) [cm]	Working width (average value) [m]	Breaking level [%]				Degree of destroying vegetal residues [%]	Working speed [km/h]	Traction force [kN]	Driving necessary power [kW]	Fuel consumption [l/ha]	Motor wheels skidding [%]
		> 100 mm	50 ÷ 100 mm	20 ÷ 50 mm	< 20 mm						
8.8	7.2	0.8	4.1	25.7	69.4	98.5	12.2	62.73	212.59	6.3	9.8

In Figure 6 is shown a couple of aspects during lab-field tests with vibro-combinator.

a.

b.

Fig. 6 - Vibro-combinator during tests performed in summer ploughed field (a) and in scarified land (b)

The analysis of data from Table 6 has showed that the working qualitative indexes obtained with the vibro-combinator at a superior working speed and with reduced fuel consumption, have been appropriate.

CONCLUSIONS

After working the soil with the new vibro-combinator, soil porosity has increased by 2.82 % within the interval of 47.34÷50.16% for all the types of soils analyzed. The water stock in terms of depth is suitable for a high quality germinating bed performed with vibro-combinator. In all analyzed cases, the compaction level has been smaller after working the soil with the new vibro-combinator.

Experimental researches have validated the modifications of soil processed with the new vibro-combinator endowed with vibro-elastic active parts that contributes to plants better living environment, reduces the negative effects of structure degradation and diminishes the fuel consumption.

Experimental results have enabled to draw up useful recommendations to farmers that use this aggregate with which they achieve a fuel saving of about 15% and superior productions comparing to those classically obtained.

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MODAL ANALYSIS OF A SOIL LOOSENING MACHINE BASIC STRUCTURE
/
ANALIZA MODALĂ A STRUCTURII DE BAZĂ A UNEI MAȘINI DE AFÂNAT SOLUL

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Keywords: *soil loosening machine, modal analysis, SolidWorks software, structures dynamics*

ABSTRACT

The paper presents the resistance structure modal analyses of a SCAR-ART soil loosening machine, namely, determining the main own structure frequencies, as well as applications of the obtained data. For calculation is used finite elements module analyse of SolidWorks software, modal analyse sub-module. The geometry of the structure is constructed in the same program, after which the meshing and the frequency analysis are made, using a structural model constructed with linear elastic materials, considering that in normal operation no tensions are achieved outside the linear elasticity range.

The results consist in a number of 30 own frequencies and vibration that are used (the first 2-3) to avoid resonant operating modes. Also, in perspective, these can be used to simulate the resonant working regimes and identify possible damages under these conditions.

REZUMAT

Articolul prezinta analiza modala a structurii de rezistenta a masinii de afanat solul SCAR-ART, adica determinarea frecventelor proprii principale ale structurii, precum si aplicatii ale datelor obtinute. Pentru calcul se foloseste modulul de analiza cu elemente finite a programului SolidWorks submodulul de analiza modala. Geometria structurii se construieste in acelasi program dupa care se face discretizarea si analiza in frecvente, folosind un model structural construit cu materiale de tip liniar elastic, considerand ca in functionarea normala nu se ating tensiuni in afara palierului de elasticitate liniara.

Rezultatele constau intr-un numar de 30 de frecvente proprii si moduri proprii de vibratie, care se folosesc (primele 2-3), pentru evitarea regimurilor rezonante de functionare. De asemenea in perspectiva ca acestea pot fi folosite pentru simularea regimurilor rezonante de lucru si indentificarea avarilor posibile in aceste conditii.

INTRODUCTION

Structures dynamics is a very broad discipline, which uses a huge range of theoretical and experimental methods to solve a fundamental problem of structures: the dynamic response to variable loads over time.

A real definition of the structure dynamics structure field would require a large number of pages, compared to the space reserved for this article, so those interested are sending to the technical literature (*Horea Sandi,1983; Nuno Manuel Mendes Maia and Julio Martins Montalvao e Silva,1997; Buzdugan Gh., 1982; Cyril M. Harris and Charles E. Crede,1961; Mircea Rades, 2008*).

Vibrations and especially vibrations in resonance modes are problems that occur frequently in large structures. Because large structures with large numbers of components cannot be optimally engineered for resonant regimes, it is often done to modify structures or improve them by using modal analysis of the mathematical models of these structures (*Cardei P., 2012*). The modal analysis is only an instrument of modal analysis, as it claims (*Nuno Manuel Mendes Maia and Julio Martins Montalvao e Silva,1997*), the beginnings of its use being around the 1940's.

The analyzed structure in this article is a modern structure of soil loosening machine, with the load bearing structure consisting of plates. The modal analysis or frequency analysis for this structure aims to determine its own frequencies and identify the components with maximum amplitude on each of its base own frequencies. The utility of the own frequencies calculation and modes of vibration it results from the fact that these can explain certain resonance modes of external or internal origin. External working arrangements are less common.

These may be caused by a possible periodic soil structure (very improbable, but not impossible if we refer, for example, to surfaces previously profiled for various cultures or for anti-erosion purposes), and / or because of critical working speeds or even oscillations traction. Internal resonances may come from the oscillations of some structure components, on frequencies equal to or very close to one of the structure's own frequencies. Internal resonances disturb the working regime, affect the quality of the works or even lead to premature wear of the agriculture machine and the aggregate.

The intense interaction with the tractor can induce own vibrations of the analyzed structure in the structure of the tractor, eventually retransmitted by suspension to the operator on the tractor. The consequences can be estimated using the knowledge about the effects of vibrations on the human body (*Bruel & Kjaer, 1989*). The effects of vibrations on the quality of the work of machines for soil processing are also intensive discussed (*H. F. Mahmood, 2011; Ragni L., 1999; Karoonboonyanan R., 2007; Matache M., 2015*).

Starting from the findings of the modal analysis, improvements can be made to the system through minor modifications of some components of the assembly or through modifications of permitted operating or operating conditions. Finally, we mention that the frequency analysis is the first step in the dynamic analysis, because it uses the primary results for calculating the structure response to various variable loads in time.

MATERIAL AND METHOD

The analyzed structure is the same as in (*Gheorghe G., 2017*), Figure 1. The structural model, whose geometry is given in Figure 2, is the geometric model of the load-bearing structure, supports and working body of the SCAR-ART scarifier, Figure 1.

Fig. 1 - SCAR-ART scarifier

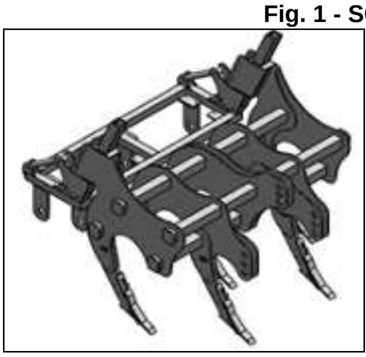


Fig. 2 – Structural model of SCAR-ART scarifier

Fig. 3 – Meshing the scarifier structural model

To calculate the own frequencies of the structural model, the finite element method was used, working in the SIMULATION package of SolidWorks software. The meshing was made with a number of 119698 of solid (three-dimensional) finite elements, having 230269 knots (similar meshing to that used in (*Gheorghe G., 2017*), Figure 3.

The material of the structure is S275 steel, with hypothetical linear, elastic, homogeneous and isotropic. The characteristics of the S275 steel that is used for the analyzed structure are given in Figure 4. The material data used is part of the material database of SolidWorks program.

Property	Value	Units
Elastic modulus	2.100000031e+011	N/m^2
Poisson's ratio	0.28	N/A
Shear modulus	7.9e+010	N/m^2
Mass density	7800	kg/m^3
Tensile strength	410000000	N/m^2
Compressive Strength in X		N/m^2
Yield strength	275000000	N/m^2
Thermal expansion coefficient	1.1e-005	/K
Thermal conductivity	14	W/(m·K)
Specific heat	440	J/(kg·K)
Material Damping Ratio		N/A

Fig. 4 - Material properties of S75JR

The supporting structure is made at the points of connection to the tractor. Figure 5 presents the locations of the supporting three areas in which the displacements are cancelled.

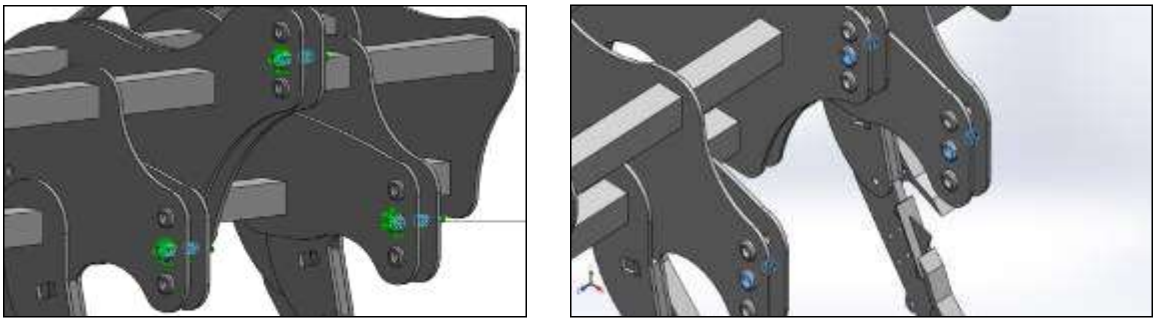


Fig. 5 – Structure supporting

The loading of the structure is pure gravitational (its own weight), gravitational acceleration having the value of -9.81 m / s^2, the only non-zero component, the Oy axis.

RESULTS

The result of calculating frequencies or modal analysis is essentially in the list of a number of its own frequencies (in Hz) (pulses in Hz/and periods, in s), in order from the lowest (fundamental frequency). There are also the relative displacements on the directions and the resultant in the structure, for each vibration mode, separately. Also, colour maps of the field of relative displacements, on components or resultant.

In Table 1 is given from the SOLIDWORKS program report, by which (using SIMULATION module) frequency analysis was made, a list of the first thirty own frequencies, corresponding to thirty vibration modes, each of them with the normalized displacements the three directions.

Table 1

Mass Participation (Normalized)

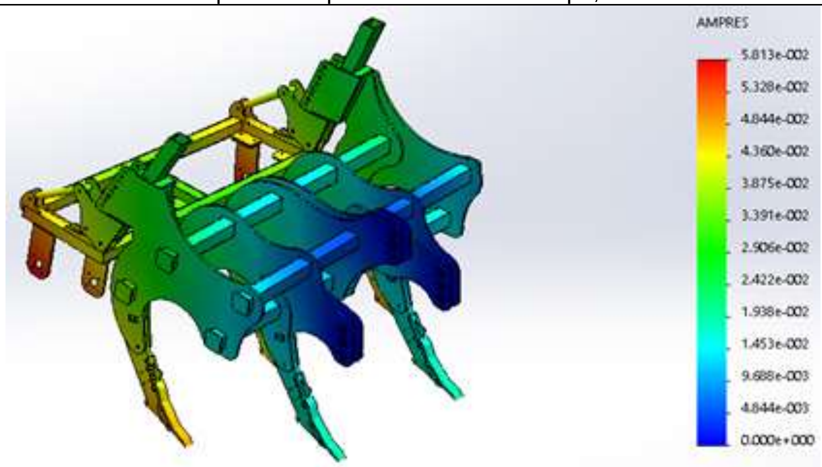
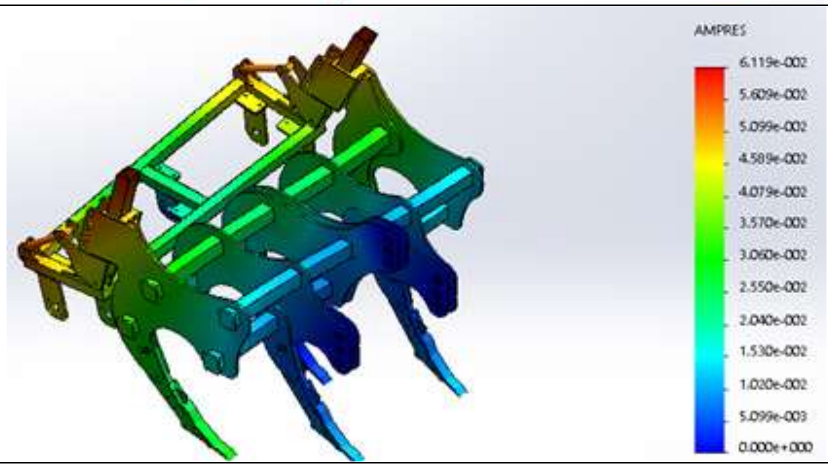
Mode Number	Frequency(Hertz)	X direction	Y direction	Z direction
1	11.836	5.7712e-009	3.6409e-007	0.50851
2	16.548	3.4761e-008	1.9406e-007	0.28879
3	20.833	0.0014834	0.44604	2.3625e-007
4	34.032	0.00012379	7.277e-006	0.08223
5	35.647	0.22697	0.026452	4.3091e-005
6	41.268	6.7646e-006	3.2569e-006	0.033911
7	44.32	0.089385	0.033156	8.7665e-006
8	47.779	1.4392e-005	5.2461e-009	0.00080615
9	48.703	0.010968	0.0034752	1.3275e-005
10	50.341	1.7564e-005	4.1108e-008	0.010133
11	56.245	0.030533	0.021727	6.5548e-006
12	60.115	1.6123e-005	8.1905e-006	0.005221
13	63.435	7.2434e-006	1.9381e-006	0.018262
14	70.494	3.3421e-005	8.2401e-005	0.0049109
15	71.889	0.057049	0.12249	5.0486e-006
16	75.487	3.6315e-005	0.00015334	4.8081e-005
17	79.918	0.021966	0.0088722	4.2245e-008
18	85.769	0.030122	0.049132	1.301e-006
19	91.885	0.00032949	0.00028952	0.00022521
20	97.229	0.00051331	0.00025398	3.3279e-005
21	97.377	0.080563	0.045633	8.1974e-007

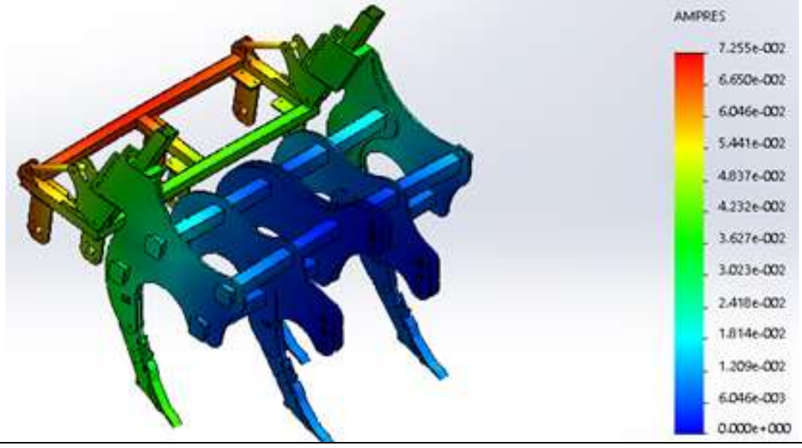
Mode Number	Frequency(Hertz)	X direction	Y direction	Z direction
22	99.892	4.4603e-005	3.5445e-005	1.9322e-008
23	101.33	0.0029429	0.0010396	3.1737e-007
24	103.06	0.0033322	0.002156	9.5024e-008
25	107.42	0.002309	0.0012114	2.258e-006
26	110.99	1.1906e-005	2.096e-005	7.2117e-006
27	119.31	0.0028534	0.0020978	2.4902e-007
28	121.27	7.0119e-006	8.1763e-007	0.00039474
29	127.95	6.0551e-005	1.2698e-006	0.00022529
30	128.83	2.3638e-006	1.5217e-007	0.0032435

Another way of giving these results is shown in Table 2, where are given its own frequencies and amplitude maps on the deformed shape of the structure in the vibration modes corresponding to that reference. In Table 2, there are only three of the three dozens of calculated vibration modes for the reason of fitting into the space of a paper.

Table 2

First three own frequencies of the structure and amplitude maps on its margins, in case of oscillation on own frequency, respectively

<table>
<tr><th>Module</th><th>Freqency, Hz</th><th>Amplitude map on the deformed shape, mm</th></tr>
<tr><td>1</td><td>11.8365</td><td>
</td></tr>
<tr><td>2</td><td>16.548</td><td>
</td></tr>
</table>

3	20.8333	

The values found for the first three frequencies of the SCAR-ART scarifier are also found in other machines of the same range (*Karoonboonyanan R., 2007*).

CONCLUSIONS

The analyze of own spectrum of SCAR-ART scarifier allows accurate identification of the main frequencies on which a resonant working regime can occur. The fundamental frequency of the analyzed structure is 11.8365 Hz.

This is an unreachable frequency in normal working conditions, where the tractor does not induce dangerous excitations. For example, a wheeled tractor with a diameter of about 1.75 m should have 8-profile gauge that emits an excitation at a frequency of 11.5 Hz, that could cause resonance in the scarifier structure.

There are four pairs of frequencies, close in their own spectrum, namely, modes 20-21, 4-5, 8-9 and 14-15. In the event of oscillation problems that affect the quality of the work or disturb the human operator, any improvements may be obtained by modifying the physical and / or geometric characteristics of the components having the maximum amplitude on the frequencies of each pair.

Regarding the possibility of generating oscillations on own frequencies to be transmitted through the tractor coupling system and implicitly to the operator on the tractor, although the phenomenon is very unlikely, from the point of view of the dangerous frequencies, the danger exists. For example, modes from 3 to 18 have frequencies within the range that can affect the eyeball, the frequencies corresponding to modes 10 to 22, are within the range of frequencies affecting the chest box, the baseline frequency is in the range that affects the spine. Oscillations in modes 4 to 9 are done on frequencies that can affect the hands. Oscillations in modes 2 and 3 (with frequencies closest to the fundamental frequency may affect the forearm). These statements are made using Table 1 of this paper and map of the human body areas affected by oscillations on certain frequencies (*Bruel and Kjaer, 1989*).

Finally, its own spectrum is also useful in identifying the source of some parasitic oscillations. Once this oscillation has been identified, the source is usually searched for: either accidental phenomena (different deficiencies of the aggregate), or, in the analyzed structure of some work devices (pumps for spraying machines, mechanical devices for cutting , etc.) that operate on the structure's own frequencies or very close frequencies. In these cases, changes are made to the operating regime of the devices or the isolation of these devices is improved by the rest of the structure.

The usefulness of this analysis is particularly evident in the testing phase and even in the first stages of operation, when the working regime of a product by the type analyzed is to be improved (*Cardei P., 2017*).

COMMENTS

The results obtained and provided by modal analysis for mechanical structures are relatively few and their uses are accurate.

As it is known, the main result of the modal analysis is the set of calculated frequencies. In principle, it may be required to calculate a number of its own frequencies. In fact, useful, there are only a few among first of them. The most important is the fundamental frequency, which has the lowest value of the calculated ones. Most of the time, the list of its own frequencies is used to avoid resonant work regimes and, in general, the resonance phenomena that can occur in various circumstances.

For the structure analyzed in this paper, we limited the number of frequencies calculated to the upper value of 130 Hz. We considered that this way we cover all the basic frequencies that can occur in the scarifier's working process. The highest frequencies we were considering were those that usually come from the tractor's engine (33-67 Hz), although by the coupling mode between the scarifier and the tractor, the transmissions of these frequencies from the tractor to the scarifier are extremely unlikely to amplitude that is noticeable by the usual measurement and control equipment.

On the other hand, we sought to cover the spectrum that could affect the operator's health on the tractor, according to the standards (*Bruel and Kjaer, 1989*). Impaired by the operator of the scarifier own frequencies is also unlikely, as the periodic signals transmitted from the scarifier to the tractor are weak in intensity due to all the coupling mode and attenuated in the tractor suspension system (including wheels for wheeled tractors). Concerns on the ergonomic line remain in place and receive new dimensions (*Makoto FUTATSUKA, 1998*).

Also from the calculated own frequencies list, there are several pairs of frequencies that are very close and the oscillations on these frequencies can lead to a phenomenon in which the oscillations on one of the components of the pair automatically produce the oscillation on its pair. In this way, the phenomenon, known in the field of vibrations as the beating, may appear (*Rades M., 2008; Fathi N. Mayoof, 2009*).

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This work was supported by Grant of the Romanian National Authority for Scientific Research, CNCS, UEFISCDI, PN-III-P2-2.1-BG-2016, Project number: 78BG/2016, SC Artecom SRL upgraded competences through deep soil tillage machinery optimization.

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CONSIDERATIONS ON TECHNOLOGIES FOR REDUCING THE EFFECTS OF PARTICULATE DUST FROM SEED TREATMENT WITH INSECTICIDES THAT ARE EMITTED IN THE ENVIRONMENT – A REVIEW
/
CONSIDERAŢII PRIVIND TEHNOLOGIILE UTILIZATE PE PLAN MONDIAL PENTRU DIMINUAREA EFECTELOR PRODUSE DE PARTICULELE DE PRAF, EMISE LA TRATAREA SEMINTELOR CU INSECTICIDE – REVIEW

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Keywords: *seeding, dust, insecticides, environment*

ABSTRACT

As a consequence of the acute honey bee poisoning events observed in several European countries during maize drilling, the dust drift topic has received increasingly more attention. We aimed to quantify the dust drift risk, develop reduction measures and innovate sowing techniques using an integrated experimental and modelling approach. Active ingredients can contaminate the environment and may expose operators and passers-by during sowing operations. In order to achieve a significant reduction in dust deviation and to increase safety for operators, new engineering solutions applicable to signatures have been developed and developed on the basis of an air recycling / air filtration system.

REZUMAT

Ca urmare a evenimentelor acute de otrăvire a albinelor, observate în mai multe țări europene în timpul semănării porumbului, subiectul driftului de praf a primit din ce în ce mai multă atenție. Ne-am propus să cuantificăm riscul de deviație a prafului, să dezvoltăm măsuri de reducere și de inovare a tehnicilor de însămânțare utilizând o abordare integrată experimentală și de modelare. Ingredientele active pot contamina mediul înconjurător și pot conduce la expunerea operatorilor și a trecătorilor în timpul operațiunilor de însămânțare. Pentru a obține o reducere semnificativă a deviației de praf și pentru a spori siguranța pentru operatori, la nivel international s-a studiat și s-a dezvoltat soluții inginerești noi aplicabile semănănării, pe baza unui sistem de reciclare / filtrare a aerului.

INTRODUCTION

The present review focus studies about technical solutions to reduce dust drift and losses from the drills in order to set up research strategies for further investigations. The pneumatic precision drills implement on a seed distribution system based on vacuum effect created by a centrifugal fan. The sucked air in the circuit of the seeder is finally expelled through the fan opening, dragging with it powder and seed particles that can contain dressing substances. The situation is particularly serious in Italy, since maize is a major cereal crop, grown on almost one million hectares (*Istat, 2011*).

Some manufacturers proposed devices, called air deflectors, able to redirect the output flow from the fan exit towards the soil, to reduce the diffusion of dust in the atmosphere. In previous works, tests showed that the adoption of the air deflectors determined a reduction of dust drift at least around 50% of the active ingredients amounts observed without deflectors at ground level. In the same trials, it was observed a lesser reduction of active ingredient concentrations in the air. (*Biocca et al., 2011*).

However, it was ascertained that sub-lethal effects to honey bees are still possible with these levels of dust dispersion (*Apenet, 2011; Pochi et al., 2012*), and the Italian Government decided the precautionary suspension of use of all the four active ingredients registered for seed dressing (i.e. imidacloprid, thiamethoxam, clothianidin and fipronil).

MATERIAL AND METHOD

We performed a search in the databases on the internet and at the same time, we introduced in this mini-review our original data obtained in our investigation and researches in the laboratory on a seed drill designed and executed by INMA Bucharest.

RESULTS

In the first paper "*Engineering solutions applied to pneumatic drills to reduce losses of dust from dressed seeds*" (*Biocca et al., 2013*), we can see the concentration of the active ingredient emitted by drills equipped with innovative systems developed at CRA-ING, represented in Figure 1. The data are expressed in terms of residue concentrations both in the air and at ground level. Starting from these results, the relative reduction of emission incited by the prototype, was expressed as percentage with reference to a conventional drill. In other terms the comparison of the drill performance was based on real data of active ingredient contents.

Fig.1 - The Gaspardo drill equipped with innovative systems developed at CRA-ING

The results presented in Table 1, obtain by Pochi et al. in 2013, show a remarkable reduction of drift and the efficacy of the innovative systems. The systems were applied to commercial drills without interferences with the quality of seed deposition. The effect of reduction of dust emission incited by the innovative systems was always higher than the one caused by other drift reducing devices (air deflectors) previously tested (*Biocca et al., 2011; Pochi et al., 2011*). Nevertheless, even with the strongest reductions of dust drift, some undesirable effects for honey bees may occur during their flight in and around contaminated areas due to the high sensitivity of these insects to neonicotinoids and fipronil (*Pochi et al., 2012*).

Table 1

Relative reductions of active ingredient emissions incited by prototype 2, with reference to the conventional drill

Active ingredient	Fixed point		Field
	Ground [%]	Air [%]	Air [%]
fipronil	92.1	95.0	93.6
thiamethoxam	90.6	88.2	98.6
clothiadinin	74.4	86.0	-25.3
imidacloprid	87.4	70.7	86.0

In the second article "*Comparing different techniques to assess the risk of dust drift from pesticide-coated seeds*", Dieter Foqué et al.,2017, we can see a lot of methods to assess the risk of dust drift.

The first techniques study by Forque was "Heubach test method" (The described method is intended to assess the amount of free floating dust and abrasion particles of treated seeds under defined mechanical stress conditions) and apparatus for this method is:

1. Analytical balance (accuracy 0.1 mg). As the last digit of a scale carries a larger error it is recommended to use a 5-decimal scale to achieve an accurate reading of the 4th decimal.

2 Heubach Dustmeter device (Heubach GmbH, Heubachstrasse 7, 38685 Langelsheim, Germany), 2.1 Metal rotating drum, 2.2 Glass cylinder, 2.3 Non-electrostatic filter housing with conditioned glass fiber filter disc (Whatman GF 92 or Macherey Nagel Type MN 85/70 BF, or equivalent specification), 2.4 Drive & control unit with touch screen control panel

3. Constant climate chamber (e.g. Binder, KBF 720)

4. Paper bags (not airtight)

5. Air ionizer (e.g. Sartorius, STAT-FAN YIB-01, or PRX U field ioniznER from Haug GmbH, Germany, or equivalent),

6. Seed Counter (e.g. Pfeuffer, Contador or GTA Sensorik, Marvin, or equivalent).

In opinion of Forqué it seems difficult to adapt the Heubach dust meter protocol and/or set-up in order to create an air flow equal to the air speed at the outlets of pneumatic drills or the observed wind speeds in field conditions. This should be done for every species individually, as the drift able fraction is not only influenced by particle size but also by particle density and shape, which are significantly different between species. It seems easier to assess the total amount of particulate matter abraded as a result of the physical stress of the drilling process and to determine its driftable fraction. The latter requires some knowledge of the envelope density and shape of the particles as a function of particle size.

In the second techniques "the individual sowing element set-up", represented in Figure 2, requires a higher initial investment, but it is the most realistic simulation of in-field dust drift generation and allows for quick and easy seed testing. Therefore, this set-up is most suitable for specialised labs and should be used for further research in this area. An inline particle sizing of the emitted dust could be incorporated in this set-up.

Fig. 2 - Individual sowing element set-up

1 – seed collector; 2 – sowing; disc; 3 – pre-fan cyclone; 4 – centrifugal fan; 5 – frequency converterhousing; 6 – air exhaust; 7 – post-fan cyclone

Based on the measurements present in Figure 3, where ZM-6 have the active ingredient Fludioxonil+metalaxyl-M+thiram and ZM-8, ZM-9, ZM-10 have the active ingredient Methiocarb+thiram in which both the pre- and post-fan cyclones they mounted, the efficacy of the small pre-fan cyclone was determined to be 99% for maize.

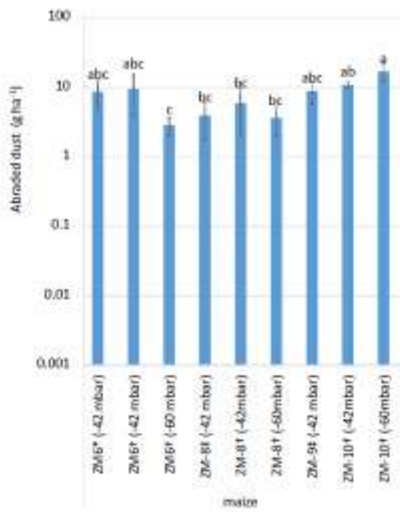

Fig. 3 - Amount of dust harvested from maize seed batches with the individual sowing element set-up *(mean±SD). Bars with a different letter label denote statistically significant differences (P <0.05). * Only a pre-fan cyclone at −42 mbar; † only a post-fan cyclone; ‡ combination of pre- and post-fan cyclone at −42 mbar*

In other study, it's used the method based on tests at a fixed point, presented in figure 4, with side wind artificially provided, seems reliable, reproducible and accurate. It appears suitable for testing the predisposition of sowing machinery to spread abrasion dust, as well as the contained chemicals and to verify the effectiveness of the devices aimed at reducing dust emissions. The method, through a proper data processing, also seems capable to provide a good estimation of the distribution of active ingredients at ground level that would occur in the field, under the same conditions of wind, travel speed and sowing density.

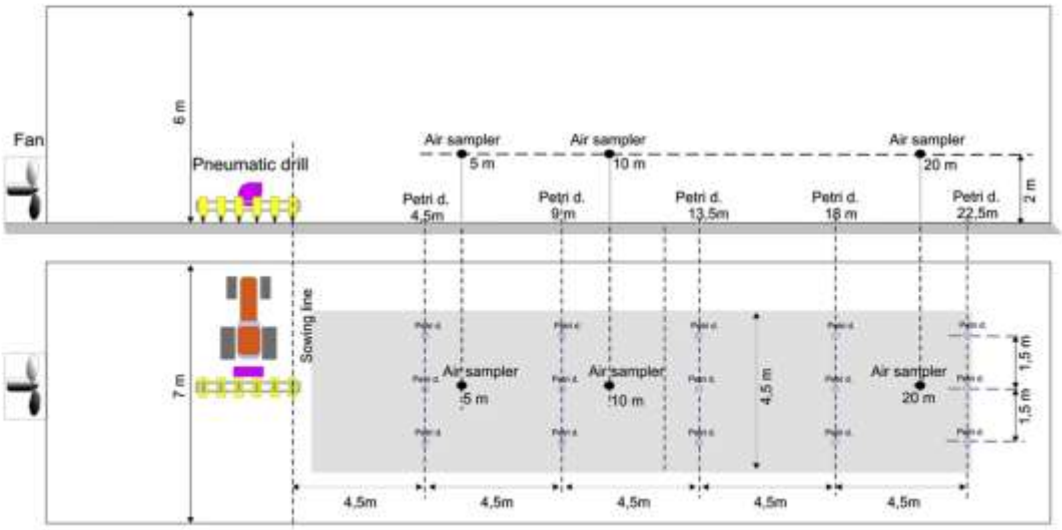

Fig. 4 - Layout of the static tests area.

The results of static test are presented in Figure 5, who shows the virtual pattern of dust drift (at ground level) resulting from the data at the fixed point processed as described in 2.6. The curves show the predicted dust deposition at ground level from 4.5 m to 72 m from the drill, in the hypothesis of 16 drill passages.

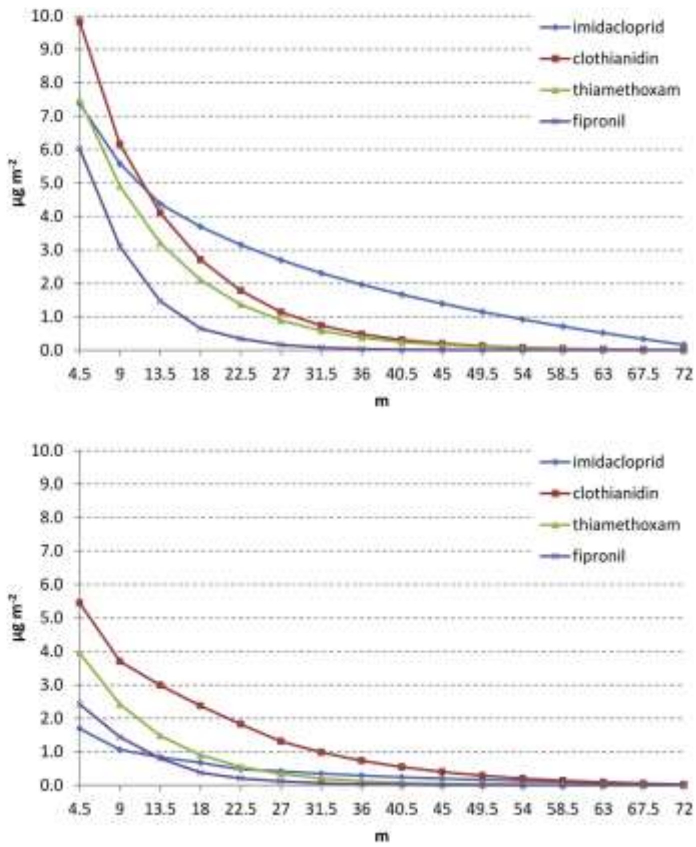

Fig. 5 - Prevision of the pattern of dust deposition from the results of static tests: conventional drill (up); drill with deflectors (down)

The prototype, with respect to the conventional drill operating with the same setting, exhibited a remarkable reduction of abrasion dust drift. The plots in Figure 6 show the comparison between drills in terms of concentrations of active ingredients at soil level (in the Petri dishes) an in the air (in the PTFE filters). The prototype exhibited an overall reduction of active ingredients emissions observed for the four active ingredients of 86%, at ground level, and of 85% in the air. In detail, the percentage reductions at ground level were: 74% for clothianidin, 92% for fipronil, 86% for imidacloprid and 91% for thiamethoxam.

As for the air concentrations, the reductions were similar: 86% for clothianidin, 95% for fipronil, 71% for imidacloprid and 88% for thiamethoxam. Figure 6 shows the values of the dry ground residues represented as concentration per surface area (μg m^{-2}); in the case of static tests these amounts are referred to the quantity of seed necessary for sowing a surface of 0.67 ha. According to the calculations proposed by Biocca et al., this data can be utilized to estimate the quantities that the drill will emit under field sowing conditions.

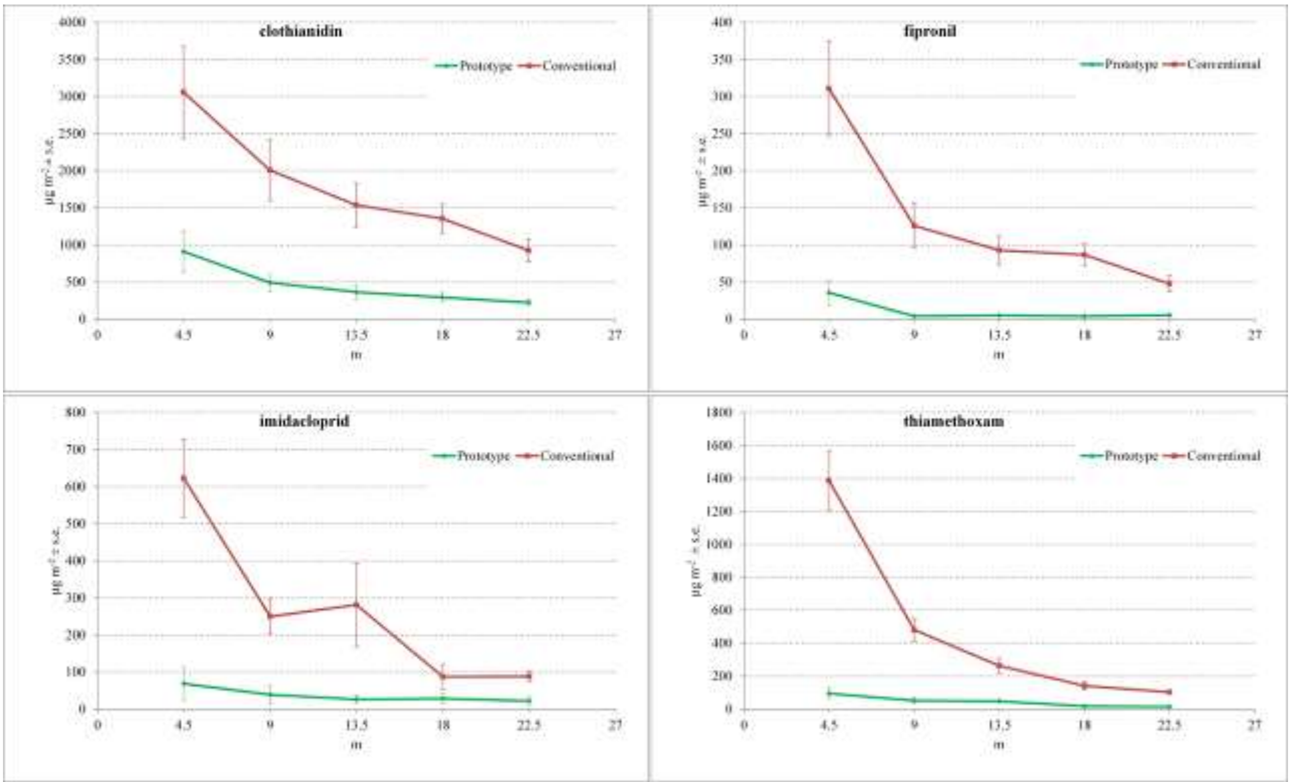

Fig. 6 - Comparison between drift values in the sampling area obtained with the conventional drill and the prototype. Values are expressed in terms of μg m^{-2} ± standard error.

CONCLUSIONS

This study contributes to finding a standardized method to verify the capability of drills to release abrasion dust during the sowing. The determination of the quantity of active ingredients (i.e., real amounts of active ingredients) expelled by the drills during the sowing, represents the starting point for further studies to define threshold value of drift that could allow the development of a drill evaluation system.

Further studies are necessary to improve the prototype and to study the exposure of the environment and of the operators during the dressed seed sowing.

Besides providing conclusions about good dust drift assessment techniques, this paper also provides advice to seed coating companies and regulatory bodies. Most dust was found at the bottom of the seed bags, which points towards dust generated during production and/or transport.

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ROLE OF SPRAYING AGAZONE AND ATONIK IN IMPROVING THE STORAGE ABILITY OF EGG PLANT (*SOLANUM MELONGEN* L.) HYBRIDS JAWAHER AND BARCELONA

/

دور الرش بالأكازون والأتونيك في تحسين القابلية الخزنية لثمار الباذنجان للهجينين جواهر و برشلونه

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***Keywords:** eggplant, agazone, atonik, total soluble solids*

ABSTRACT

The experiment was conducted in one of the greenhouses of the Agricultural Research Station, College of Agriculture, University of Basrah, during the growing season 2017-2018 in order to improve the storage behavior of eggplant fruits hybrids Jawaher and Barcelona*. Agazone at three concentrations (zero, 1.5, 3 ml L*$^{-1}$*) and atonik at three concentrations (0, 0.5, 1 ml L*$^{-1}$*) were prepared and the plants were sprayed in the early morning four times starting from 29/11/2017* with a two-week interval*. Fruits were harvested before maturity stage in the early morning and brought to the laboratory of storage technology, then cleaned and packed in perforated polyethylene bags (16 hole with a diameter of 5 mm per bag and weighed 2 kg per bag).*

Then the samples were stored at a temperature of 13°C for four weeks. Results indicated that the percentage of weight loss and the percentage of total soluble solids increased while the fruit firmness and the amount of vitamin C decreased with an increment of storage periods. The lowest percentages of the weight loss and the highest percentage of total soluble solids were in fruits treated with 3 ml L^{-1} *agazone.* Barcelona *fruits gave the highest fruit firmness, vitamin C, total soluble solids and lowest percentage of weight loss compared to Jawaher fruits.*

ABSTRACT

أجريت التجربة في إحدى البيوت البلاستيكية التابعة لمحطة البحوث الزراعية بكلية الزراعة جامعة البصرة خلال موسم النمو 2017-2018 من أجل تحسين السلوك التخزيني لثمار الباذنجان للهجينين جواهر وبرشلونه تم تحضير الأكازون بثلاثة تراكيز هي (صفر، 1.5، 3 مل .لتر-1) وتم تحضير الأتونيك بثلاثة تراكيز هي (صفر، 0.5، 1 مل .لتر-1) وتم رش النباتات في الصباح الباكرأربعة مرات ابتداء من 2017/11/29 مع فاصل زمني لمدة أسبوعين. تم جني الثمار في قبل وصولها الى مرحلة اكتمال التكوين في الصباح الباكر وجلبت الى مختبر تكنولوجيا التخزين نظفت وعبئت في أكياس البولي ايثلين مثقبة (16 ثقب لكل كيس قطر الثقب 5 ملم ويتسع الكيس الى 2 كغم ثمار). خزنت الثمار عند درجة حرارة 13 م° لمدة أسبوعين. أشارت النتائج إلى أن النسبة المئوية لفقدان الوزن ونسبة المواد الصلبة الذائبة ازدادت في حين أن صلابة الثمار وكمية فيتامين ج انخفضت مع زيادة فترات التخزين. وكانت أقل نسبة للفقد بالوزن وأعلى نسبة للمواد الصلبة الذائبة الكلية هي في الثمار المعاملة بالأكازون 3 مل .لتر-1 . سجلت ثمار الهجين برشلونه أعلى صلابة للثمار وأعلى كمية لفيتامين ج وأعلى نسبة مئوية للمواد الصلبة الذائبة الكلية وأقل فقد بالوزن مقارنة بثمار الهجين جواهر.

INTRODUCTION

Eggplant (*Solanum melongena L.*) is one of the most important vegetable crops in Iraq, which belongs to Solanaceae family of more than 75 species and 2,000 plant species spread around the world (*Chouhury, 1976*). India and China are the original home, growing wild since old time (*Christman, 2003).*

Each 100g of fresh eggplant fruit contains 92.4 g water, 1.2 g protein, 5.6 g carbs, 0.2 g fat, 0.9 g g fiber and 25 calories (*Al-Dagawi, 1996*). Eggplant is known for its medicinal properties as it is used to treat many diseases such as asthma. It has also been found to have a high ability to rid the body of free radicals and protect against oxidation of fat (*Noda et al*., 2000). Potassium salts found in the fruit are helping to release fluids from the body (*Jorge et al., 1998*).

The new orientation in agriculture is to move away from the use of chemical fertilizers, chemical growth regulators and pesticides of different kinds and composition, because of their toxic effects on human and animal organisms. Therefore, researchers in agriculture have tended to find safer materials such as bio stmulator. Agazone is a natural liquid extract of algae *Ascophyllum nodosum*, a brown seaweed belonging to the Fucaceae family, located on the northwestern coasts of Europe and the northeastern coasts of North America. It has long been used as organic fertilizer for many crop varieties because of its major nutrient content

(NP; K, Mg; S; Mn; Cu; Fe; Zn;) It also contains cytokines, Auxins, gebrilins, organic acids, sugars, amino acids and proteins. Atonic is a synthetic bio stmulator. The studies have the effect of encouraging vegetative growth and increasing the quality of the plant as it is used to increase the vital activities in the plant and without any toxicity or deformation of the plants used in it (*Grajkowski, and Ochmian, 2007*) and it is a substance free of collateral damage to humans or animals By the Environmental Protection Agency (EPA).

The organization of the supply of the fruits of this crop in the local markets and the increase in the duration of its presentation in fresh condition and high quality of consumption requires the improvement of the storege ability of the fruits if we take into account the weakness of storage behaviour of fruits because of the high water content and thus infected with the mold, especially gray mold, black mold and mildew (*Silier, 2009*) in addition to lose weight ,so the storage considers an active method used to try to keep the fruits fresh as long as possible and this process requires storing fruits at temperatures above 10 °C because the fruits sensitive to Chilling Injury (*Shirokov, 1988*).

Due to the lack of studies related to using bio stemulators, especially agazone and atonik, in improving storage ability of eggplant fruits hybrids Jawaher and Barcelona, the present study was conducted.

MATERIAL AND METHOD

The experiment was carried out during the 2017-2018 season in one of the greenhouses of the Agricultural Research Station / Faculty of Agriculture / Basrah University / Karma Ali site, in order to study the effect of pre-harvest spraying agazone and atonik in storage ability of eggplant hybrids Jawaher and Barcelona grown in plastic greenhouses.

The seedlings were planted in the plastic house on 12/10/2017 and all the processes using in the production of this crop grown in plastic greenhouses were conducted. Solutions of agazone with three concentrations (0, 1.5, 3) ml L^{-1}, and atonik with three concentrations (0, 0.5, 1) ml L^{-1} were prepared and the plants were sprayed in the early morning four times starting from 29/11 /2017, with a time interval of 30 days from the date of planting for the first spray and the operation returned after 14 days.

Fruits were harvested before reaching the maturity stage in the early morning and brought to the laboratory of storage technology, then cleaned and left to dry at room temperature. All the fruits were packed in perforated polyethylene bags (16 hole with a diameter of 5 mm per bag and weighed 2 kg per bag), and then stored at the temperature of (13°C) for two weeks. Fruit firmness (kg·cm^{-1}) determined by using fruit pressure instrument, the weight loss was calculated as a percentage, Vitamin C (mg / 100 g) determined according to *A.O.A.C. (1992).* Total soluble solids determined by using hand refractometer and the results were corrected to 20 ºC.

Experiment was carried out as factorial experiment consisting of three factors: spraying with agazone and atonik, two hybrids of eggplant Jawaher and Barcelona and storage period, using Complete Rondomize Design (CRD) with 3 replicates. The results were statistically analyzed using the statistical program Genstat. The mean differences were compared by using the least significant difference (L.S.D) test at the probability level of 0.05 (*Al-Rawi & Khalf Allah 1980*).

RESULTS

Fruit firmness (kg·cm^{-1}) The results presented in Table 3 showed the effect of hybrids, spraying treatments with agazone and atonik and storage period and their interaction on fruit firmness (kg·cm^{-1}) stored at 13°C. The results indicated that the fruit firmness increased with an increment of storage periods till reached (4.149 kg·cm^{-1}) after two weeks of storage.

The highest amount of fruit firmness was in Barcelona fruits which recorded (3.741 kg·cm^{-1}) . As for the effect of spray treatments, results showed that the highest amount of fruit firmness was in fruits of with 3 ml L^{-1} agazone which recorded (4.149 kg·cm^{-1}) while the lowest amount of fruit firmness was in untreated fruits that gave (2.997 kg·cm^{-1}).

The results also showed a significant interaction between hybrids and spraying treatments with agazone and atonik . The highest amount of fruit firmness was in the fruits of Barcelona plants sprayed with 3 ml L^{-1} agazone which was (4.378 kg·cm^{-1}) whereas the lowest amount of fruit firmness was in the untreated fruits of Jawaher plants that recorded (2.990 kg·cm^{-1}).

The Table also showed the significant interaction between the spraying treatments and the storage period. The highest amount of fruit firmness was in fruits of 3 ml L^{-1} agazone which was (5.005 kg·cm^{-1}) after two weeks of storage, while the lowest amount of fruit firmness was in untreated fruits after a week of storage which was (2.413 $kg\cdot cm^{-1}$). As for the interaction between hybrids and storage periods, the results showed that the highest amount of fruit firmness was in Barcelona fruits after two weeks of storage which gave (4.234 $kg\cdot cm^{-1}$), while the lowest amount of fruit firmness was in Jawaher fruits after a week of storage which was (3.019 $kg\cdot cm^{-1}$).

The interaction between hybrids, spraying treatments and storage periods, the highest amount of fruit firmness was in the fruits of Barcelona plants sprayed with 3 ml L^{-1} agazone after two weeks of storage which was (5.353 $kg\cdot cm^{-1}$).

As previously mentioned, spraying of eggplant with agazone, increased the fruit firmness. That might be due to the content of agazone from gibberellins and Auxins which inhabited the activity of ethylene and thus, delayed the ripening of fruits (*Mitra, 1997*).

Table 1

Effect of hybrids, spraying agazone and atonik, storage period and the interaction among them on fruit firmness ($kg\cdot cm^{-1}$) of eggplant fruits stored at 13 °C

Hybrids	**Treatments (ml L^{-1})**	**Storage period (week)**				**Hybrids × treatments**
		1		2		
Jawaher	Control 0	**2.423**		**3.557**		**2.990**
	Agazone 1.5	**3.197**		**4.142**		**3.653**
	Agazone 3	**3.450**		**5.005**		**4.053**
Barcelona	Atonik 0.5	**2.857**		**3.737**		**3.297**
	Atonik 1	**3.170**		**4.267**		**3.713**
	Control 0	**2.403**		**3.603**		**3.003**
	Agazone 1.5	**3.150**		**4.173**		**3.662**
	Agazone 3	**3.403**		**5.353**		**4.378**
	Atonik 0.5	**2.903**		**3.763**		**3.333**
	Atonik 1	**3.270**		**4.277**		**3.773**
						Means of hybrids
Hybrids × storage period	Jawaher	**3.019**		**4.063**		**3.430**
	Barcelona	**3.026**		**4.234**		**3.741**
						Means of treatments
Treatments× storage period	Control 0	**2.413**		**3.580**		**2.997**
	Agazone 1.5	3.173		4.142		3.657
	Agazone 3	3.427		5.005		4.216

	Atonik 0.5	2.880		3.750		3.315
	Atonik 1	3.220		4.267		3.743
Means of storage period		3.023		4.149		
RLSD 0.05						
Hybrids **0.1583**	treatments **0.2502**	storage period **0.1583**	hybrids× treatments **0.3539**	hybrids× storage period **0.2238**	treatments× storage period **0.3539**	hybrids× treatments× storage period **0.5005**

Weight loss percentage. Date presented in Table 2 showed the effect of hybrids, spraying treatments with agazone and atonik and storage period and their interaction on the percentage of weight loss of eggplant fruits cvs. Jawaher and Barcelona stored at 13°C. The results indicated that the percentage of weight loss increased by increasing the storage period reached to 8.842% after two weeks of storage.

As for the effect of spraying treatments, the lowest percentage of weight loss was in fruits treated with 3 ml L^{-1} agazone which reached 3.399% with significant difference with the rest treatments. The lowest percentage of weight loss was in Barcelona fruits which recorded (6.490%).

The results of the same table showed a significant difference between hybrids and the spray treatments. The lowest percentage of weight loss was in fruits sprayed with Barcelona plants sprayed with 3 ml L^{-1} agazone which was 3.211%. The highest percentage of weight loss was in untreated fruits of Jawaher hybrids which reached to 9.673%.

Regarding the correlations between hybrids and storage periods and the correlations between spraying treatments and storage periods, the lowest weight loss percentages (**4.402**%, **2.293**%) were in Barcelona hybrid and in untreated fruits after two weeks of storage respectively.

In regard to triple interaction, the highest the highest amount of fruit firmness was in the fruits of Jawaher plants sprayed with 3 ml L^{-1} agazone after one weeks of storage which was **2.273**%.

As previously mentioned, spraying with agazone and atonik, reduced the weight loss percentage of eggplant. The effect of agazone and atonik on the reduction of weight loss may be due to the fact that they contain Auxins, cytokines and gebrilins, which have a role in inhibiting the production of ethylene gas, reducing the respiration rate of fruits, maintain the permeability of cellular membranes and reduce the loss of food stored in fruits (*Wang et al., 1996*).

As for the effect of the storage period, the results indicate to an increase in the percentage of weight loss by increasing storage period. This is due to the reduction of weight of the fruits as the storage period progresses, resulting in loss of the water content of the fruits while the storage period continues, as well as the consumption of the food stored in the fruit as a result of breathing. These finding are in the accordance with those previously reported by *Taain et al. (2007)* for Super Maramond tomato cultivar.

Table 2

Effect of hybrids, spraying agazone and atonik , storage period and the interaction among them on fruit weight loss (%) of eggplant fruits stored at 13 ° C

Hybrids	**Treatments (ml .L^{-1})**	**Storage period (week)**				**Hybrids × treatments**
		1		**2**		
Jawaher	Control 0	**7.033**		**12.313**		**9.673**
	Agazone 1.5	**4.110**		**9.203**		**6.657**

	Agazone 3	**2.273**		**4.900**		**3.587**
Barcelona	Atonik 0.5	**5.823**		**10.570**		**8.197**
	Atonik 1	**3.500**		**7.433**		**5.467**
	Control 0	**6.987**		**12.353**		**9.670**
	Agazone 1.5	**4.040**		**9.370**		**6.705**
	Agazone 3	**2.312**		**4.110**		**3.211**
	Atonik 0.5	**5.400**		**10.557**		**7.978**
	Atonik 1	**3.273**		**7.610**		**5.442**
						Means of hybrids
Hybrids × storage period	Jawaher	**4.548**		**8.884**		**6.827**
	Barcelona	**4.402**		**8.800**		**6.490**
						Means of treatments
Treatments× storage period	Control 0	**7.010**		**12.333**		**9.672**
	Agazone 1.5	**4.075**		**9.287**		**6.681**
	Agazone 3	**2.293**		**4.505**		**3.399**
	Atonik 0.5	**5.612**		**10.563**		**8.088**
	Atonik 1	**3.387**		**7.522**		**5.454**
Means of storage period		**4.475**		8.842		
RLSD 0.05						
hybrids	treatments	storage period	hybrids× treatments	hybrids× storage period	treatments× storage period	hybrids× treatments× storage period
0.1835	**0.2902**	**0.1835**	**0.4104**	**0.2596**	**0.4104**	**0.5804**

Vitamin C (mg 100 g^{-1}). Table 3 showed the effect of hybrids, spraying treatments with agazone and atonik and storage period and their interaction on the amount of vitamin C for eggplant fruits stored at 13°C. The results indicated that the amount of vitamin C decreased with the continuation of storage period reached to 4.29 mg. 100 g^{-1} after two weeks of storage. Results showed that there were no significant effect of spraying treatments with agazone and atonik on the amount of vitamin C. The highest percentage of amount of vitamin C was in Barcelona fruits which recorded (4.87%).

In regard to Binary interactions, there were significant differences between factorial treatments, the highest value of vitamin C was in Barcelona fruits sprayed with 1.5 ml. L^{-1} agazone which recorded 5.08mg 100 g^{-1}. The lowest amount of vitamin C was in Jawaher fruits sprayed with 1.5 ml L^{-1} agazone, which reached to 3.76mg 100 g^{-1}.

The table also showed the significance of the interaction between the spray treatments and the storage period. The highest vitamin C value was in the fruits of the 3 ml L^{-1} agazone spray after a week of storage, which was 5.40 mg 100 g^{-1}, while the lowest value of vitamin C was in fruits of 0.5 ml L^{-1} atonik spray after two weeks of storage, which was 4.12 mg 100 g^{-1}.

The highest value of vitamin C in Barcelona fruits after a week of storage was 5.08 mg 100 g^{-1}. The lowest value of vitamin C was in Jawaher fruits after two weeks of storage, which amounted to 4.18 mg 100 g^{-1}. In regard to triple interaction, the highest value of vitamin C was in was in Jawaher fruits sprayed with 3 ml L^{-1} agazone after a week of storage which amounted 5.5018 mg 100 g^{-1}, wheras the lowest amount of vitamin C was in was in Jawaher fruits sprayed with 1.5 ml L^{-1} agazone after two weeks of storage, which amounted to 3.42 mg 100 g^{-1}.

The reason for decreasing the vitamin C with the continuation of storage period may be due to the continuation of vital processes and increased the activity of ascorbase and oxidase with the continuation of storage period and to the oxidation of vitamin C to dehydroascorbic acid. This is in agreement with *Taain (2011)* for jujube fruits cv. Tufahi.

Table 3

Effect of hybrids, spraying agazone and atonik , storage period and the interaction among them on vit. C (mg 100 g^{-1}) of eggplant fruits stored at 13 ° C

Hybrids	**Treatments (ml L^{-1})**	**Storage period (week)**				**Hybrids × treatments**
		1		2		
Jawaher	Control 0	5.00		4.60		4.80
	Agazone 1.5	4.10		3.42		3.76
	Agazone 3	5.50		4.43		4.96
Barcelona	Atonik 0.5	5.46		4.30		4.88
	Atonik 1	4.96		4.16		4.56
	Control 0	4.96		4.66		4.81
	Agazone 1.5	5.26		4.90		5.08
	Agazone 3	5.30		4.18		4.74
	Atonik 0.5	4.66		3.94		4.30
	Atonik 1	5.23		4.33		4.78
						Means of hybrids

Hybrids × storage period	Jawaher	5.00		4.18		4.46
	Barcelona	5.08		4.40		4.87
						Means of treatments
Treatments× storage period	Control 0	4.98		4.63		4.80
	Agazone 1.5	4.68		4.16		4.42
	Agazone 3	5.40		4.30		4.85
	Atonik 0.5	5.06		4.12		4.59
	Atonik 1	5.10		4.24		4.67
Means of storage period		5.04		4.29		
RLSD 0.05						
hybrids 0.393	treatments N.S	storage period 0.393	hybrids× treatments 0.879	hybrids× storage period 0.556	treatments× storage period 0.879	hybrids× treatments× storage period 1.244

Percentage of total soluble solids (T.S.S). Results presented in Table 4 showed the effect of hybrids, spraying treatments with agazone and atonik and storage period and their interaction on total soluble solids of eggplant fruits stored at 13°C. Results showed that the percentage of total soluble solids increased up to 6.81% after two weeks of storage.

The increment in the percentage of total soluble solids may be due to the reduction of moisture content of fruits with the continuation of storage periods, as the storage period progresses, the lower moisture content of the fruit increases the concentration of the cell juice of the fruit and thus increases the percentage of soluble solids *(Burton, 1982).* Obtained results are in agreements with *Taain (2005)* for date pale fruits cv. Barhi.

The highest percentage of TSS was in Barcelona fruits which recorded 6.55% with significant differences with Jawaher fruits which recorded the lowest percentage of TSS. (6.25%). In regard to treatments, the highest percentage of TSS was in fruits with 3 ml L^{-1} agazone which gave 7.13%.

The content of agazone on gibberellins and cytokines, which increased the area of leaves leaded to increase the efficiency of photosynthesis, which provides the largest amount of food produced to fruits and increase the content of chemical components *(Stern, 2008)* and this result in agreement with Maliki (2012) in his study on the effect of spraying with terasporp and kilpac on growth and yield of eggplant and Zodape *et al.* (2011) in their study on spraying tomato plants with *Alvarezii Kappaphycus* extract.

In regard to Binary interactions, the highest percentage of TSS was in fruits of Barcelona hybrid plants sprayed with 3 ml L^{-1} agazone which gave 7.15%, while the lowest percentage of TSS was in untreated Jawaher fruits which gave 4.97%. The highest percentage of TSS was recorded in fruits with 3 ml L^{-1} agazone which gave 7.48% after two weeks of storage, while the lowest percentage of TSS was in control fruits after one week of storage which recorded 4.65%.

In regard to triple interaction, the highest percentage of TSS was in in fruits of Barcelona hybrid plants sprayed with 3 ml L^{-1} agazone after two weeks of fruits, which amounted to 7.59 %.

Table 4

Effect of spraying with licorice extract , postharvest treatments and storage period on TSS (%) of eggplant fruits stored at 13 °C

Hybrids	Treatments (ml L^{-1})	Storage period (week)				Hybrids × treatments
		1		2		
Jawaher	Control 0	4.74		5.20		4.97
	Agazone 1.5	6.18		7.14		6.66
	Agazone 3	6.84		7.37		7.11
Barcelona	Atonik 0.5	6.03		6.71		6.37
	Atonik 1	6.26		7.15		6.71
	Control 0	4.56		5.55		5.06
	Agazone 1.5	6.32		7.19		6.75
	Agazone 3	6.72		6.79		7.15
	Atonik 0.5	5.91		7.01		6.46
	Atonik 1	6.30		7.24		6.77
						Means of hybrids
Hybrids × storage period	Jawaher	**6.01**		6.71		6.25
	Barcelona	5.96		6.91		6.55
						Means of treatments
Treatments× storage period	Control 0	4.65		5.37		5.01
	Agazone 1.5	6.25		7.16		6.71
	Agazone 3	6.78		7.48		7.13
	Atonik 0.5	5.97		6.86		6.41

	Atonik 1	6.28		7.19		6.74
Means of storage period		5.99		6.81		
RLSD 0.05						
hybrids 0.146	treatments 0.232	storage period 0.146	hybrids× treatments 0.328	hybrids× storage period 0.207	treatments× storage period 0.328	hybrids× treatments× storage period 0.464

CONCLUSIONS

The results obtained in the present work clearly indicated to the role of spraying agazone and atonik in improving storage ability of eggplant fruits hybrids Jawaher and Barcelona stored at 13°C for four weeks. Obtained results indicated that The lowest percentages of the weight loss and the highest percentage of total soluble solids were in fruits treated with 3 ml L^{-1} agazone. Barcelona fruits gave the highest fruit firmness, vitamin C, total soluble solids and lowest percentage of weight loss compared to Jawaher fruits.

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ANALYSIS OF TECHNIQUE CURRENT STAGE IN THE FIELD OF SORGHUM PRESSING EQUIPMENT DESIGNED TO PRODUCE THE RAW JUICE NECESSARY TO OBTAIN THE BIOETHANOL

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ANALIZA STADIULUI ACTUAL AL TEHNICII IN DOMENIUL ECHIPAMENTELOR PENTRU PRESAREA SORGULUI IN VEDEREA PRODUCERII SUCULUI BRUT NECESAR PRODUCERII DE BIOETANOL

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Keywords: *sorghum, bioethanol, press, equipment.*

ABSTRACT

The paper presents the technique current stage in the field of equipment designed to produce the juice from sweet sorghum. Therefore, it is of great importance to know the technology and pressing parameters for establishing the optimum functional and constructive solution for one new equipment, that will be used in this purpose.

REZUMAT

In lucrare este prezentat stadiul actual al tehnicii in domeniul echipamentelor pentru producerea sucului din suc zaharat. Analiza acestora are drept scop cunoasterea tehnologiei si parametrilor de presare in vederea stabilirei solutiei optime functionale si constructive a unui nou echipament ce va fi utilizat in acest scop.

INTRODUCTION

Topical interest theme

During this period of human evolution, ensuring the energetic safety represents an essential element of great concern in research activity. A forefront place is represented by the biomass energy. The internal combustion engines have the highest energy consumption and use approximately 35% out of the total amount of energy resources and, generally, are supplied with gasoline or diesel oil. Taking into account the energetic crisis, the reduction of oil resources and air pollution, researches were made for finding out a viable fuel able to replace the traditional fuel. Thus, bioethanol is of a great interest in this field.

Description of research current situation and identification of research issues

Since 1908, when Ford Company in US began to manufacture motor cars, the researches performed aimed at the supplying of these cars with gasoline, ethanol or a mixture of both. At the present moment, at world level, the most important manufacturers are USA and Brazil. After 1970, the wide scale ethanol production began in the whole world.

Teams of researchers from USA, (Lowus S.O., Devote R.S., Maiorella B.I., Turon M, Brasil (Carlos Coelho de Carvalho Neto, Goldemberg I. I.), Germany (Schaffrath M.) have studied and tested the performances of engines fed with biofuel: their starting capacity, energetic and economic parameters, exhaust gas chemical composition. Utilization of biofuel mixed with gasoline in a percentage up to 15…20 %, practically presents similar energetic and economic performances (engine power, fuel specific consumption), to clean gasoline feeding. At the same time, CO concentration within the exhaust gases at engines supplied with mixture of monoatomic alcohol and gasoline is smaller than at gasoline fed engines, due to increment of combustion efficiency of biofuels (*Weller, 2007; Goel, 2015*).

In Romania, (*Manea Gh., Georgescu M., Apostolache N., Sfinţeanu D., Borta V.M., Segal B., Anghelache I.*) have confirmed the results obtained by researchers from USA, Brasil, Germany. As a conclusion, methanol should be used for obtaining the esters aiming to improve the gasoline propreties.

The ethanol can have the smallest price when it is produced from sugar cane and sweet sorghum. Therefore, the researchers from Romania (Goian M., Antohe I.), Italy (Giuliano Grassi, Pietro Moncada, Henri Zibetta), Republic of Moldova (Moraru Gh.) studied the possibility of cultivating and processing the sweet sorghum and the most suitable technologies for climate and soil conditions in Southern Europe. The preliminary results obtained have shown the efficiency of cultivating saccharate sorghum for obtaining alcohols. At the same time, a series of specific technical, economic and environment features, were emphasized, for which a scientifically argued approach is necessary.

The most common mixture of ethanol and gasoline is made of 90% gasoline and 10% ethanol. This mixture was approved by each American car manufacturer for each model that uses an engine fed with gasoline (*Growth Energy, 2009*). In a model which the engine was modified, pure ethanol can better operate than pure gasoline (*RFA, 2009*).

Recently, many researches were made at the State University of Oklahoma (OSU) on obtaining ethanol from sweet sorghum. Sweet sorghum is an attractive biofuel, because it can be cultivated in fields inappropriate to corn growing. Lee McClune developed a process for producing ethanol from sweet sorghum. This process comprises two stages, namely sorghum harvesting and obtaining the juice directly in the field.

Juice extraction in field and its fermentation on the spot are methods used by McClune process for preventing the juice degradation. Juice extraction in field is performed with the sweet sorghum harvest patented by *McClune (2008). McClune* also offered to OSU researchers a small sorghum press for tests involving the sweet sorghum pressing in field.

The main arguments for supporting the extent of sccharate sorghum cultures and industrialization in Romania, are:

• Making more efficient the non-exploited or less efficient large agricultural surfaces through massive sorghum crops and thus, enabling the creation of new employments;

• Cultivation of sorghum can produce large quantities of biomass (80-120 t/ha) with 15-30% sugar content (5-7 t sugar/ha), renewable raw material for chemical industry, petrochemical industry, agriculture, food industry, pharmaceutical industry and others.

• By total industrialization of sorghum, the following can be obtained: bioethanol (biofuel for means of transport, mobile and fixed farm equipment), syrup, vinegar and drinkable alcohol, cellulose and paper, acetic acid and ethylene, natural fibers, vegetal proteins, livestock fodder, etc.;

• Biofuel produced from sorghum is ecological, enabling to reduce the emissions of carbon dioxide as main source of greenhouse effect at which the terrestrial atmosphere is submitted lately;

According to technical and economic estimations, in Romania it would be possible to obtain bioethanol from sweet sorghum based on traditional technologies, at a total price below 200 euros per ton, including the duties, transport cost, commissions, etc., as a competitive prize on European market, in case of obtaining a production of about 5 tons ethanol per hectare.

Material pressed can be also used for obtaining cellulose. Sorghum cellulose is of similar quality to hardwood cellulose (inferor species) designed to produce cellulose. Production of bleached cellulose per hectare of sweet sorghum is cheaper and 2.5-3 times bigger than the usual one per hectare of forest. Therefore, it is almost compulsory to rapidly develop the technologies and technical methods of high efficiency for harvesting, processing and burning the products obtained.

MATERIAL AND METHOD

Presentation of current stage of this domain, specialty literature analysis

Sweet juice has been well known as an excellent source for sugar (NAS,1882), being easily fermented and distilled to fuel high quality ethanol (*Cardno, 2008; Neale, 2008; Sabater, 2008; Zenk, 2008*). Main factor that preserves the sweetness of sorghum comparing to corn, as a fuel crop, is the lack of method of production established (*Neale, 2008; Robinson, 2007*). Mechanical harvesting of sweet sorghum requires a specialized harvesting equipment, able to take out the saccharate juice from the stems, in field (*McClune, 2008a*) or a modified machine for harvesting sugar cane and a pressing installation close to it (*Hugot, 1986*). The juice should be rapidly moved into a fermentation installation for preventing its degradation.

Patents analysis

Due to resemblances between sweet sorghum and sugar cane, the improvements performed at the roller press for sweet sorghum were the result of the assessment of sugar producing technology.

1. US Pat. 5273512: Core feed roll

This design of rollers uses an external semi- smooth housing, juice channels under the carcass and detachable notch insertions that cover the holes from external housing, leading to juice channels (*Ducasse, 1993*). *Ducasse (1993)* designed this roller associated to another roller of similar design in order to "force the stems to pass trough the rollers.

2 US Pat. 3969802: Mill Roll *Bouvet (1976)* specified he improved the basic roller with grooves including a channel system under the rollers surface and holes leading to them. This aimed at reducing the reabsorption of juice in sorghum stem.

3 US Pat. 4391026: Mill Roll

Researches performed by *Casey and Ducasse (1983)* were similar to those belonging to *Bouvet (1976).* Their design comprises V-shaped grooves, juice channels and holes leading to juice channels(Casey and Ducasse, 1983). Once again, it was aimed at decreasing the juice reabsorption in sugar cane or sorghum.

4 US Pat. 4546698: Pressing roller with increased capacity of juice flowing.

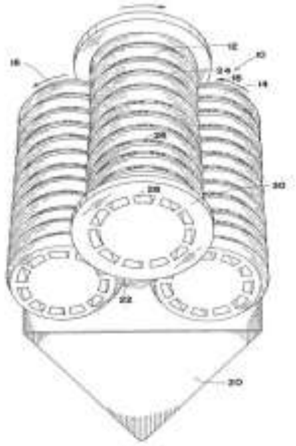

Fig. 1 – Pressing roller system of Bouvet type

Figure 1: For pressing rollers with V thickness channels and inner juice channels (*Bouvet, 1985*) Bouvet (1985) designed a pressing roller with juice tubes on its surface and holes leading to these channels (tubes), as it is shown in Figure 1. This roller was different from the previous models, (*Casey and Ducasse, 1983; Bouvet, 1976*) because the juice channels had a spiral configuration comparing to roller axis.

5. US Pat. 4989305: Sugar cane cylinder. Pol and Dhavlikar (1991) have underlined the importance of designing a cylinder with a series of machines endowed with juice channels on the surface of a grooved roller. This design presented holes in outer surface punched in multiple angles leading to juice channels [9].

6. US Pat. 4407111: Syrup extractor for Infield Mobile. Brune and Schmidt (1983) designed a press working in the field and which comprises two crushing rollers and a three rolling mills. Crusher rollers were similar to those designed by Ducasse (1993), excepting the fact that both rolls had proeminent flanges and round surfaces resembling to Krajewski crusher (*Hugot, 1986*). The three rolling mills comprise two lower rollers and one bigger roller. The front roller and the upper roller are endowed with grooves, and the lower roller was described as being smooth (Brune and Schmidt, 1983).

7. US Pat. 4168660: Sugar Mill. Zelle (1979) designed a mill with four rolls with V- shaped radial grooves. Rollers are arranged so that one is in front, two are placed in centre one above other and another rear roller(Zelle, 1979). Material is vertically introduced at the upper part.

8 .US Pat. 6039276: Apparata and methods of crushing the sugar cane Hatt and all. (2000) designed a sugar mill comprising sets of two grooved rollers, which holes are one above other. They were arranged so that to allow the sugar cane vertical movement downwards through the press.Rollers are equipped with V-shaped radial channels, cut in their surfaces.. This design presents a detachment system for removing the material blocked in rollers grooves.

9. US Pat. 0274238A1: Mobile installation for sorghum press. It consists in a mobile harvesting process in field and processing the sugar crops, such as sweet sorghum. Beneficiary: LeeMax, LLC, Shawnee, (USA). It comprises the crop cutting, stems pressing, for final pressing being used a screw press.

Presentation of sorghum pressing equipment

Within the capitalization of saccharate sorghum energy potential, squeezing the crude juice represents an important stage. The technological line is designed to squeeze juice from crushed stems of sorghum (fig. 2) ensures the storage, dosing and raw material feeding by means of conveyors, the juice being squeezed in roller pressing systems, afterwards being evacuated together with waste into transport means.

1. **Mecagro Company from Basarabia** achieved one high performance equipment for pressing the sorghum juice. The pressing block (Figure 2) includes the recipient bin 1, block 2 with 2 feeding rollers that

crush the stems, conveyor 3, pressing block with 4 rollers, the gearmotor 5, control system 6. Within the pressing block, the upper roller is placed on two bearings 7, each of them being installed on two vertical guiding rods. At bearings upper part 7 act the disk-springs, which tightening is set by nuts 8. Each of the lower rollers is mounted on two bearings 9, at their turn, mounted on horizontal guiding rods 10. The distance between rollers is set by moving the lower rollers on guide rod by means of screw mechanisms 11. Speed of pressing rollers is set by changing the gear reduction rate and electric current frequency from the inverter. The juice squeezed is collected in recipient 12, from where, by means of a pump13, it is emptied(*Cerempei, 2012*).

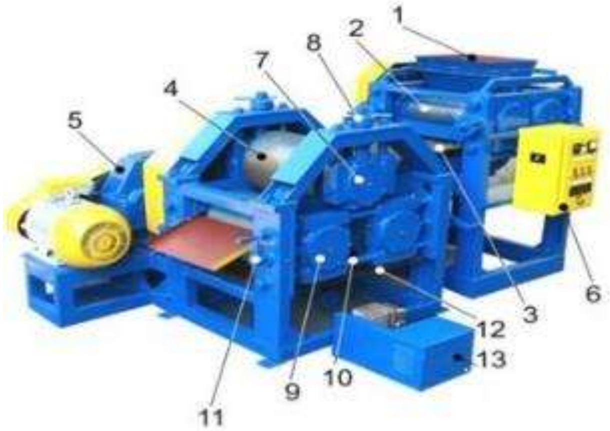

Fig. 2 - Installation ITA „Mecagro" for sweet sorghum processing

2.**Kamdhenu Agro Machinery Wathoda Company, Nagpur, Maharashtra, India, manufactures** a press with 3 rollers.

Fig. 3 – Sorghum press with three rollers

Technical characteristics.

Roller diameter=254 mm, driving system- electric engine of 25 HP, pressing capacity=2200 kg/hour**.**Variant -5.5 HP.

3.PATEL MANUFACTURIN COMPANY-, Gujarat, India, **manufactures the press with 5 cylinders (rollers), model Double Mill Sugar Cane Crusher**

Fig. 4 – Sorghum press with 5 rollers

Technical characteristics

Roller diameter =267 mm, length 270 mm., speed 240 rot/min, driving system- 40+20+3=63 HP. Pressing capacity 2750-2950 kg/hour.

4. **TINYTECH PLANTS** Company Tagore Road, Near Bhaktinagar Station, Rajkot - 360002, Gujarat, India, produces a press with 3 cylinders (rollers), model Model Sugarcane Crushers Gear Box.

Fig. 5 – Sorgum press with 3 rollers

Technical characteristics:

Roller diameter =260 mm, length 280 mm, engine power=20 HP, rollers speed=9 rot/min. Capacity 1600 kg/h.

5.**Penagos-Columbia Company manufactures the model** SUGAR CANE MILL TH [10]

Fig. 6 – Sorgum press with 3 rollers

Technical characteristics:

Productivity 600-800 kg/h, electric engine power-6 HP, roller speed-12 rot/min, rollers diameter -16 inch,capacity of extraction 55-60% according to quantity of stem fibers.

RESULTS

Theoretical presentation of constructive and kinematic parameters of presses endowed with sorghum pressing rollers.

Based on constructive analysis of existing technologies and equipment designed to extract the juice from saccharate sorghum stems, the option of roller presses for squeezing the juice from sorghum stems is justified and its basic parameters that enable the production of high raw juice quanities, are presented. Thus, alcohols and other products are obtained.

Driving the stems between rollers

Extraction of juice from sweet plants stems is frequently performed by pressing the matter between two rollers with equal diameters and speed. Scheme of this pressing method is shown in Figure 7. The layer of raw material with initial thickness *h*, is pressed until it reaches the thickness *s*, equal to rollers space value. According to (*Cerempei V., 2012*), forces with which the rollers act on stems layer for each area are led perpendicularly to the contact surface and can be reduced at a resultant force ***P.*** Decomposing this force in two perpendicular directions of material compression and, respectively, of its displacement, we obtain the components ***Py*** (compresses the material) and ***Px*** (pushes the material). At the same time, the friction forces act on material, tangentially to rollers surface, presented by resultant ***F***.

After decomposing the resultant force ***F**, we* obtain the components ***F*x**, that drives the material between rollers and ***F*y** that enables the material pressing.

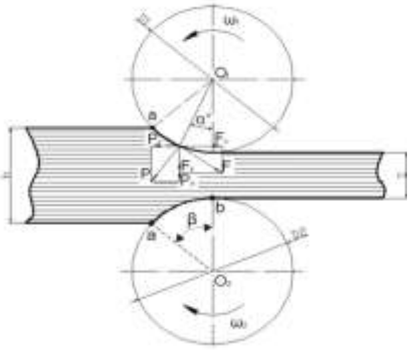

Fig. 7 – Scheme of applying the forces on the material pressed

After thoroughly studied the pressing process, it is obvious that, when rollers approach, the gap is diminished and the contact angle α icreases (if thickness remains constant ***h=const*.)** and point of applying the force **P** moves away from the centre line ***O1O2***. This leads to an increment of component ***P*x** from ***P*y.** When force ***P*x** surpasses the friction force component *F*x the roller begins to skid and material movement is stopped (*Cerempei, 2012*).

As it results of those above, the condition of driving the material between rollers is:

Fx ≥ Px or **F cos ą≥Psinα,** results **P tgφcos α≥P sinα.**

Thus, thickness ***h*** and compression degree ***Δh***a of driven layer, designed to be pressed between two rollers, depend on diameter of rollers ***D*** and coefficient of friction *(**f=tgφ**) of material on roller surface.* Therefore, increasing diameter ***D*** and friction coefficient ***tgφ*** enlarge the layer thickness ***h*** and its thinning D*h*, that improves the driving conditions of stem layer and increases productivity ***Q*** and[i] squeezing degree of juice ***GE***.

Productivity and extraction degree of liquid obtained at material pressing between rollers

Volume of material passing, in a certain unit of time, through a space between two rollers, which peripheral speed is equal, considering there is no skidding, is determined by relation:

V = b·h·v*;* where ***b*** is cylinder length (width of pressing area) measured in mm; ***h*** – thickness of layer driven between rollers, measured in mm; ***v*** – peripheral speed of rollers, in inm/s.

Mass of material processed in a certain unit of time (productivity) can be found out, knowing the bulk mass (volumetric mass) **φ** of material (kg/m³):

Qmv =Vφ=bhφъ.

When material is pressed between rollers, the layer is compressed from the thickness ***h*** up to ***s*** (gap value). After the compression, the liquid from the respective material is released and volumetric mass of squeezed material increases. The initial gap does not surpass 5 mm and the raw material layer can be non-uniform: stalks with bigger diameter are harder pressed than those with smaller diameter. Also, when force **P** is increased, the non-uniformity of stems pressing is diminished, though ensuring maximum values of gap limited at 6-7 mm. This phenomenon can be explained by the fact that once the pressure is increased, the vegetal mass compression coefficient **K = γb/m** (ratio between bagasse volumetric mass and that of raw material, kg/m3), increases.

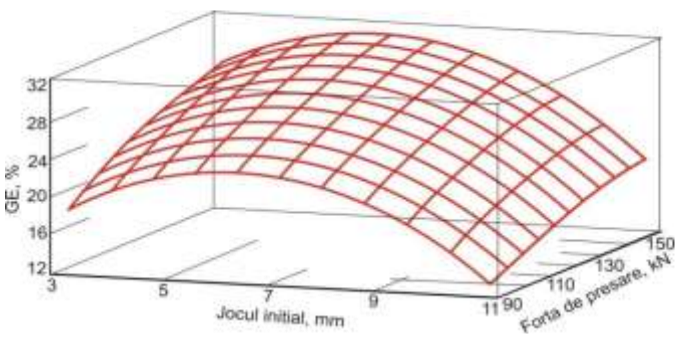

Fig. 8 – Degree of extraction of juice from saccharate sorghum according to technological pressing regimes (roller speed n = 11 min^{-1}

Power consumed at pressing the material between rollers

As it was mentioned before, for driving and pressing the stems by rollers, it should act with a common force P, normal for contact surface. For driving the rollers more rapidly (increased speed), according to (*Cerempei and Habasescu, 2012*), a torsion moment is necessary:

*Mt=2P¥ l*unde ¥ is the arm coefficient, α **,**β – angles of applying the force *P* and respectively the driving-pressing system; ***lp, l*** – length of arm of applying the force *P* and, respectively of the driving-pressing system. According to experimental data offered by authors (*Cerempei and Habasescu, 2012*), values of arm coefficient are within ¥ = 0.33÷0.67, average value being ¥ = 0.5, then the torsion moment will be:

$$Mt = pmbR\,\Delta h. \quad (1)$$

In this case, the power consumed for green matter driving –pressing process will be:

$$N = Mt\,\omega = = pmbR \cdot \Delta h\omega \;. \quad (2)$$

Analysis of power consumed in relation with technological regimes has emphasized that when changing the initial gap within a range of 3-10 mm, power consumed is maintained at a level of 7.4±0.4kW, and increasing the pressing force from 90 to 150 kN leads to a greater consumed power, namely from 5.4 up to 9.4 kW. The roller speed mostly influences the power consumed. When roller revolutions are increased from 7 to 15 min^{-1}, then the power consumed is increased from 4.4 to 10.2 kW.

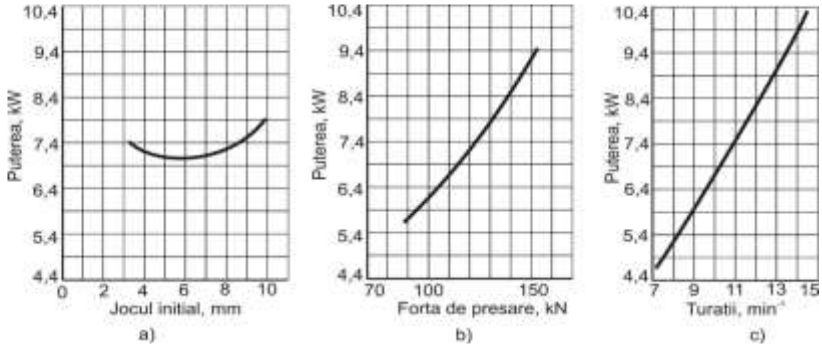

Fig. 9 – Influence of technological regimes on consumed power

force P = 150kN, revolution no. n = 11min^{-1}; b) gap =$6.5mm$, speed =$11min^{-1}$; *c)* gap=$6.5mm$, P=$150kN$

After analyzing the current stage of the technique in the field, the following design theme for a functional prototype to be used in research project, has been established:

Press with 3 rolllers, driving belt system and reduction gear with parallel axes, electric engine power 5.5 kw, roller diameter 370 mm, roller length 500 mm, established according to power and gearmotor, pressing capacity 300-500 kg/hour, determined according to gearmotor and roller length.

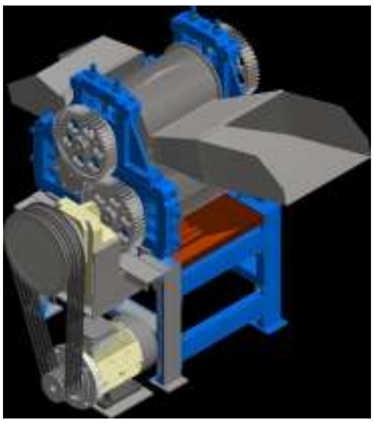

Fig. 10 – Project of functional prototype

CONCLUSIONS

The paper presented the importance of the subject proposed to be studied, the analysis of the main relevant patents and sorghum roller presses manufactured by different companies. There were also presented and analyzed the main constructive data necessary to design the sorgum roller presses and the influence of main parameters on the power consumed.

Consequently, studying the constructive solutions and calculation elements necessary to this type of installations, the constructive project of sorghum pressing prototype has been successfully achieved.

ACKNOWLEDGEMENT

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MATHEMATICAL MODEL FOR DETERMINATION OF SOIL TILLAGE RESISTANCE FORCES
/
MODEL MATEMATIC PENTRU DETERMINAREA FORŢELOR DE REZISTENŢĂ LA PRELUCRAREA SOLULUI

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Keywords: *mathematical model, soil tillage, soil strength, energetic consumption.*

ABSTRACT
In this paper is developed a mathematical model for strength forces evaluation in the soil tillage process. Two tools with plane and cylindrical surfaces are used in order to describe the mathematical model. These mathematical equations include all the influence factors of the working process: constructive parameters, functional parameters of agricultural machine and soil parameters. A PC program is elaborated using the mathematical model. The analytical method is validated by experimental results. Finally, some recommendations are made regarding the optimization of geometric parameters of tillage tools, which may be useful in the stages of designing, manufacturing and exploitation of equipment.

REZUMAT
În lucrare este elaborat un model matematic pentru evaluarea forţelor de rezistenţă în procesul de prelucrare a solului. Pentru descrierea modelul matematic se utilizează două unelte cu suprafaţa plană şi cilindrică. Aceste ecuaţii matematice includ toţi factorii de influenţă ai procesului de lucru: parametrii constructivi, parametrii funcţionali ai maşinilor agricole şi parametrii solului. Este elaborat un program PC având la bază modelul matematic. Metoda analitică este validată de rezultate experimentale. În final, sunt făcute câteva recomandări privind optimizarea parametrilor geometrici ai sculelor de lucrat solul, care pot fi utile în etapele de proiectare, fabricare şi exploatare a echipamentelor.

INTRODUCTION
Tillage tools are used to apply energy to the soil to cause some desired effects such as cutting, breaking, inversion or movement of the soil. Tillage tools usually produce several effects simultaneously (*Biriş S. et al., 2009; David A. et al., 2014; Stănilă S., 2014*). In terms of mechanical manipulation of the soil, our goal is to design an optimum tool that will ensure an adequate quality of the soil, efficiency and economy of the tillage process (*Fechete Tutunaru, L. V. et al., 2009; Karamousantas D. et al., 2001*; *Kupchuk I.M. et al., 2018; Stănilă S. et al.,2013*).

Mechanical soil tillage is a process with high – energy consumption. The objective of mechanical manipulation of the soil destined to agricultural production is to create soil conditions and favorable environment to crop growth by changing bulk density, soil – aggregate size distribution and other characteristics of the soil (*Kobets A. et al., 2018; Rusu T. et al., 2013; Ţenu I. et al., 2009*).

The energy required to till the soil depends to a large extent on the physical properties of soil, operating conditions and the design parameters of the tillage tools (*Ajmera B. et al., 2017*; *Bashar M. et al., 2015*; *Vlăduţ D. I. et al., 2018*).

Reducing the energy to change the physical properties of the soil is an important consideration, since tillage tools consume a large portion of the energy required to produce the crop (*Fechete Tutunaru L. V. et al., 2014*). Because of the large amount of energy involved in the process of soil cultivation, even small economy, which might be developed in this process, may have significant value.

MATERIAL AND METHOD
Development of a mathematical model
Considering of the process complexity of the tillage, for the modeling of mathematical model of the strength from soil it impose the following simplifying assumptions (*Callaghan O., 1965; Ghereş M. I., 2013*):

- The soil furrow is divided in to elementary prisms of dx·dy·dz dimensions (dz = a – working depth) by section of furrow with vertical planes (parallel and perpendicular to the direction of machine movement);
- The prisms are moving in the reverse direction of forward speed (with the speed $v_x = v_m$) and rotate in the transversal plane, being in contact with the tool surface, without breaking (Figure 1);

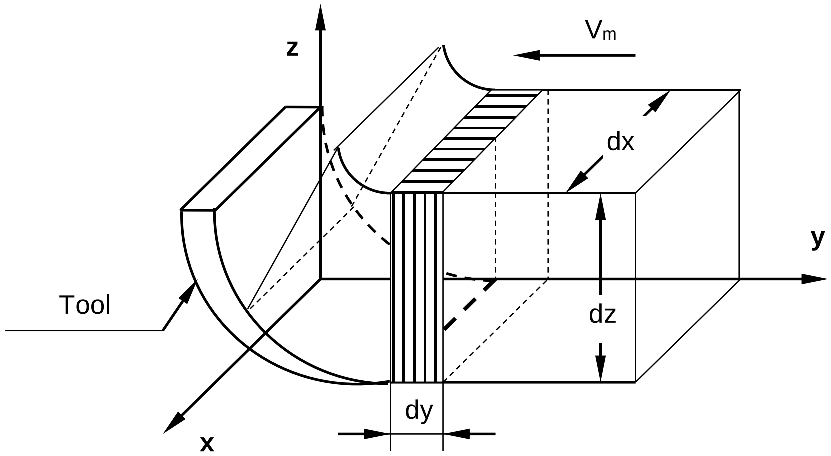


Fig.1 - The idealization of tillage process.

The tool is composed of many plane surfaces ABC (tangent to the tool surface – Figure 2). Each of these plane, tangent in an arbitrary chose point M(x, y, z) are characterized by the geometrical parameters of the tool α, β, γ (see Table 1 for plane and cylindrical surface).

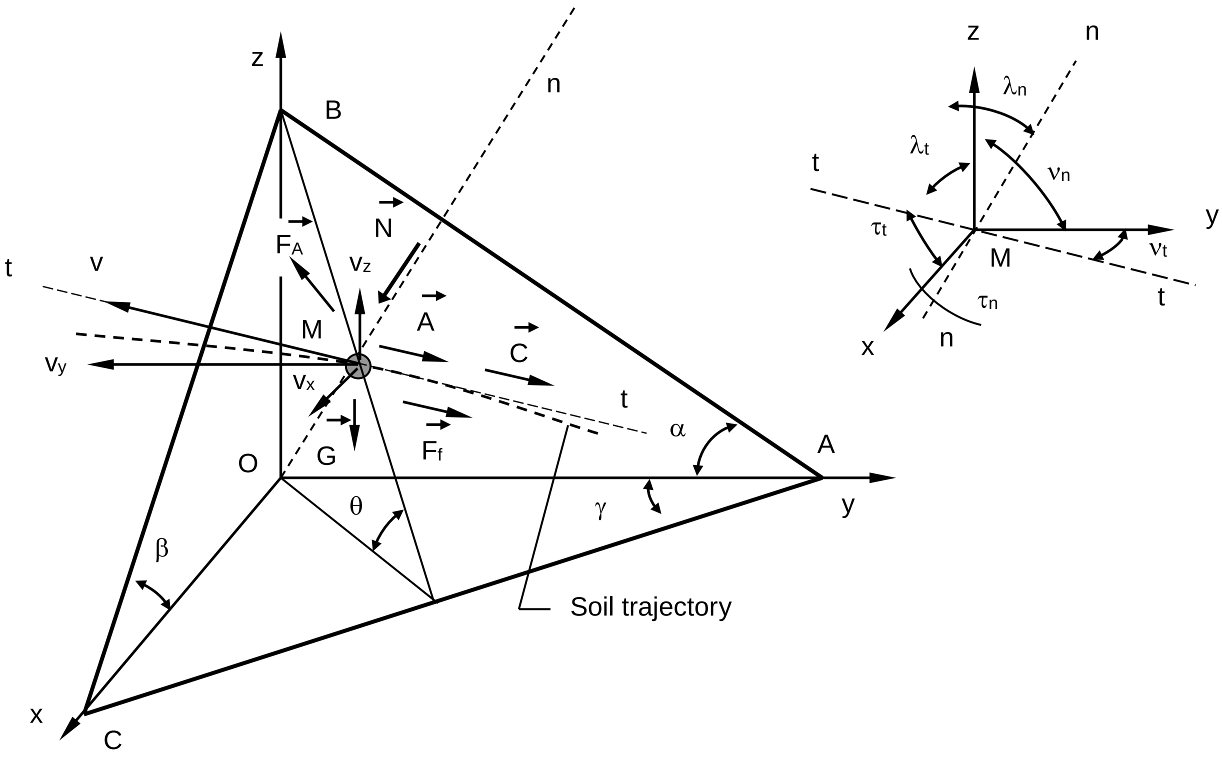


Fig. 2 - Representation of forces and soil movement path over the tool surface

For the analytical calculation of the interaction forces it is consider the system of axes tMnp. Mt is the direction tangent to the trajectory of soil prism on the tool surface, Mn is the normal direction to the work surface and Mp is the perpendicular direction on the plane definite by the Mt and Mn.

For determining the tool-soil interaction forces are defined the directions of the tMnp axes system in relation to the fixed system xOyz using the geometrical relations between angles (Figure 2).

Tangent direction to the trajectory, Mt, it is definite by directional cosines of the tangent, by the derivation of the trajectory parametric equations:

$$cos\tau_t = \frac{dx}{dt}\cdot\frac{1}{\sqrt{\left(\frac{dx}{dt}\right)^2+\left(\frac{dy}{dt}\right)^2+\left(\frac{dz}{dt}\right)^2}}, \tag{1}$$

$$cos\tau_t = \frac{dy}{dt}\cdot\frac{1}{\sqrt{\left(\frac{dx}{dt}\right)^2+\left(\frac{dy}{dt}\right)^2+\left(\frac{dz}{dt}\right)^2}}, \tag{2}$$

$$cos\tau_t = \frac{dz}{dt}\cdot\frac{1}{\sqrt{\left(\frac{dx}{dt}\right)^2+\left(\frac{dy}{dt}\right)^2+\left(\frac{dz}{dt}\right)^2}}, \tag{3}$$

where:

$$\frac{dy}{dt} = -\left(cos^2\gamma + sin^3\gamma\cdot\frac{1}{\sqrt{sin^2\gamma+tg^2\alpha}}\right)\cdot v = v_m, \tag{4}$$

$$\frac{dx}{dt} = \sin\gamma\cdot\cos\gamma\left(1-\frac{\sin\gamma}{\sqrt{sin^2\gamma+tg^2\gamma}}\right)\cdot v, \tag{5}$$

$$\frac{dz}{dt} = \left(\sin\gamma\cdot\frac{\sin\gamma\cdot tg\,\gamma}{\sqrt{sin^2\gamma+tg^2\gamma}}\right)\cdot v, \tag{6}$$

represents the soil velocity components (*Ghereş M.I., 2014*).

The normal Direction (Mn) in an arbitrary point M (x, y, z) coincides with perpendicular to the plane surface (ABC) and forms the with the axes of the coordinate system (xOyz) the angles τ_n, ν_n şi λ_n. directional cosines of the normal to the tool surface (Mn) can be defined from the equation of tangent plane (ABC), described of the matrix equation:

$$\begin{vmatrix} x & y & z & 1 \\ dy\cdot tg\,\gamma & 0 & 0 & 1 \\ 0 & dy & 0 & 1 \\ 0 & 0 & dy\cdot\frac{1}{tg\,\alpha} & 1 \end{vmatrix} = 0, \tag{7}$$

that, for $\alpha \neq 0$ is equivalent to the expression

$$x + y\cdot tg\,\gamma - z\cdot tg\,\gamma\cdot tg\,\alpha - dy\cdot tg\,\gamma = 0. \tag{8}$$

Using mathematical relationships that define the direction of the normal to a plane, result:

$$\cos\tau_n = \frac{1}{\sqrt{1+tg^2\gamma\cdot(1+tg^2\alpha)}}, \tag{9}$$

$$\cos\nu_n = \frac{tg\,\gamma}{\sqrt{1+tg^2\gamma\cdot(1+tg^2\alpha)}}, \tag{10}$$

$$\cos\lambda_n = \frac{-tg\,\gamma\cdot tg\,\alpha}{\sqrt{1+tg^2\gamma\cdot(1+tg^2\alpha)}}, \tag{11}$$

For determining the directional cosines of the Mp direction it is considered that it is perpendicular to the tangent direction (Mt) and the direction of the normal (Mn). Based on these considerations can use vectorial equations of the perpendicular to two planes. This results in:

$$\cos\tau_p = \begin{vmatrix} \cos\nu_p & \cos\lambda_p \\ \cos\nu_n & \cos\lambda_n \end{vmatrix}, \tag{12}$$

$$\cos\nu_p = \begin{vmatrix} \cos\lambda_t & \cos\tau_t \\ \cos\lambda_n & \cos\tau_n \end{vmatrix}, \tag{13}$$

$$\cos\lambda_p = \begin{vmatrix} \cos\tau_t & \cos\nu_t \\ \cos\tau_n & \cos\nu_n \end{vmatrix}, \tag{14}$$

resulting:

$$\cos\tau_p = \cos\nu_t \cdot \cos\lambda_n - \cos\lambda_t \cdot \cos\nu_n\ , \tag{15}$$

$$\cos\nu_p = \cos\lambda_t \cdot \cos\tau_n - \cos\tau_t \cdot \cos\lambda_n\ , \tag{16}$$

$$\cos\lambda_p = \cos\tau_t \cdot \cos\nu_n - \cos\nu_t \cdot \cos\tau_n\ , \tag{17}$$

Relations (1), (2), (3), (9), (10), (11), (15), (16) and (17) allow for determining the projections of the tool - sol interaction force components on the system axis xOyz

The resultant of the tool - soil interaction force is obtained by summing all the components involved in the work process: the acceleration force of the soil F_A, deformation force of soil prism by the flexural F_I, soil adhesion forces at the tool surface A and cohesion C, the forces of friction between soil and steel F_f, the gravity force of soil G and the elastic deformation force of soil Q (Fig.3). Components A, C, F_f and F_I be acting in the direction tangent to the soil trajectory and soil weight G on the vertical direction Oz *(Gebresenbet G., 1991; Roş V. et. al., 1995; Yniesta S. et al., 2017*).

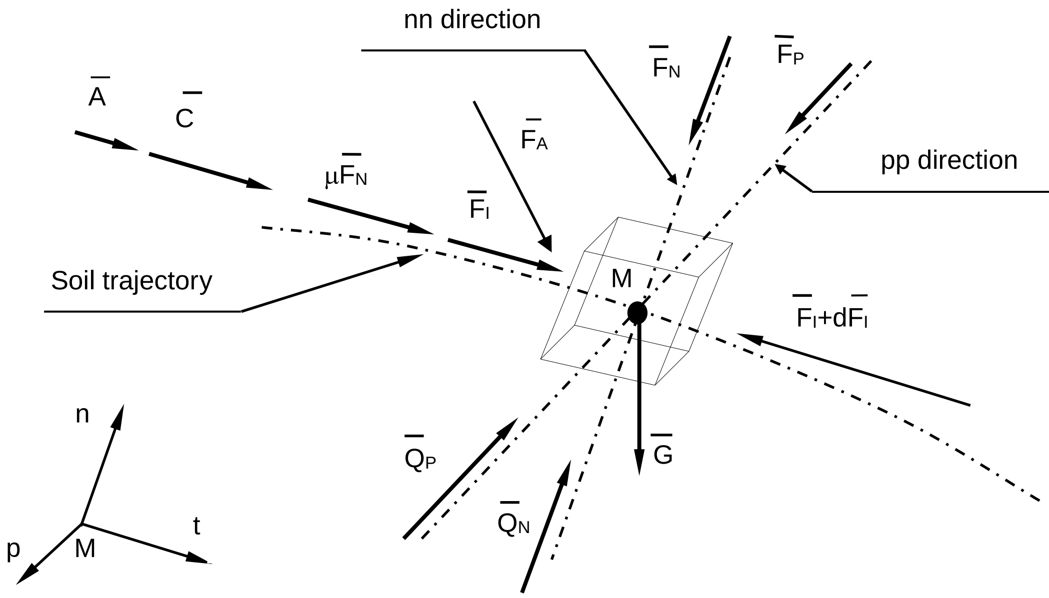


Fig. 3 - The components of interaction forces - tools - soil

For determining the normal component of the resultant forces of tool - soil interaction F_n using the equilibrium equations of the system of forces after the direction normal Mn:

$$-G_n + F_n - F_{An} = 0 \tag{18}$$

and to determine the perpendicular component Mp and the tangential component Mt of the system of forces, the equations:

$$dF_p - \mu \cdot F_n - A - C - G_p = 0 \tag{19}$$

$$F_{At} - G_t + F_{It} = 0\ . \tag{20}$$

Relations (15), (16) and (17) are true if we neglect the effect of the elastic forces of the soil Q.

The acceleration forces of the soil.

According to the above, the resultant of forces acceleration of the soil can be determined by the summation of all forces for accelerating of the elementary prisms of soil, that

$$F_A = \sum F_A\,(x,y,z) \tag{21}$$

where, $F_A(x, y, z)$ is the acceleration force of elementary prism of soil that has its center of gravity at arbitrary points, coordinates M (x, y, z).

The accelerating force of soil elementary prism of the mass m, is determined with relation:

$$F_A(x,y,z) = m \cdot v'(x,y,z) \tag{22}$$

where:

$$m_p = \rho \cdot dx \cdot dy \cdot dz \tag{23}$$

acceleration components:

$$v'_x(x,y,z) = \frac{d^2x}{dt^2} \tag{24}$$

$$v'_y(x,y,z) = 0 \tag{25}$$

$$v'_z(x,y,z) = \frac{d^2z}{dt^2} \tag{26}$$

and absolute acceleration:

$$v'(x,y,z) = \sqrt{v'^2_x(x,y,z) + v'^2_y(x,y,z) + v'^2_z(x,y,z)} \tag{27}$$

The force of gravity of the soil.

Weight of elementary soil prism is defined by the relation:

$$G\,(x,y,z) = \rho \cdot dx \cdot dy \cdot dz \tag{28}$$

where, g=9,81 m/s², represents the gravitational acceleration.

The friction force tool-soil

The friction force tool - soil is determined by the normal force F_N corresponding to the point M(x, y, z), and the coefficient of friction μ, using the equation:

$$F_n(x,y,z) = G_n\,(x,y,z) + F_{An}\,(x,y,z) \tag{29}$$

Thus, the amount of friction in the particular point M (x, y, z) is given by the expression:

$$F_f\,(x,y,z) = \mu \cdot [G_n\,(x,y,z) + F_{An}\,(x,y\,z)] \tag{30}$$

The force of adhesion of the soil on the surface of tool

The adhesion elementary force is determined by the coefficient of adhesion τ_a and the surface the contact *dx·dy*, with relation:

$$A\,(x,y,z) = \tau_a \cdot dx \cdot dy \tag{31}$$

Because the adhesion force is tangent to the soil trajectory, the components its will be described by the expressions:

$$A_x = \sum \tau_a \cdot dx \cdot dy \cdot \cos\tau_t \tag{32}$$

$$A_y = \sum \tau_a \cdot dx \cdot dy \cdot \cos\nu_t \tag{33}$$

$$A_z = \sum \tau_a \cdot dx \cdot dy \cdot \cos\lambda_t \tag{34}$$

The cohesive force of the soil.

The cohesive elementary force is determined by the soil cohesion coefficient τ_c with relation:

$$C\,(x,y,z) = \tau_c \cdot dx \cdot dy \tag{35}$$

and its components in xOyz system, with expressions.

$$C_x = \sum \tau_c \cdot dx \cdot dy \cdot \cos\tau_t \tag{36}$$

$$C_y = \sum \tau_c \cdot dx \cdot dy \cdot \cos\nu_t \tag{37}$$

$$C_z = \sum \tau_c \cdot dx \cdot dy \cdot \cos\lambda_t \tag{38}$$

The soil cutting resistance forces

For determining the effort required for cutting a soil furrow is considered that to soil resistance is due only of horizontally cutting the soil, at a depth equal to working depth. Is considered that resistant force to cutting T, is contained in the horizontal plane and is perpendicular to the edge cutter quantitatively, the force T is determined by a relation of the form:

$$T = k_t \cdot L \tag{39}$$

where: - k_t represents the linear specific resistance of soil cutting;
- L – length of the tool cutting edge.

From scheme of determining of the resistance forces to cutting of soil (Figure 4) we obtain the longitudinal and transversal components of the force of resistance to cutting of the soil according to the working width:

$$T_x = k_t \cdot \frac{b}{tg\,\gamma} \tag{40}$$

$$T_y = k_t \cdot b \tag{41}$$

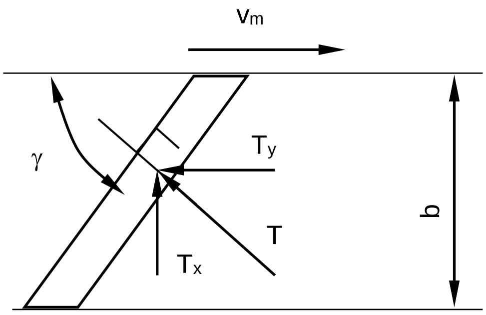


Fig. 4 - The scheme of determining the resistance forces for the soil cutting

The calculation to resultant of soil- tool interaction forces.

The resultant of the forces of interaction tool - soil is determined by the vector sum of the force components: the cutting forces, the acceleration, the flexion, the weight, the forces of friction, adhesion and cohesion the soil:

$$\overline{F} = \overline{T} + \overline{F_A} + \overline{G} + \overline{F_f} + \overline{A} + \overline{C} \tag{42}$$

It is noted that in the mathematical model presented in this chapter, we neglect the forces of elastic deformation the soil Q.

PC Program

A PC program based on the previous mathematical model has been developed for soil tillage energy evaluation. In order to compile the program, the user has to know the following: initial soil parameters, geometrical parameters of tool surface and working parameters. The parameters are listed in Tables 1, 2 and 3.

The program contains:

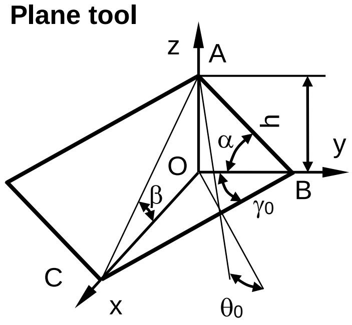
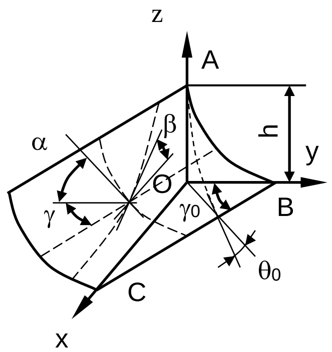
- Equation for the calculation of the (x, y, z) coordinates of a number of (m·n) arbitrary points M, obtained by the intersections of vertical planes, parallel to the direction of travel (m) and transversal planes (n) to the furrow. The variables m and n are imposed by the user;
- Calculation of geometrical parameters α, β and θ in accord with each plane surfaces ABC;
- Calculation of soil travel speed components (v_x, v_y and v_z) and elementary displacements of soil particles (dx, dy and dz) using the relations (4, 5, and 6);
- Calculation the forces of soil – tool interaction (eq. 42);
- Calculation the directional cosine of normal and tangent at soil particle path (eq. 1, 2, 3, 9, 10 and– 11) and directional cosine of soil – tool interaction projection forces upon the axes of xOyz coordinate system;

Experimental research on determining the interaction forces tool - soil

For the validation the mathematical model developed in Chapter 2 were tested two types of tools are characterized by plane and cylindrical surfaces (Table 1).

Table 1

Tool geometry

<table>
<tr><td rowspan="4">Plane tool

</td><td colspan="3">Surface equation: $h - z = y\cdot\sin\gamma\cdot tg\,\theta + x\cdot\cos\gamma\cdot tg\,\theta$,
where: $tg\,\alpha = \sin\gamma\cdot tg\,\theta$
$tg\beta = \cos\gamma\cdot tg\theta$.</td></tr>
<tr><td rowspan="3">Initial dates</td><td>Surface height h, [mm]</td><td>100</td></tr>
<tr><td>Horizontal tool angle γ, [^{0}]</td><td>45</td></tr>
<tr><td>Angle between tool and horizontal plane θ, [^{0}]</td><td>45</td></tr>
<tr><td rowspan="4">Cylindrical tool

</td><td colspan="3">Surface equation: $(z - h)^2 - 2\cdot p\left(y + \frac{1}{tg\,\gamma_0}\cdot x\right) = 0$,
where: $p = h\cdot tg\,\theta_0\cdot\sin\gamma_0$,
$\alpha = arc\,tg\,\frac{p}{z-h}$, $\beta = arc\,tg\left(\pm\frac{p}{z-h}\cdot\frac{1}{tg\,\gamma_0}\right)$</td></tr>
<tr><td rowspan="3">Initial dates</td><td>Surface height h, [mm]</td><td>100</td></tr>
<tr><td>Horizontal tool angle γ_0, [^{0}]</td><td>45</td></tr>
<tr><td>Angle between tool and horizontal plane θ_0, [^{0}]</td><td>30</td></tr>
</table>

The investigations were made in the two types of soil are characterized by physical and mechanical parameters, shown in Table 2.

Table 2

Soil initial parameters

Soil type	Type 1	Type 2
Soil Texture	44,6% clay	19,2% clay
Moisture w, [%]	14,67	11,98
Density ρ_a , [t/m^3]	1,75	1,85
Friction coefficient, μ	0,428	0,372
Internal friction coefficient, μ_i	0,418	0,398
Adhesion coefficient τ_a [kN/m^2]	3,90	3,04
Cohesion coefficient τ_c, [kN/m^2]	47,84	39,62

During the test of tools have been respected operating parameters described in the Table 3.

Table 3

Working parameters

Speed v_m, [m/s]	2
Working depth a, [cm]	15
Working width b, [cm]	25

For measuring the resistance forces to soil tillage was used the measuring system presented in Figures 5 and 6.

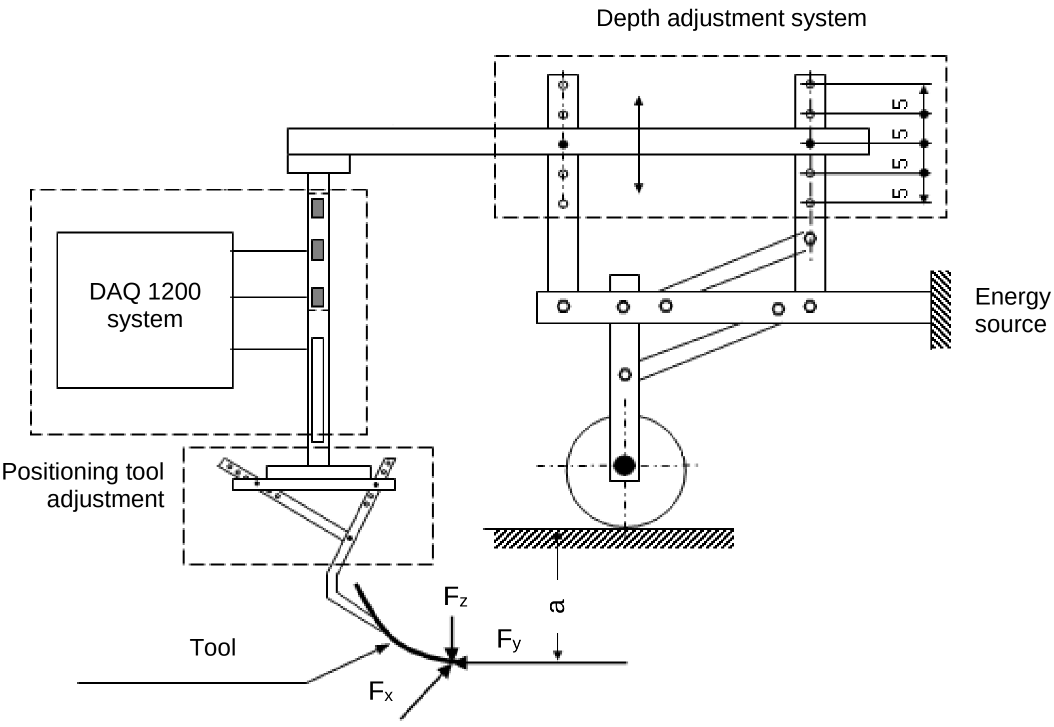


Fig. 5 - Construction of the measurement system

The measuring system allows adjustment of working depth (a) and correct positioning of the tool (characterized by angles γ and θ) relative to the forward direction

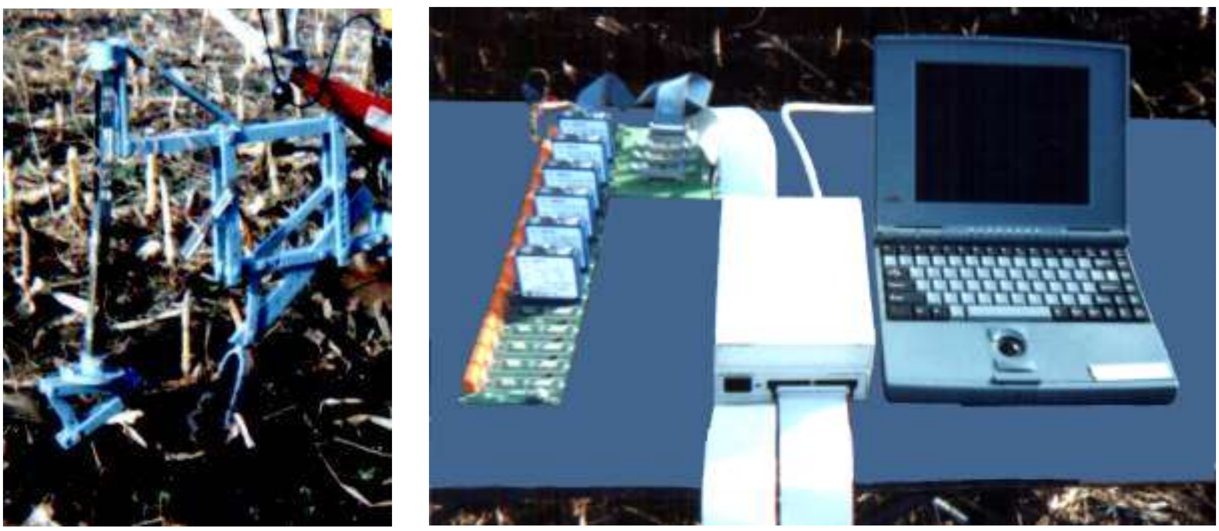


Fig. 6 - The system for measuring interaction forces tool-soil

For data acquisition is used an DAQ 1200 system and tensometric traductors, that are connected in the Wheatstone bridge for measuring the components of soil resistance forces F_x, F_y and F_z.

For collecting and recording data has been developed a PC program, using Labview software. The program provides the graphic representation of the variation components F_x, F_y and F_z and of values determined by calculating the resultant force F.

For the interpretation of the results the program determines the minimum, maximum and average and the standard deviations of the measurements.

RESULTS

Tests made according to the methodology demonstrate the influence of tools geometry on resistance forces of the soil tillage.

In Table 4 shows the average values of components of the interaction forces - tool - soil (F_y - longitudinal, F_x - transverse and F_z - vertical) the experimentally determined and the analytical calculated accordance with the model developed in Chapter 2, for a working width b = 1m.

Comparing the force component values of soil resistance the mechanical processing, using plane and cylindrical tools, it is found that the forces of interaction - tool - soil have minimum values when used the plane surface tools. One of the reasons of this aspect is that speed of movement of the soil is constant over the entire surface of tools, which means that the soil acceleration forces are zero.

Given that the angles α, that characterize the plane tools, it follows that the bending forces of the soil are minimal.

These two findings justify that the comminuting degree the soil using plane tools is minimal.

Analyzing the components of interaction forces - tool - soil, it is found that when used the plane tools, the normal forces F_n and friction forces F_f are lower, which demonstrates an improvement in energy transmission efficiency from tool to soil by reducing losses friction.

Table 4

The influence of tool geometry over the forces of interaction - tools - soil.

Interaction force components	Type tool	Type 1 (44,6% clay)			Type 2 (19,2% clay)		
		Theoretical values, [N]	Measured values, [N]	Errors*, [%]	Theoretical values, [N]	Measured values, [N]	Errors*, [%]
F_y	Plane	3786,45	4206,85	9,98	3438,69	3865,62	11,03
	Cylindrical	5404,76	5971,77	9,49	5003,15	5587,28	10,45
F_x	Plane	874,50	1043,35	16,20	879,23	1066,87	17,52
	Cylindrical	1087,76	1322,73	17,77	1125,79	1346,23	16,36
F_z	Plane	588,45	685,72	14,16	635,19	735,18	13,60
	Cylindrical	820,36	937,64	12,48	914,63	1020,15	10,33
F	Plane	3930,42	4402,54	10,72	3604,35	4006,88	10,03
	Cylindrical	5602,93	6197,33	9,60	5208,74	5743,35	9.31

* *The errors were calculated using the expression:*

$$\frac{Measured\ value - Teoretical\ value}{Measured\ value} \cdot 100$$

CONCLUSIONS

The results demonstrate that the theoretical values are lower than the measured values by about 10%. These differences are caused by the forces of elastic and plastic deformation of the soil and the soil internal frictions that have been neglected in the theoretical model described in paper. In these conditions the proposed theoretical method can be used for comparative studies.

Researches made to determine the optimal geometry in order reduction the interaction forces tools - soil, demonstrates that plane tools are characterized by constant angles α, ensures the work with minimal effort. The cylindrical tools characterized by variable angles α involves resistance forces of processing the soil with 30-40% higher than with the plane tools.

The mathematical model can be developed to solve optimization problems of the constructive and functional parameters of tools for working the soil to reduce the resistance forces.

ACKNOWLEDGEMENTS

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ALGORITHM AND COMPUTER PROGRAM FOR THE DETERMINATION OF THE MATERIAL JUMPS PARAMETERS ON THE ACTIVE SURFACE OF ROLLING SCREEN FITED WITH ELLIPTIC SHAKING ROLLS
/
ALGORITM ŞI PROGRAM DE CALCUL PENTRU DETERMINAREA TEORETICĂ A PARAMETRILOR SALTURILOR MATERIALULUI PE SUPRAFAŢA ACTIVĂ A GRĂTARELOR RULANTE PREVĂZUTE CU ROLE ELIPTICE DE SCUTURARE

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Keywords: *material jumps, rolling screens, elliptic shaking rolls, algorithm, computer program*

ABSTRACT
In the paper are presented the algorithm and the computer program developed on the basis of the theoretical study for determining the material jumps on the active surface of the rolling screens provided with elliptical shaking rolls. The computer program is interactive and allows the quick and convenient determination of the characteristic parameters of the material jump on the active surface of the rolling screens depending on the dimensional parameters of the elliptical rolls (size and eccentricity), on the rolling screen speed and on the angle of inclination to horizontal of its active surface. The use of the computer program for calculating the material jump parameters on the rolling screen allows optimization of the positioning of the elliptical shaking rolls along their active surfaces in order to achieve a uniform shaking process over the entire length of the rolling screen active surfaces.

REZUMAT
În lucrare sunt prezentate algoritmul şi programul de calcul dezvoltate pe baza studiului teoretic de determinare a salturilor materialului pe suprafaţa activă a grătarelor rulante prevăzute cu role eliptice de scuturare. Programul de calcul este interactiv şi permite determinarea rapidă şi comodă a parametrilor caracteristici ai salturilor materialului pe suprafaţa activă a grătarelor rulante în funcţie de parametrii dimensionali ai rolelor eliptice de scuturare (marime şi excentricitate), de viteza grătarului rulant şi de unghiul de înclinare faţă de orizontală a suprafeţei sale active. Utilizarea programului de calcul al parametrilor caracteristici ai salturilor materialului pe suprafaţa activă a grătarelor rulante face posibilă optimizarea poziţionării rolelor eliptice de scuturare de-a lungul suprafaţelor lor active în scopul obţinerii unui proces de scuturare cât mai uniform pe toată lungimea suprafeţelor active ale grătarelor rulante.

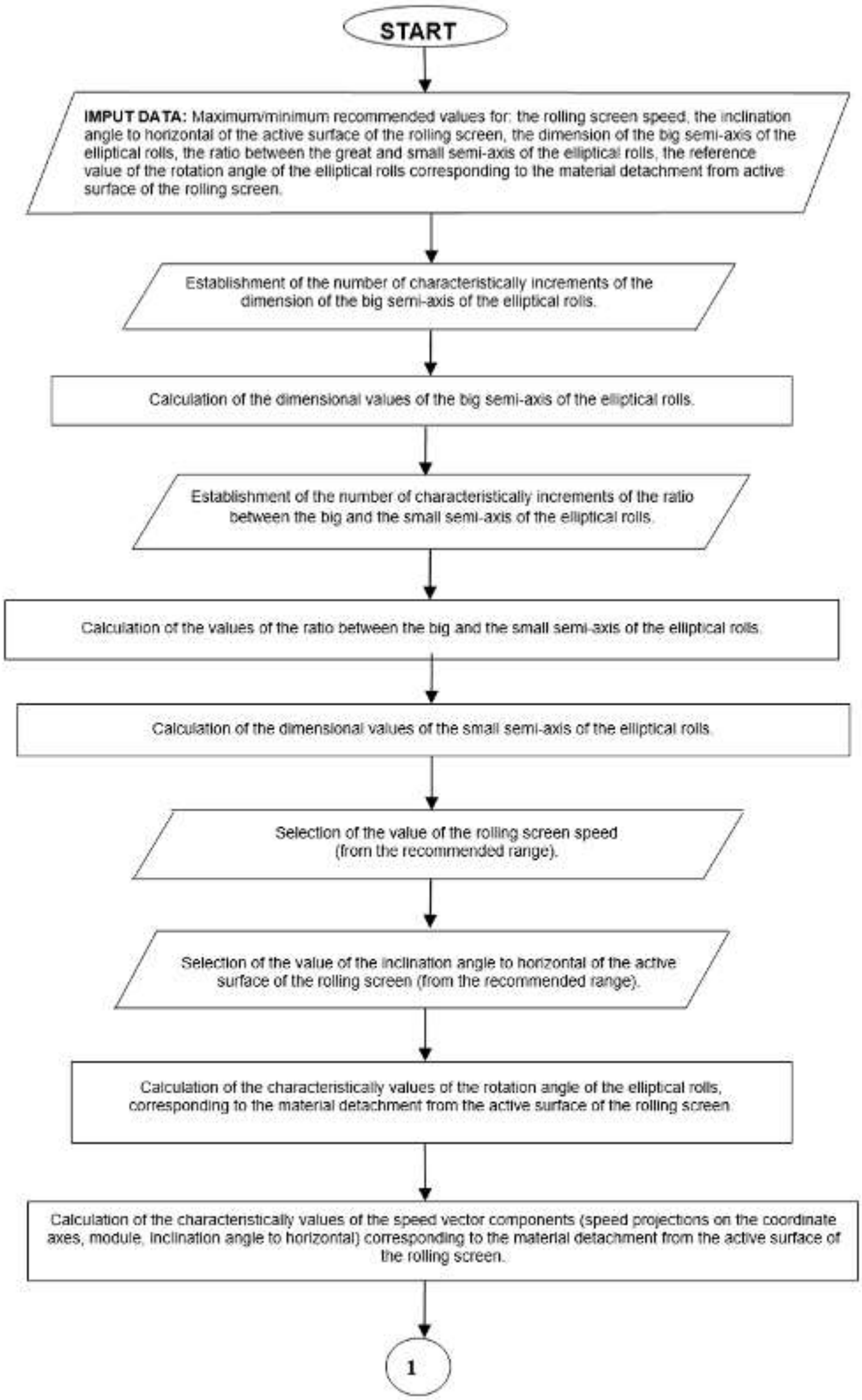
INTRODUCTION
The bulb, tuber or root plants harvesters have in their structure impurities cleaning systems which perform the separation of the useful products from the comminuted soil bed, resulted after their dislocation. The impurities cleaning systems, which usually occupy most of the technological flow of the harvesters, are composed of separators with very various construction. From these different types of separators, the most frequatly used in the impurities cleaning systems and conditioning lines construction are the screening type separators, which can be classified into two major categories: *rolling screens* and *ossilating and vibrating screens*, relative equaly proliferated in practise.

In this context, in previous paper (*Safta V.V., 2017*) was presented a theoretical study for determining the material jumps on the active surface of the rolling screens provided with elliptical shaking rolls. The study is based on the mathematical modeling of the constituent elements of the working process of the active surface in the area of action of the shaking rolls, namely: the movement of the active surface of the rolling screen in contact with the elliptical shaking rolls, the detachment of the material from the active surface of the rolling screen, the displacement of the material in free-movement, the return of the material on the active surface of the rolling screen.

On the basis of this theoretical study there were developed an algorithm and a computer program for determining the characteristic parameters of the material jumps on the active surface of the rolling screens provided with elliptical shaking rolls, respectively the duration, the length and the height of the jumps depending on the dimensional parameters of the elliptical rolls, respectively the size and the eccentricity, on the rolling screen speed and on the angle of inclination to horizontal of its active surface.

MATERIAL AND METHOD

The structural chart of the algorithm for determining the characteristic parameters of the material jumps on the active surface of the rolling screens provided with elliptical shaking rolls is presented in Figure 1.



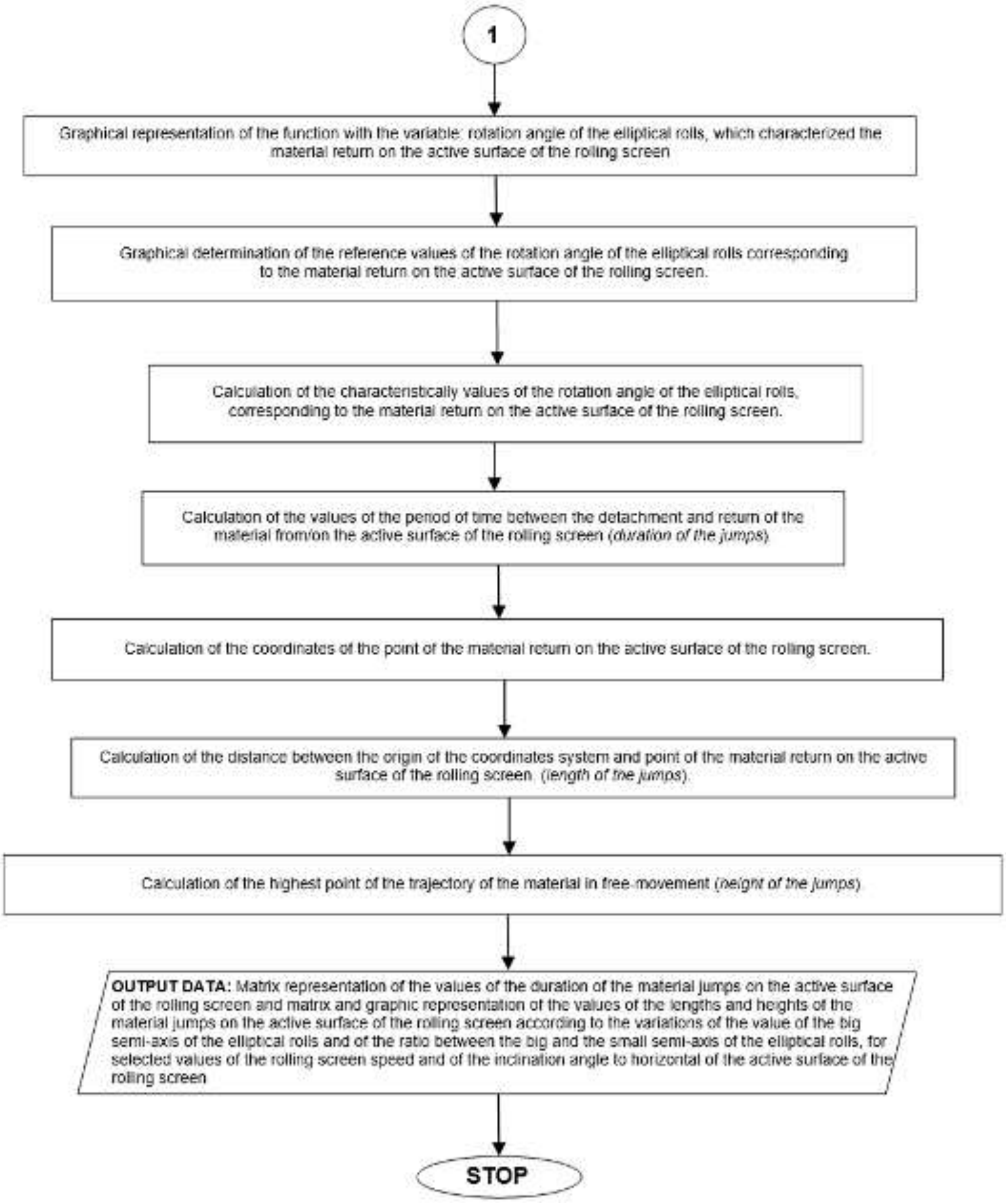


Fig. 1 - The structural chart of the algorithm for determining the characteristic parameters of the material jumps on the active surface of the rolling screens provided with elliptical shaking rolls

Following this algorithm an interactive computer program was developed in MathCad which allows the quick and convenient determination of the characteristic parameters of the material jump on the active surface of the rolling screens depending on the dimensional parameters of the elliptical rolls (size and eccentricity), on the rolling screen speed and on the angle of inclination to horizontal of its active surface.

Knowing the characteristic parameters of the material jumps makes it possible to optimize the positions of the elliptical shaking rollers along the active surface of the grate so as to obtain a proper shaking regime.

Hence, an optimizing procedure may be applied to the rolling screens with long active surfaces which need many successive pairs of elliptical shaking rolls along them for a much intense shaking as posible without damaging the useful products, by establishing optimal distances between successive pairs of elliptical rolls along the active surface of the rolling screen.

For this purpose, they must be respected the following simultaneous conditions:

- the posterior pair of elliptical rolls must be placed in a position situated after the return area of the material detached under the action of the anterior pair of elliptical rolls on the active surface of the rolling screen;
- the posterior pair of elliptical rolls must be placed in a position where the shaking motion of active surface of the rolling screen, induced by the anterior pair of elliptical rolls is amortized.

For respecting the first condition it is necessary to know the position on the active surface of the rolling screen of the return of the material detached under the action of the previous elliptical rolls, position determined by the length of the material jump in a certain regime of the rolling screen determined by the dimensional parameters of the elliptical rolls (size and eccentricity), on the rolling screen speed and on the angle of inclination to horizontal of its active surface.

The distance after which the shaking motion of the active surface of the grate induced by a pair of elliptical shaking rolls is amortized is strongly influenced by the elasticity of the rolling screen, characteristic mainly determined by its construction mode.

In practice, in most of the cases the shaking motion of active surface of the rolling screens is amortized soon after the area of action of the elliptical shaking rolls because the significant internal friction of the rolling screens, the distances to the amortization area being generally reduced, much lower compared to the material return distances following the jumps.

In these conditions optimal positioning of successive elliptical rolls based on the return distance of the material following the jumps becomes prevalant and suitable positions between successive elliptical rolls along the active surface of the rolling screen can been established knowing the characteristic parameters of the material jumps.

RESULTS

As a practical application, will be presented below the results obtained with the computer program for the characteristic parameters of the material jumps on the active surface of the rolling screens provided with elliptical shaking rolls, for the rolling screen regime characterized by:

- the values of the elliptical roll size (more precisely of the big semi-axis of the roll profile) between 0.05 - 0.11 m (in 10 uniform increments);
- the values of the eccentricity of the elliptic rolls profile between 0.5 - 0.7 (in 10 uniform increments);
- the value of the rolling screen speed of 2.1 m/s (from the recommended range: 1.7-2.5 m/s);
- the value of the angle of inclination to horizontal of the active surface of the rolling screen of 30˚ (from the recommended range: 22-32˚).

Determination of the period of time betweethe detachment and return of the material from/on the active surface of the rolling screen

$$tdr_{i,j} := \frac{a_i}{vt} \cdot \left(\phi r_{i,j} - \phi d_{i,j}\right) \cdot \sqrt{\left(e_j\right)^2 + \left[1 - \left(e_j\right)^2\right] \cdot \left(\sin\left(\phi r_{i,j}\right)\right)^2}$$

tdri,j [s] - the period of time between the detachment and return of the material from/on the active surface of the rolling screen

$$tdr = \begin{pmatrix} 0.361 & 0.337 & 0.308 & 0.287 & 0.268 & 0.241 & 0.224 & 0.208 & 0.194 & 0.167 \\ 0.359 & 0.333 & 0.311 & 0.282 & 0.262 & 0.244 & 0.227 & 0.212 & 0.184 & 0.17 \\ 0.359 & 0.335 & 0.304 & 0.283 & 0.264 & 0.247 & 0.217 & 0.201 & 0.187 & 0.173 \\ 0.361 & 0.329 & 0.306 & 0.286 & 0.267 & 0.236 & 0.219 & 0.204 & 0.19 & 0.177 \\ 0.354 & 0.33 & 0.309 & 0.289 & 0.255 & 0.237 & 0.221 & 0.207 & 0.193 & 0.181 \\ 0.356 & 0.333 & 0.311 & 0.276 & 0.257 & 0.24 & 0.224 & 0.21 & 0.197 & 0.157 \\ 0.358 & 0.335 & 0.298 & 0.278 & 0.259 & 0.242 & 0.227 & 0.213 & 0.172 & 0.157 \\ 0.36 & 0.321 & 0.299 & 0.28 & 0.262 & 0.245 & 0.23 & 0.188 & 0.172 & 0.159 \\ 0.346 & 0.322 & 0.301 & 0.282 & 0.264 & 0.248 & 0.206 & 0.188 & 0.173 & 0.161 \\ 0.347 & 0.324 & 0.303 & 0.284 & 0.267 & 0.251 & 0.204 & 0.189 & 0.175 & 0.163 \end{pmatrix}$$

Determination of the coordinates x1 and y1 of the returning point of the materialon the active surface of the rolling screen

$$x1_{i,j} := vd_{i,j} \cdot tdr_{i,j} \cdot \cos\left(\varepsilon d_{i,j}\right)$$

x1i,j [m] - the abscissa of the returning point of the material on the actve surface of the rolling screen

$$y1_{i,j} := \frac{-g \cdot \left(tdr_{i,j}\right)^2}{2} + vd_{i,j} \cdot tdr_{i,j} \cdot \sin\left(\varepsilon d_{i,j}\right)$$

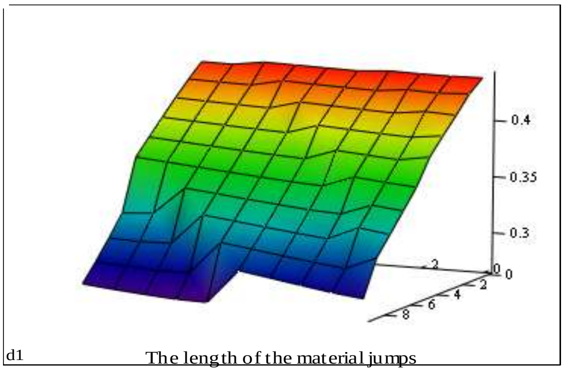
y1i,j [m] -the ordinate of the returning point of the material on the actve surface of the rolling sc

Determination of the distance d1 between the points of detachment/return of the material of/on the active surface of the rolling screen

$$d1_{i,j} := \sqrt{\left(x1_{i,j}\right)^2 + \left(y1_{i,j}\right)^2}$$

d1i,j [m] - distance between the points of detachment/return of the material of/on the active surface of the rolling screen

$$d1 = \begin{pmatrix} 0.439 & 0.429 & 0.415 & 0.401 & 0.386 & 0.364 & 0.347 & 0.331 & 0.315 & 0.283 \\ 0.438 & 0.428 & 0.416 & 0.397 & 0.382 & 0.366 & 0.351 & 0.335 & 0.303 & 0.286 \\ 0.438 & 0.429 & 0.412 & 0.398 & 0.384 & 0.369 & 0.341 & 0.323 & 0.306 & 0.29 \\ 0.439 & 0.426 & 0.413 & 0.4 & 0.386 & 0.359 & 0.342 & 0.326 & 0.31 & 0.295 \\ 0.437 & 0.427 & 0.415 & 0.402 & 0.377 & 0.361 & 0.345 & 0.329 & 0.314 & 0.3 \\ 0.437 & 0.427 & 0.416 & 0.393 & 0.378 & 0.363 & 0.348 & 0.333 & 0.318 & 0.269 \\ 0.438 & 0.428 & 0.409 & 0.394 & 0.38 & 0.365 & 0.351 & 0.336 & 0.289 & 0.27 \\ 0.438 & 0.423 & 0.41 & 0.396 & 0.382 & 0.368 & 0.353 & 0.309 & 0.289 & 0.272 \\ 0.434 & 0.423 & 0.411 & 0.397 & 0.384 & 0.37 & 0.329 & 0.308 & 0.291 & 0.275 \\ 0.435 & 0.424 & 0.412 & 0.399 & 0.386 & 0.372 & 0.327 & 0.309 & 0.293 & 0.277 \end{pmatrix}$$



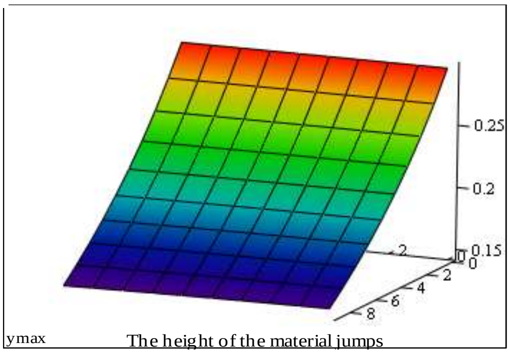
The length of the material jumps

Maximum height ymax of the trajectory of the material detached from the active surface of the rolling screen (which is in free movement)

$$ymax_{i,j} := \frac{\left(vd_{i,j}\right)^2 \cdot \left(\sin\left(\varepsilon d_{i,j}\right)\right)^2}{2 \cdot g}$$

ymaxi,j [m] - maximum height of the trajectory of the material detached from the active surface of the rolling screen (which is in free movement)

$$ymax = \begin{pmatrix} 0.297 & 0.273 & 0.252 & 0.233 & 0.216 & 0.2 & 0.185 & 0.172 & 0.16 & 0.149 \\ 0.297 & 0.273 & 0.252 & 0.233 & 0.216 & 0.2 & 0.185 & 0.172 & 0.16 & 0.149 \\ 0.297 & 0.273 & 0.252 & 0.233 & 0.215 & 0.2 & 0.185 & 0.172 & 0.16 & 0.148 \\ 0.297 & 0.273 & 0.252 & 0.233 & 0.215 & 0.199 & 0.185 & 0.172 & 0.159 & 0.148 \\ 0.297 & 0.273 & 0.252 & 0.233 & 0.215 & 0.199 & 0.185 & 0.171 & 0.159 & 0.148 \\ 0.296 & 0.273 & 0.252 & 0.232 & 0.215 & 0.199 & 0.185 & 0.171 & 0.159 & 0.147 \\ 0.296 & 0.273 & 0.251 & 0.232 & 0.215 & 0.199 & 0.184 & 0.171 & 0.159 & 0.147 \\ 0.296 & 0.273 & 0.251 & 0.232 & 0.215 & 0.199 & 0.184 & 0.171 & 0.158 & 0.147 \\ 0.296 & 0.272 & 0.251 & 0.232 & 0.214 & 0.198 & 0.184 & 0.17 & 0.158 & 0.146 \\ 0.296 & 0.272 & 0.251 & 0.232 & 0.214 & 0.198 & 0.183 & 0.17 & 0.157 & 0.146 \end{pmatrix}$$



As it can be observed, the values resulted for the characteristic parameters of the material jumps for the mentioned rolling screen regime are:

- *the duration of the jumps* has values in the range *0.157-0.361 s*;
- *the length of the jumps* has values in the range *0.269-0.439 m*;
- *the height of the jumps* has values in the range *0.146-0.297 m*.

By analyzing the value ranges obtained for the material jumps parameters, can be choosen one or more sets of convenient values, for certain sets of values of the size and eccentricity of the elliptical shaking rollers and for a certain speed and a certain horizontal inclination of the active surface of the rolling screens (obtained on the basis of the analysis of the working process of the rolling screens provided with elliptical shaking rolls in order to obtain an intense shaking of their active surfaces, as much as possible, but without damaging the useful products (*Safta V.V., 2001; Safta V.V., 2007; Safta V.V., 2008*) by which the optimization procedure of positioning the elliptical shaking rolls along the active surface of the rolling screens can be initiated.

CONCLUSION

There is presented the algorithm and the computer program developed on the basis of the theoretical study for determining the material jumps on the active surface of the rolling screens provided with elliptical shaking rolls.

The computer program is interactive and allows the quick and convenient determination of the characteristic parameters of the material jump on the active surface of the rolling screens depending on the rolling screen regime parameters such as the dimensional parameters of the elliptical rolls (size and eccentricity), the rolling screen speed and the angle of inclination to horizontal of its active surface.

The computer program for calculating the parameters of the material jumps on the rolling screen constitutes a powerfull instrument for the designers of this kind of devices which allows optimization of the positioning of the elliptical shaking rolls along their active surfaces in order to achieve a uniform shaking process over the entire length of the rolling screen active surfaces.

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CONSIDERATIONS ON DECONTAMINATION OF SOILS POLLUTED WITH HEAVY METALS
/
CONSIDERAŢII PRIVIND DECONTAMINAREA SOLURILOR POLUATE CU METALE GRELE

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ABSTRACT
Pollution of environment have become one of the most noxious factors in terms of life quality. This scourge of modern world influences all the ecosystems (air, water, soil). Pollution of these ecosystems may have also natural causes, but, generally the human activity is the main cause of pollution.

This paper presents a series of methods for decontaminating soils polluted with heavy metals, this type of pollution being very toxic and difficult to fight against. Therefore, the noxious effect of heavy metal pollution is emphasized, needing to find appropriate solutions to fight against this pollution. Important steps have been made in this field, but, in order to preserve the future of future generations, research studies must continue and new efficient methods of soil decontamination able to ensure human food safety, should be found.

REZUMAT
Poluarea mediului înconjurător a devenit unul din factorii cei mai nocivi în ceea ce priveşte calitatea vieţii. Acest flagel al lumii moderne influenţează toate ecosistemele (aer, apă, sol). Poluarea acestor ecosisteme poate să se producă şi din cauze naturale, dar în cea mai mare măsură se produce din cauza activităţilor umane.

În această lucrare se prezintă o serie de metode de decontaminare a solurilor poluate cu metale grele, fiind un mod de poluare toxic şi greu de combătut. Prin asta vrem să tragem încă un semnal de alarmă asupra nocivităţii poluării cu metale grele şi asupra faptului că trebuie găsite mai multe soluţii pentru combaterea acestui tip de poluare. S-au făcut paşi importanţi în acest domeniu, dar pentru ca viitorul generaţiilor viitoare să nu fie pus în pericol, trebuie ca lucrările de cercetare să nu se oprească, ci, dimpotrivă, să găsească noi şi eficiente metode de decontaminare a solului care trebuie să asigure securitatea alimentară a umanităţii.

INTRODUCTION
Pollution represents the environment contamination with materials that can affect human health, life standard or natural function of ecosystems (living organisms and their environment).

There are two types of pollutants:

- *Biodegradable pollutants-* substances such as those contained in wastewater, that decompose rapidly through natural processes.
- *Non-degradable pollutants-* substances that do not decompose, or decompose very slowly in natural environment.

Decontamination is the action that removes the noxious activity of bodies contaminated with different substances. A special part within decontamination activities is represented by soil decontamination, where there is a high degree of unpredictability. Even though consistent studies in field are existing, the final volume of soil to be contaminated, can be only estimated.

In fact, the major difficulty in terms of treating the contaminated soils consists in separating the soil of the contaminant contained. Given the large number of soil types, each having a specific composition and also the wide range of contaminants, it results a multitude of possible situations. One of the main issues is the incomplete data and information related to sites potentially contaminated, because there is not any land planning in terms of sustainable use of lands, where industrial enterprises have previously existed (*Grama et al, 2016*).

According to European and national concerns related to soil protection and its sustainable use, recently, Romania is supporting the creation of a legal appropriate framework of harmonization to European laws. Thus, the *„National strategy and national plan of action for managing the contaminated areas in Romania”,* was established.

The goal of this National Strategy is to establish the public policies related to managing the contaminated places up to 2015, (as short term); to solve the problem of areas that require urgent actions by 2020, (as medium term), and finalizing the whole action by 2050 (as long term).

When establishing the National Strategy, the following regulatory documents were taken into consideration:

a) EU laws: - EU Strategy for Soil (Directive EU 2006/0086 (COD)) that proposes to establish the framework for soil protection.

b) Romanian Legislation:

- Law of environment protection no.265/2006 with subsequent alterations and supplements;
- Law regarding the prevention and integrated control of pollution;
- Law of waters no.107/96 with subsequent alterations and supplements;
- HG 1408/19.11.2007 on the methods of investigation and evaluation of soil and subsoil pollution;
- HG 1403/19.11.2007 on the recovering of areas where soil, subsoil and terrestrial ecosystems were affected.

The two big general objectives of National Strategy for management of contaminated areas are:

Strategic Objective 1: Protecting human and environment health against the effects of contaminants resulting from anthropic activities.

Strategic Objective 2: Protecting soil and underground water according to sustainable development principles (*Iofcea et al, 2014*)

MATERIAL AND METHOD

Soil is the vital environment for human being, but it is also very fragile, always submitted to pollution coming from human activities development (industry, transport, agriculture, etc.). Besides these aspects, it is important that the soil acts as a filter for groundwater and it may be also very polluted.

Without human intervention, soil decontamination could take hundreds of years. Therefore, at world level, different methods of soil decontamination were developed, that need to be supported by appropriate organisms and laws.

Table 1 presents the available categories and types of methods and technologies of safety and remediation of soil contaminated by inorganic-heavy metals pollutant (*Malschi, 2014*).

Table 1

Matrix of applicable remedying options: inorganic substances		
Remedying options	**Applying at**	
	Environment (soil, water)	**Heavy metal ions**
Engineering methods		
Limitation of closing systems	soil	x
Limitation of soil isolation barriers	soil/water	x
Excavation and storing	soil	x
Biological methods		
Phyto-remediation	soil	x
Chemical methods		
Soil jet washing	soil	x
Physical methods		
Soil washing	soil	x
Methods of stabilization and solidification		
Binders	soil	x
Vitrification	soil	x
Thermal methods		
Cremation	soil	x
Thermal desorption	soil	x

Methods and technologies of remedying the polluted soils can be classified after the following criteria:

- *Place of application;*
- *Nature of processes to be performed.*

Thus, according to the first criterion, there are *„ex situ"* processes and *„in situ",* processes, and after the second criterion, there are *thermal, physico-chemical and biological processes.*

Methods of treatment ex situ means to excavate the contaminated soil, then to treat it either on the spot, on-site remediation", or in an external installation, „off-site remediation". Methods of treatment in situ are achieved directly in area contaminated, without digging the soil.

A decontamination „in situ"technology, applied especially to soil polluted by metals and that is more and more used nowadays is the *technology of electrochemical remediation.*

Electrochemical remediation process can remove heavy metals and organic compounds out of soil with reduced permeability. This methods use electrochemical and electrokinetic processes for extracting and then removing the pollutants, such as metals.

Principle of electrochemical remediation (Figure 1) is based on applying a low-intensity current into the polluted soil, by means of electrodes made of different materials (stainless steel,graphite,precious metals, etc.). Species charged with current are mobilized, ion and water movement producing towards the electrodes. Metal and ammonium ions and the organic compounds positively charged move to the cathod. Anions, such as chlorine, fluorine, nitrates and organic compounds negatively charged move to anode. Generation of acide conditions in situ enables the mobilization and transport of pollutants towards the catode collecting system.

The main phenomena observed when an electric current is applied to soil, are: electrolysis, geochemical reactions, electro-phoresis,electro-osmosis and electro-migration. This method can be successfully applied to heavy metal contaminated lands, the costs involved depending on: soil quantity to be treated, soil conductivity, type of pollutants, distance between electrodes, type of process applied (*Malschi, 2014*).

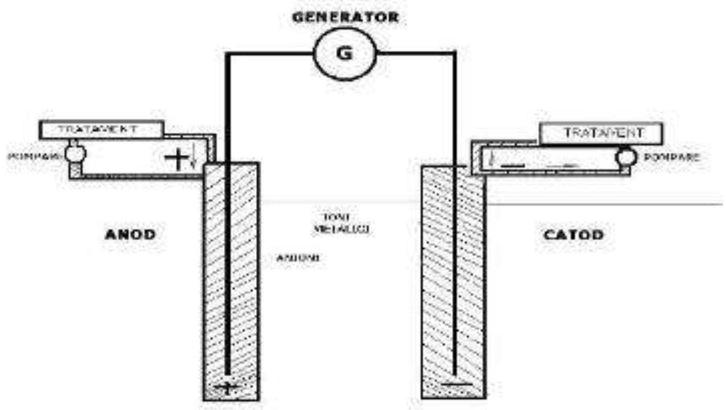

Fig. 1 – Principle scheme of electro-chemical remediation (*Malschi, 2014*)

Cremation is an ex-situ procedure that involves the use of high temperatures designed to destroy pollutants like hydrocarbons, that are transformed into carbon dioxide and water. The working procedure is initially based on the excavation of respective area and transport of contaminated soil at a working unit where it is submitted to preparation operations in view of cremation: drying, breaking and volumetric classification.

The effective cremation of contaminated soil is usually achieved in two phases:

- First phase consists in pollutants volatilization at temperatures smaller than 400 ºC;
- Second phase consists in destroying the pollutants by burning them at temperatures over 1000 ºC.

Material resulted from the preparation unit is introduced into the rotative stove, where it is heated and stirred, in order to remove the volatile pollutants. The thermal process is adjusted so that when it is evacuated from the stove, the solid material be exempt of pollutants. After cooling, this material may be put again in the excavated area. Heavy metals volatize or remain in soil matrix bound to mineral compounds. If the soil cremated contains volatile heavy metals (Zn, Cd, or Pb), combustion gases should be treated in order to separate, recover and eventually recapitalize these metals.

Principle scheme of an ex-situ cremation installation is shown in Figure 2.

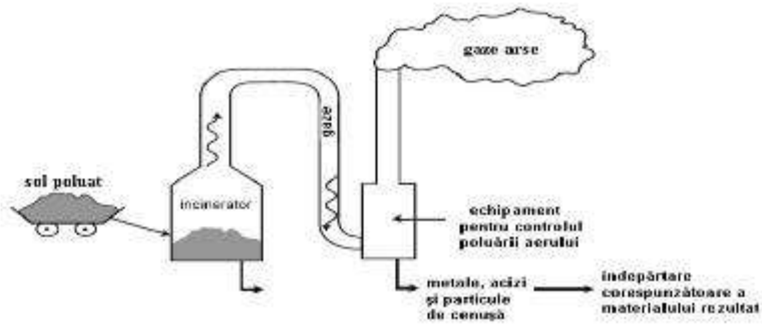

Fig. 2 - Priciple scheme of an ex-situ cremation installation for soil (*Malschi, 2014*)

Bacteria use represents a biotechnology frequently used for soil decontamination. It is well known that microorganisms and especially bacteria have an impressive capacity of treating the substances. Nowadays, bacteria degrade phenol, hydrocarbons, pesticides and contribute to elimination of arsenic and heavy metals.

This biomass, that can be found until 500 m depth, can be considered as a huge natural washing machine, able to treat and recycle and even remove unwanted elements like hydrocarbons or heavy metals. Using bacteria activity, it is possible to diminish the metals harmfulness by fixation, or, instead, facilitate their recovering (*Resolmet Report, 2008*).

Figure 3 shows the scheme of a biotechnology of «in-situ» treatment.

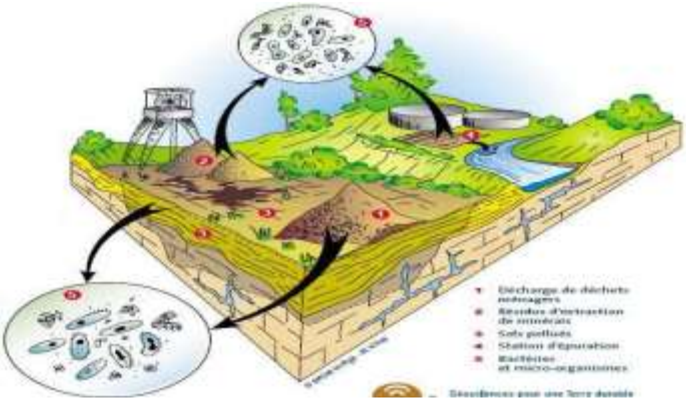

Fig. 3 – Biological technology allowing „in situ » treatment, that limits the costs (*Resolmet Report, 2008*)

Also based on bacteria, another technique of decontamination is useful, namely *bio-xliviant process*, successfully used in Romania too. This method is based on the microorganisms capacity of transforming the solid compounds, namely heavy metals into soluble elements, that are afterwards extracted and can be recovered.

Therefore, it is of great interest to find, isolate and select bacteria in the area polluted, so that to find the most efficient microorganisms necessary to remove the pollutant from soil. The selected bacteria cultures will be processed in laboratory, in order to increase their decontaminating efficiency, being afterwards introduced in habitats affected, respectively in experimental models designed to remediation of contaminated soils.

Among the biological treatments for recovering the heavy metal contaminated soil, the *phyto-remediation is successfully used.*

Major advantages of phyto-remediation comparing to traditional remedying technologies include:
-possibility of generating less secondary waste;
-minimum degradation of environment;
-possibility of leaving the soil in the same place and able to be used after treatment;
-reduced design costs for lands to be remedied;
-method requires less technique, because the implementation requires only the basic agricultural techniques.

Disadvantages include:
- long time required (generally, several seasons of growing);
- limited depth (1.2 m for soil) because the roots can ensure an appropriate cleaning up to a limited depth;
- possibility that pollutants enter the food chain through plants consume by animals;
- operation characteristics and implementation costs have not been entirely evaluated;
- plants residues may be dangerous sediments or require additional treatment;
- degraded by-products can be led to groundwater or bio-accumulated in animals;
- if contaminants concentration is too high, then plants might die;
- plants growing can be seasonal depending on location;
- climate and hydrological conditions (eg. floods, drought) can limit the growing development of plant to be used;
- surface of respective land can be modified for preventing the floods or erosion;
- soil amendments may be necessary, including chelation agents for enabling the plants to take over the pollutants by breaking the bounds between contaminants and soil particles (*https://www.scribd.com*).

Phyto-remediation mechanisms include intensified biodegradation in rhizosphere (*rizo-degradation*), phy*to-extraction* (phyto-accumulation), *phyito-degradation and phyto-stabilization*.

Rizo-degradation takes place in the soil section that circles the plants roots.

Phyto-extraction is the process by which plant roots absorb not only the water but also the nutrients and contaminants from soil(metals, especially) (*https://www.scribd.com*).

European Union have started a research phyto-remediation program named PHYTOTEC.

Seven countries are partners in this program: Poland, Italy, Spain, Czech Republic, Holland, Belgium and France. Other research institutions are working together, such as Pasteur Institute, Ineris, Agency Apeim CEA, CNRSSP. Objectives are to find and jointly gather the results related to decontamination methods and costs involved.

Phyto-remediation can be performed by several mechanisms. It comprises 2 categories:

- Active remediation, that effectively destroys the pollution;
- Passive remediation, that only stabilizes the pollution.

Decontamination techniques based on plants are of four types:

- P*hyto-stabilization:* Roots settle the pollutants limiting their horizontal and vertical circulation. This technique is used as the first measure in case of soils polluted with heavy metals.

- *Phyto-extraction:* It is a method of soils decontamination of heavy metals (copper, silver, gold, mercury, cadmium, lead). It is based on plant culture, having characteristics of tolerance and heavy metal accumulation on their harvesting part. There are two types of phyto-extraction:

A. Continuous phyto-extraction: Plants used are able to accumulate a high quantity of pollutants. These plants cannot live without metals. They are called metallophytes.

B. Induced phyto-extraction :Metals from soil are not always soluble into water(bio-available) In this case, it is recommended to use molecules named « Chelates » for releasing the metals. For example, for lead should be used EDTA: ethylene diamino tetra-acetic acid. Today, over 320 plants accumulating heavy metals are known, among which the plants of type I, accumulate Al, Ag, As, Be, Cr, Cu, Mn, Hg, Mo, Pb, Pd, Pt, Se, Zn.

- *Rizo-degradation*: It is used mostly for pollution treatment with hydrocarbons.

- *Phyto-volatilization*: Plants can also degrade organic pollutants in their cells.

In this context, we may say that there are many plants able to decontaminate the soil from different pollutants and, especially from heavy metals. In 1980, Bradshaw and Chadwick from Great Britain have classified 140 of species of grass and 70 species of vegetables. At the same time, the wild plants are not at all neglectable, having excellent features for fighting against soil pollution. Also, the trees or shrubs have their contribution.

Examples of grassy plants, shrubs and trees efficient in phyto-remediation of contaminated soils:

-bentgrass, meadow foxtail, cock's-foot, festuca, corncockles, reygrass, Timothy grass, bluegrass, bird's foot trefoils, narrow-leaf lupin, alfalfa, beans, trefoil, sweet clover, coronilla,fenugreek, broom, sea medick, Mongolian milkvetch, goat's thorn purple oxytropis, liquorice, crown vetch, alpine sainfoin, sainfoin, chickpea, garden vetch, lentil, black pea, cowpea;

- sycomore maple, American maple, black alder, white alder, maple tree, fluffy apple, beech, Russian olive, ash tree, European larch, pine, black pine, sycomore, black poplar, common aspen, acacia, violet willow, brown willow, large grey willow, purple willow, chokeberries (*https://ro.wikipedia.org*).

RESULTS

Having in view that soil pollution is a delicate issue within current life on this planet, the goal aimed both at national and world level is to take the necessary measures to reduce this scourge. In Romania, within the context of industrial enterprises (with high heavy metal potential) abolishment, the respective areas were successfully decontaminated with the methods above.

Thus, in Copşa Mică area, considering the large surfaces polluted with Pb and Cd, a series of researches were performed with good results.

It has found that at basic pH, metals are transformed in insoluble compounds heavy to access by plants, therefore, one method would consist in modifying the pH by using certain materials:

- Absorption on different compounds of big surface and appetency;

- Materials: limestone, zeolites, iron oxyde, Chinese red.

In terms of texture the arable layer of soil in the area is mainly of clay-sandy type, rich in carbons, therefore the pH is rather high, instead the acid rains.

Soil high pH- directly influences the mobility of heavy metals, diminishing it. Thus, at below 50-100 cm depth, the concentration of heavy metals is very reduced and the possibility of contaminate the groundwater is also very small.

At the same time, another approach is to cultivate technical plants within *phyto-exclusive plants*, defined as plants that do not allow to high concentrations of heavy metals to reach the upper parts; such a plant is *Miscanthus sinensis x gigantheus*. The first results show that *Miscanthus sinensis x gigantheus*se can be successfully cultivated in soil polluted with heavy metals, and its chemical and combustion features are excellent.

In this area, several plots cultivated with *Miscanthus* and poplar were studied.

Important results were obtained in terms of heavy metals, where values were of 3.71 ± 0.73 mg/kg d.m. for lead and 2.12±0.44 mg/kg d.m. for cadmium.

These values extremely small, close to values suitable to human consumption, are very important, because in soil the content of Pb was of 682.50 mg/kg d.m. and that of Cd -13.47 mg/ kg d.m. Advantage is that the resulted biomass can be used subsequently for obtaining briquettes or pellets for heating.

Laboratory of Microbiology of UBB Biology Cluj-Napoca has a rich expertise in terms of bioremediation of technogenous soils, namely of refuse material resulted from mining of Pb, Zn and Fe. Thus, we participated at the research activity aimed at the bioremediation of useless materials from Rodna, Bistriţa county (Pb and Zn), respectively, Iara, Cluj county (Fe).

14 experimental plots were installed on mining refuse material from Rodna and were submitted to different treatments and sown with perennial *Lolium and Trifolium pratense*. Aterwards, in this area were planted seedlings of underbrush *Hippophae rhamnoides*.Biotechnologies applied created favourable conditions for microorganisms development and for an intense and durable enzyme activity. The best technology for bioremediation of mining waste containing impurities of Pb and Zn was to cover with a layer of 10 cm of natural soil, from the neighbourhood area, mineral fertilization with NPK and sowing a mixture of herbal plants from region spontaneous flora. On terraces and slopes of refuse material coming from Iara iron mine, over 2000 seedlings of trees and shrubs, majority underbrush *Hippophae rhamnoides, were planted*. 26 experimental plots, cultivated with different herbal species were established.

At the same time, the method of induced *phyto-extraction*, by using the molecules named chelation molecules, for releasing metals such as lead for which is recommended (EDTA), has been successfully applied in France. The procedure was tested at Caldarache with the support of PHYTODEC program and it was concluded that 20% out of zinc, 40% out of lead and 60% out of cadmium were extracted from the sediment tested.

CONCLUSIONS

Once polluted, soils are difficult to recover. Therefore, it is better to prevent, to think that Earth belongs not only to us but also to future generations, so let us keep it as clean as possible.

There are not infallible secure and unique methods for soil decontamination. Methods used up to present should be combined according to soil type and pollutant concentrations.

Costs necessary to decontaminate the polluted soils are rather big.

Therefore, for preventing and develop the decontamination techniques it is necessary a joint effort from all parts involved, starting from simple citizens up to decision actors at national and international level and ecosystem decontamination should continue.

ACKNOWLEDGEMENT

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RESEARCHES ON THE ACID HYDROLYSIS OF THE PEAT FOR THE REALIZATION OF BIOSTIMULATORS FOR THE GROWTH OF PLANTS / *CERCETĂRI PRIVIND HIDROLIZA ACIDĂ A TURBEI ÎN VEDEREA REALIZĂRII DE BIOSTIMULATORI PENTRU CREĂTEREA PLANTELOR*

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Keywords: *peat, hydrolysis, biostimulators, plant growth*

ABSTRACT

The paper presents the results of the research carried out for obtaining, through acid hydrolysis of peat, some biostimulators (humic acids, fulvic acids) for the growth of plants. The experiments were carried out in two variants: hydrolysis with sulfuric acid and hydrolysis with phosphoric acid. Parameters used during hydrolysis were: 2.5%, 5% and 10% acid concentration; autoclave temperature 100, 120 and 130 °C, autoclave pressure 1, 2 and 2.7 bar and autoclaving time 1.5 respectively 3 hours. As a measure of the hydrolysis effectiveness, the yields of the hydrolysates were determined. Parameter variation has influenced the hydrolysis process, with higher values leading to an increase of dissolution performance. For the same conditions of sample preparation and analysis, higher dissolution yields were obtained for hydrolysis with sulfuric acid than with hydrolysis with phosphoric acid.

REZUMAT

Lucrarea prezintă rezultatele cercetărilor efectuate pentru obținerea, prin hidroliză acidă a turbei, a unor biostimulatori (acizi humici, acizi fulvici) pentru creșterea plantelor. Experimentele au fost efectuate în două variante: hidroliza cu acid sulfuric și hidroliza cu acid fosforic. Valorile parametrilor utilizați în timpul hidrolizei au fost: concentrația acizilor 2,5 %, 5% si 10%; temperatura în autoclavă 100, 120 și 130 °C, presiunea în autoclavă 1, 2 şi 2,7 *bar, durata de menținere în autoclavă 1,5 si 3 ore. Ca masură a eficacității hidrolizei au fost determinate randamentele de dizolvare (extracție) ale hidrolizatelor. Variația parametrilor a influențat procesul de hidroliză, valori mai mari conducând la creșterea randamentului de dizolvare. Pentru aceleași condiții de preparare și analiză a probelor s-au obținut randamente mai ridicate de dizolvare în cazul hidrolizei cu acid sulfuric decât în cazul hidrolizei cu acid fosforic.*

INTRODUCTION

Agricultural production depends, among others, on the amount of nutrients available in the soil. To improve the organic soil content, there are several possibilities, such as crop rotation (*Gidea et al., 2015*), different cropping techniques, applying conservative soil cultivation techniques (*Vlăduţ V. et al., 2018*), green fertilizer application (*Ramia et al., 2014*) and animal fertilizer application (*N'Dayegamiye and Tran, 2001*)

Biostimulators are extracts obtained from organic raw materials that have bioactive components in the structure and are used as such or as components of green fertlizer. The most important components of biostimulators are mineral elements, humic substances, vitamins, amino acids, chitin, chitosan, and poly- and oligosaccharides (*Bulgari et al., 2015*).

It has been found that humic substances stimulate plant growth and yield by acting on the mechanisms involved in cell respiration, photosynthesis, protein synthesis, water and nutrient uptake, enzyme activities, improvement of soil structure and increase of microbial populations (*Canellas and Olivares, 2014; García et al., 2012; Keller et al., 2009).*

Peat, due to its complex structure and chemical composition, can be used as a raw material in chemical and biochemical processes. Hence, it is possible to use it as a fertilizer in agriculture. For a long time, peat has been used only as a mean to improve the soil structure and increase its organic mass content.

It has been found that the use of chemical compounds resulting from peat facilitates the growth and development of plants, shortens the period to maturity and increase the quantity and quality of crops.

The main disadvantage of unprocessed peat is that the active substances it contains: humic and fulvic acids, biostimulators such as cytokinins, gibberellins, auxins, steroids, vitamins and amino acids are strongly bound in the peat structure by both chemical and hydrogen bonds, which is why these compounds are hardly accessible by the plants and thereby used in a lesser proportion than the optimal one.

On the other hand, peat, in addition to biostimulating compounds, also contains compounds (waxes, bitumens, resins etc.) with inhibitory action on the metabolic processes in soil and plants. Removal of these by extraction with selective solvents proved to be practically uneconomical.

Many research has been carried out in articles or patents, with the objective of making available, for the plants, of the bio-stimulating components from the peat and to increase the content of soluble carbohydrates, nutrients of microorganisms, bacteria and enzymes facilitating the absorption of the elements fertilizers (N, P, K), which leads to fully plant development (*Botero et al., 2010; Cota et al., 2017; Helal et al. 2011; Prado et al., 2016; Shulgin, 2013*).

MATERIAL AND METHOD

The materials used for the experiments were:

- wet peat from Mircurea Ciuc, Harghita, 72% moisture content, relative to the wet substance and an ash content of 8%, resulting an organic content of 92% relative to dry substance;
- sulfuric acid p.a. (98% purity);
- phosphoric acid p.a. (85% purity);
- distilled water;
- tap water.

Sulfuric and phosphoric acid solutions with 2.5%, 5% and 10% concentration (C) were prepared with tap water. The wet peat was mixed with these solutions in a liquid / solid ratio of 4.

The paste obtained was milled in a mortar to break the long strands of peat and reduce the grain size below 250 µm.

The prepared samples were transported in sealed glass containers. Three samples of each composition in their own vessel were placed in a autoclave at a temperature (T) of 100 °C, 120 °C and 130 °C respectively at 1 bar, 2 bar and 2.7 bar, respectively.

Duration (t) in autoclave was 1.5 hours respectively 3 hours.

After removing from the autoclave and cooling, 10 g from the content of each container was mixed with 100 ml of distilled water. The mixtures were stirred under heat at 50 °C for 10 minutes, then passed through a filter paper funnel.

In order to filter the entire amount of solubilized material from the sample, the remaining residue on the filter was washed with distilled water until the pH of the filtrate reached 6.5.

To determine the mass of the undissolved substances contained in the samples, the residue remaining on the filter was dried in the oven at a temperature of 105 °C up to reaching constant mass.

REZULTS

The values thus obtained were used for calculating the dissolution yields.

Dissolution yields for each sample were expressed as the ratio of mass loss, resulted from the extraction and separation of the liquid portion consisting in humic acids, fulvic acids and solubilized cellulose from the dry solid material contained in the 10 g sample taken in the analysis in each container, and the mass of dry solid material initially contained in the peat content of the 10 g samples.

The formula used to calculate the dissolution yields was:

$$\eta\ [\%] = \frac{m_{d.m.a.} - m_{d.m.res.}}{m_{d.m.a.}} \times 100 \qquad (1)$$

where:

$m_{d.m.a.}$ is the mass in grams of dry matter from 10 g of sample taken for analysis;

$m_{d.m.res.}$ - the mass, in g, of the dry matter corresponding to the same sample, of the residue remaining on the paper filter.

The results obtained are shown in Table 1 for the case where the sulfuric acid is used for extraction of biosynthetic material (humic acids and fulvic acids) from peat and in Table 2 where phosphoric acid was used.

Table 1

Dissolution yields for the use of sulfuric acid as extraction agent

Reaction time, t, [h]	T [^{0}C] / C [%]	Dissolution yields, η [%]		
		100	120	100
1.5	2.5	11.8	26.3	37.0
	5.0	15.4	37.7	50.5
	10.0	18.7	53.1	64.0
3	2.5	15.5	30.8	38.7
	5.0	20.3	36.2	58.3
	10.0	22.9	62.5	73.0

Table 2

Dissolution yields for the use of phosphoric acid as extraction agent

Reaction time, t, [h]	T [^{0}C] / C [%]	Dissolution yields, η [%]		
		100	120	130
1.5	2.5	7.8	17.9	29.3
	5.0	11.3	22.8	38.4
	10.0	16.7	42.3	55.7
3	2.5	12.4	24.7	32.5
	5.0	17.3	30.8	48.6
	10.0	20.8	42.9	62.3

Dilution yield values in Table 1 and Table 2 represent the average of the yield values of the three samples taken for analysis in each composition.

From the above mentioned, it is ascertained that for hydrolysis with sulfuric acid for t = 1.5 hours the dissolution yield increase from 11.8% for the solution concentration C = 2.5% and the autoclave temperature T = 100 °C corresponding to a pressures of 1 bar to 64% when the concentration of the C = 10% acid solution and the autoclave temperature of 130 ° C, corresponding to a pressure of 2.7 bar. If the reaction time increases to t = 3 hours, the dissolution yield increase from 15.5% for solution concentration C = 2.5% and autoclave temperature T = 100 ° C corresponding to a pressure of 1 bar to 73% when the concentration C = 10% acid solution and autoclave temperature T = 130 ° C, corresponding to a pressure of 2.7 bar

In case of phosphoric acid hydrolysis for t = 1.5 hours the dissolution yield increase from 7.8%, for the solution concentration C = 2.5% and the autoclave temperature T = 100 °C corresponding to a pressure of 1 bar, to 55.7% when the concentration of the C = 10% acid solution and the temperature in the autoclave of 130 ° C, corresponding to a pressure of 2.7 bar.

If the reaction time increase to t = 3 hours, the dissolution yield increase from 12.4% for solution concentration C = 2.5% and autoclave temperature T = 100 ° C corresponding to a pressure of 1 bar to 62.3% when the concentration of the C = 10% acid solution and the temperature in the autoclave T = 130 ° C, corresponding to a pressure of 2.7 bar.

CONCLUSIONS

Acid hydrolysis of peat is possible to obtain biostimulators (humic acids, fulvic acids) for plant growth.

Process parameters, acid concentration, reaction time, temperature and pressure, influence the process of hydrolysis, higher values result in increased dissolution performance.

For the same sample analysis conditions, higher dissolution rates are obtained for hydrolysis with sulfuric acid than with hydrolysis with phosphoric acid.

This is explained by the fact that sulfuric acid is a stronger acid, having higher acidity constants compared to phosphoric acid.

In addition, sulfuric acid can lead to high oxidation reactions, resulting in higher amounts of more soluble compounds with carboxyl groups in the hydrolysate.

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OATS AND THE GLUTEN-FREE DIET
/
OVĂZUL ȘI ALIMENTAȚIA FĂRĂ GLUTEN

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Keywords: *oats, celiac disease, CaCo2 cells, gluten-free diet, baked products*

ABSTRACT

Oats (Avena sativa L.) are high-protein cereal-grain crop, contain a high amount of lipids and represent a good source of fiber and minerals. Oats have been traditionally viewed as a nutritious cereal for infants and adults, and there are evidences that oats may help to prevent or alleviate several chronic diseases. This paper presents the results obtained using oats as a bio-resource with potential for bakery, in the production of gluten free baked products. This work was supported by the project PCCA2 no.111/2012 funded by UEFISCDI and project 26 PFE/2018 funded by Ministry of Research and Innovation through Program 1- Development of the National R&D System, Subprogram 1.2- Institutional Performance - Projects for Excellence Financing in RDI.

REZUMAT

Ovăzul (Avena sativa L.) este una dintre cerealele cu un conținut proteic ridicat, conține o cantitate mare de lipide și reprezintă o bună sursă de fibre și minerale. Ovăzul a fost privit în mod tradițional ca o cereală nutritivă pentru sugari și adulți și există dovezi că ovăzul poate ajuta la prevenirea sau ameliorarea mai multor boli cronice. Această lucrare prezintă rezultatele obținute prin utilizarea ovăzului ca resursă biologică cu potențial de aplicare în panificație, în fabricarea produselor fără gluten. Această lucrare a fost realizată în cadrul proiectului nr. 111/2012 finanțat de Autoritatea Națională pentru Cercetare Științifică, CNDI-UEFISCDI și a proiectului nr. 26 PFE/2018 finanțat de Ministerul Cercetării și Inovării prin Programul 1–Dezvoltarea sistemului național de cercetare-dezvoltare, Subprogram 1.2–Performanță instituțională-Proiecte de finanțare a excelenței în CDI.

INTRODUCTION

Celiac disease (CD) is a chronic immune-mediated inflammatory pathology of the small intestine provoked by dietary gluten. CD is the most common and increasing food intolerance, affecting approximately 1% of the worldwide population (*Lionett et al., 2015*).

It is difficult to evaluate the exact amount of gluten that people may tolerate without to develop negative effects and this varies between individuals, but less than 10 mg of daily gluten intake has considered safe and unlikely to cause significant abnormalities (*Catassi et al., 2007; Gobbetti et al., 2018)*.

Gluten-free diet (GFD) demands a lifelong exclusion of raw materials, foods, and beverages containing gluten and its toxic fractions. Following a strict GFD is the most important key to optimizing health with celiac disease. The treatment of celiac disease is based on the lifelong exclusion of gluten-containing cereals from the diet. Substitute raw foods include rice, potatoes, soybeans, maize, millet, buckwheat, amaranth, and quinoa. The diet may be low in fiber, iron, folate, calcium, magnesium, zinc, B-complex vitamins (thiamin, riboflavin, niacin, and vitamin B12), as well as vitamin D. *Kinsey et al. (2008)* found that celiacs adhering to a GFD may be at risk for inadequate intake of calcium, non-starch polysaccharides, and vitamin D. These findings demonstrate that the nutritional quality of GFDs should be considered. Lee et al. (2009) compared a “standard GFD” (naturally gluten-free grains and products) and an “alternative GFD” (oats flour, high-fiber gluten-free bread, and quinoa). The alternative grains provided a significantly higher nutritional profile.

Oats are unique among cereals for their multifunctional characteristics and nutritional profile. The oat does not contain gliadin, but an equivalent, avena. In wheat, rye and barley, prolamins represent 40-50, 30-50 and 35-45%, respectively, of the total protein. In the case of oats, prolamins represent only 10-15% of the total protein and 60 g of oats are estimated to contain 1.2 g of avenins Even though the inclusion of oats in gluten-free diets was controversial until 1996, several recent studies have indicated that oats are not unsafe for those suffering from celiac disease or herpetiform dermatitis. Moreover, adherence to a strict gluten-free diet is difficult, and any relaxation of dietary restrictions, such as oats, may make the diet easier for patients to accept. Oat improves the nutritional value of gluten-free diets without adverse effects and is appreciated by patients. Thus, oats can help the celiac patients following a strict gluten-free diet (*Butt et al, 2008*). The use of oats as part of a GFD is not widely recommended in the USA or in Europe. Ingestion of oats is generally safe for patients with celiac disease, but since oats are often contaminated with wheat gluten and other seeds, only oat from gluten-free sources is recommended for inclusion in the gluten-free diet. Although many studies suggest that oats are not dangerous for celiac disease patients (*Koskinen et al., 2009; Holm et al., 2006),* most commercially available oatmeal is contaminated with 10-15% wheat.

Silano and colleagues (2007) observed quantitatively different cytotoxicity of avenin from three oat varieties on the K562 cell line, as measured by their agglutination and damage to lysosomes. The authors suggest that some oat varieties may be potentially harmful and prevent complete mucosal recovery in individuals with CD.

$CaCo_2$ cells are most often used not as individual cells but rather for their ability to form a confluent monolayer on an insert filter (e.g., Transwell). When grown in this format, the cells differentiate to form a physical and biochemical barrier to the passage of ions and small molecules. The monolayer formed by $CaCo_2$ cells is widely used in the pharmaceutical industry as an *in vitro* model of human intestinal mucosa to predict the absorption of orally administered drugs. The epithelium of the small intestinal mucosa is a dynamic system with rapid cell regeneration through migration, differentiation and apoptosis. Different intestinal cancer cells have long been studied for the functioning of the small intestine mucosa in the context of celiac disease. Between these, a rectal adenocarcinoma cell line, $CaCo_2$ cells spontaneously undergo a differentiation process under culture conditions, forming a confluent monolayer, polarized with a brush border, and intercellular junctions. The effect of gluten (gliadin) on the intestinal epithelium, one of the most important barriers to the body's defence and the site of absorption of nutrients from the diet was assessed by using the $CaCo_2$ cell line.

This paper presents the results of experimental research on obtaining oat based gluten free biscuits, the physico-chemical properties of the obtained products and assessment of safety of the products in the diet gluten intolerant individuals.

MATERIAL AND METHOD

Samples used in the experiments: gluten-free oat flour and gluten-free oat bran were purchased from Glebe Farm Foods Limited (U.K.). These samples were used in baking tests for obtaining gluten-free food products. Commercially available sugar, eggs, shortening, citric acid, sodium and ammonium bicarbonate were used for baking tests.

Raw materials physicochemical analysis

The floury raw ingredients were analysed for: humidity (%), acidity (grades), protein content (%), ash (%), fat content (%) based on standard SR 90:2007, fibers (%) in accordance with method AOAC 991.443. Total carbohydrates (%) were calculated by difference by the following formula: 100 - (weight in grams [protein + fat + water + ash + alcohol] in 100 g of food). Mineral content was determined by atomic absorption spectrophotometry (atomic abortion spectrometer AAnalyst 400).

CaCo2 Cells for raw ingredients analysis

A human colono-rectal epithelial adenocarcinoma cell line ($CaCo_2$) was used for cytotoxicity and transepithelial electrical resistance measurements. Cells were used between passage p75-p80. Cell line was purchased from European Cell Culture Collection (UK).

Preparation of flour samples

Two flour samples (a flour containing gluten and a gluten-free flour) were predigested in an *in vitro* system after extraction with ethanol:water (2.3:1). The extract from 2.5 g of each flour assay was dissolved in 25 mL of 0.2 N HCl for 2 h at 37°C. The resulted solution was digested by adding 0.05 g of pepsin after adjusting the pH to 7.4 using 2M NaOH. After stirring for 4h at 37°C and boiling (100°C) for 3 minutes, the extracts were evaporated to rotavapor, resuspended in tampon phosphate and frozen at -20°C until use.

Viability and cytotoxicity assay

The cell viability was quantified by measurement of reduction of 3-(4,5 dimethylthiazol-2-yl)-2,5-diphenyl tetrazolium bromide (MTT) produced by dehydrogenases in mitochondria of living cells. $CaCo_2$ cells were seeded in 96 wells plate at a concentration of $2x10^5$ cells/ml in medium MEM supplemented with 20% SFV, 2 µM L-glutamine, 100 µg/ml penicillin and 100 µg/ml streptomycin for 24h. After 1h at 37^0C, 10 µl MTT solution in PBS (5 mg/ml) was added to each well and mixed thoroughly. After incubation for 4 h at 37^0C, 100 µl of MTT solvent (0.1N HCl in anhydrous isopropanol) was added to each well and plates were read within 1 hour after adding MTT solvent. The absorbance was measured at 570 nm using a microplate reader (TECAN SUNRISE, Austria) and the absorbance of the background at 650 nm was subtracted.

Measurement of transepithelial electrical resistance (TER)

CaCo2 cells were seeded at a concentration of $2x10^5$ cells/ml in insert filters. After confluence (1-2 days), the cells were cultured for a further period of 21 days at 37°C in an atmosphere with 5% CO_2 until they reached an approximate TER of 0.6 Ohm/cm^2. The culture medium was changed every two days and before the start of the experiment, the medium was changed with MEM medium with 1% fetal serum supplemented with 2 µM L-glutamine, 100 µg/ml penicillin and 100 µg/ml streptomycin in order to induce cell starvation. After 24 hours, the medium was again replaced with MEM medium supplemented with 20% SFV, 2 µM L-glutamine, 100 µg/ml penicillin and 100 µg/ml streptomycin and in the apical pore of the filters, extracts with and without gliadin were administrated at concentrations of 1 mg/ml. Transepithelial electrical resistance was measured at different time intervals: 30 min, 60 min, 90 min, 180 min, 270 min, 360 min after treatment.

Oat based gluten-free biscuits preparation

Gluten-free biscuits were obtained based on: 100% oat flour, 100% oat bran and 50% oat flour and 50% oat bran. The other ingredients were: shortening (26.6%), sugar (21.6%), egg (33.3%), sodium bicarbonate (0.3%), ammonium bicarbonate (0.3%), citric acid (0.6%) and water (33.3%). Fat, sugar and egg were creamed in a planetary mixer (Minneapolis, model PM 7, La Felsinea Srl, Italy) for 5 min at low speed (75 rpm). Then, the OF/OB blend and water containing the dissolved baking powders were added and mixed to form the dough for another 5 min. The dough was kept in the fridge for 24 h for a better hydration of the bran. Then, cookies of 8 cm length, 2 cm width and 1 cm height were obtained using a dropping machine (Mimac Italia Srl, Piovene Rocchette, model MINIDROPPRO 400-Y7). The cookies were transferred to a baking tray and baked at 190°C for 25 min in an oven (Mondial Forni, Verona, Italy). After baking the cookies were cooled at room temperature and packed in sealed bags before analysis (*Duta and Culetu, 2015*).

Oat based gluten-free biscuits physicochemical analysis

The gluten-free biscuits were analysed for: humidity (%), protein content (%), ash (%), fat content (%) based on standard SR 90:2007. Total carbohydrates (%) were calculated by difference by the following formula: 100 - (weight in grams [protein + fat + water + ash + alcohol] in 100 g of food). Calorie contents were calculated using the following conversion factors: 9 for fat, 4 for carbohydrates, 4 for protein and 2 for fibre (regulation EU no.1169/2011).

RESULTS

The proximate compositions (expressed as % dry matter) of oat flour and oat bran (Table 1) shows that bran has a higher content of protein, ash, fat and fibers than flour. This composition varies function variety and environment. Oat (*Avena sativa* L.) is distinguished from other cereals due to higher protein content, being considered to be one of the largest sources of protein.

Oats have a much higher lipid content than other cereals, thus being an excellent source of energy and unsaturated fatty acids. In the different varieties of oats, the lipid content is 2 to 5 times higher than that of wheat and barley. Oats are a good source of fibers. Whole oat has a very high fiber content (20-37%). However, after husking, the fiber level is between 10% and 12%, with about 40% as soluble fiber and 60% as insoluble fiber (*Menon et al., 2016).* The soluble fiber from oat is very effective to lower blood cholesterol and normalize blood sugar levels (*Butt et al, 2008*).

Table 1

Physico-chemical analysis of raw ingredients

Samples/ Method of analysis	Humidity, %	Acidity, grades	Protein, %	Ash, %	Fat, %	Fibers, %	Total carbohydrates, %
Gluten-free oat flour	11.20±0.15	3.8±0.2	11.40±0.25	1.51±0.04	5.17±0.3	16.30±0.5	54.42±0.2
Gluten-free oat bran	10.99±0.15	3.6±0.2	14.87±0.25	2.95±0.04	7.17±0.3	28.92±0.5	35.10±0.2

The oat is rich in phosphorus and potassium, and has a lower content of magnesium, calcium, iron, zinc and copper, concentrated mainly in bran (Table 2). However, the mineral content of cereal grains can not reflect their bioavailability due to possible interactions with whole grain fibers (*Gulvady et al., 2014*). Much of the mineral content is associated with the fraction of soluble fiber in oats and also the fibers of oat bran, which bind minerals *(Menon et al., 2016*).

Table 2

Mineral content analysis of raw ingredients

Samples	Elements								
	Ca mg/100 g	Fe ppm	Mg mg/100 g	Mn ppm	Zn ppm	K mg/100 g	P mg/100 g	Na mg/100 g	Cu ppm
Gluten-free oat flour	112.17± 11.2	16.99± 1.6	43.46± 4.3	6.99± 0.6	9.47± 0.9	322.75± 38.6	355.58± 42.6	7.85± 0.7	4.28± 0.4
Gluten-free oat bran	158.04± 15.8	32.37± 3.2	89.83± 8.9	11.8± 0.1	17.85 ±1.7	608.43± 72.9	552.13± 66.2	7.68± 0.7	4.92± 0.4

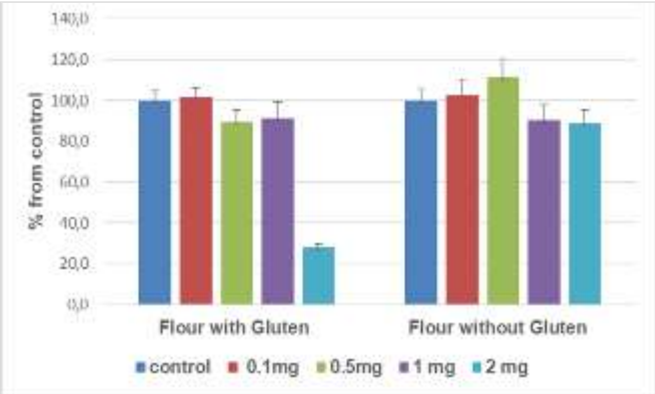

Fig. 1.- CaCo2 cells viability

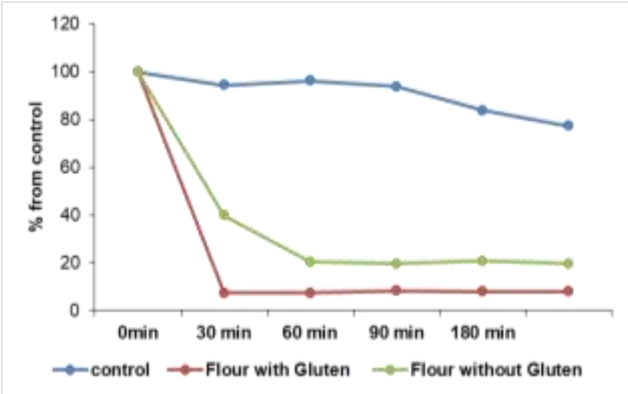

Fig. 2.- Transepithelial electrical resistance

Figure 1 presents the viability of CaCo2 cells and demonstrates that the viability is maintained high for flour without gluten, especially at concentrations up to 0.5 mg and for 1-2 mg, the viability is less decreased but still more than 80% from the control. In case of flour with gluten, for 2 mg the viability of cells decreased dramatically. Other studies have demonstrated a reduction in gliadin-induced cell viability also. Thus, Sakly et al. (2006) studied the effect of gliadin-derived peptides (p56-88, p57-68 and p31-49) whose role in celiac disease has recently been demonstrated. The authors showed a significant decrease in the number of CaCo2 cells after administration of the p56-88, p57-68 and p31-49 proteins at a concentration of 25 μM. Indeed, the percentage of CaCo2 adherent cells after 24 h and 48 h of treatment with p56-88 and p57-68 was reduced to about 50% relative to the control.

Figure 2 shows the effects of gliadin on transepithelial electrical resistance (TER) measured in insert filters. As can be seen, gluten meal extract induces a significant decrease in TER after 30 minutes of gliadin administration compared to control. And gluten-free meal extract induced a decrease in TER over control, but less important than gluten meal extract. Other studies also revealed a dramatic decrease in TER following enzyme-treated gliadin in the first few hours after administration (*Drago et al., 2006).*

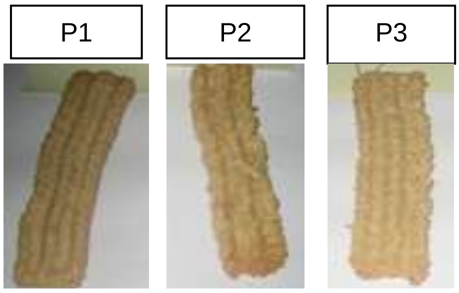

Fig. 3 - Oat based gluten free biscuits

The biscuits manufactured only from oat bran P2 (Figure 3) had a grainy aspects due to the bran particles but a higer protein and fiber content and a lower energetic value (428 kcal/100 g).

Table 3

Physico-chemical analysis of gluten-free biscuits

Samples	Humidity %	Protein %	Fat %	Ash %	Total carbohydrates %	Fibers %	Energetic value, kcal/100 g
P1 (100% oat flour)	3.77±0.15	11.5±0.25	17.01±0.3	1.45±0.04	53.64±0.2	12.63±0.5	438.91
P2(100% oat bran)	3.95±0.15	13.62±0.25	18.68±0.3	2.37±0.04	41.75±0.2	19.63±0.5	428.86
P3 (50% oat flour and 50% oat bran)	2.90±0.15	12.25±0.25	17.40±0.3	1.76±0.04	50.51±0.2	15.18±0.5	438.00

CONCLUSIONS

Several strategies are used to combat illness and potential health risks. In addition to the pharmaceutical approach, diet-based strategies are also considered to be appropriate to prevent various conditions. Oatmeal is a good source of β-glucans, complex of B vitamins, proteins, fats, minerals and soluble fiber. Moreover, it is also useful in controlling diabetes and lipid profile.

The increasing demand for safety and high quality gluten-free products containing different cereals, including oats, represents a challenging task for the industry due to the difficulties in processing oats (high lipid content, absence of gluten network). Another important issue for the limited usage of oats in gluten-free diets is the risk of gluten contamination which can appear on the whole chain of processing from harvest, transport, milling to the baking process.

New technologies are still tested for improving the production performance of gluten-free grains.

ACKNOWLEDGEMENT

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ADAPTATION OF PHYTOSANITARY TREATMENTS CORRELATED WITH THE ANALYSIS OF VEGETATION MAPS OBTAINED THROUGH THE MEANS OF AN AGRICULTURAL DRONE
/
ADAPTAREA TRATAMENTELOR FITOSANITARE CORELATĂ CU ANALIZA HĂRŢILOR STĂRII DE VEGETAȚIE OBŢINUTE PRIN INTERMEDIUL UNEI DRONE AGRICOLE

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Keywords: *unmanned aerial vehicle, precision agriculture, vegetation maps, phytosanitary treatments*

ABSTRACT

Modern agriculture continues to make important progress in line with industry's ability to produce higher output in response to demand and continued population growth. In the paper is presented a method of adaptation of phytosanitary treatments (corresponding to the concept of agriculture 4.0) correlated with the analysis of the vegetation state maps obtained by means of an agricultural drone.

REZUMAT

Agricultura modernă continuă să facă progrese importante corelate cu capacitatea industriei de a produce producții din ce în ce mai ridicate ca răspuns la cererea și creșterea continua a populației. În lucrare este prezentată o metodă de adaptare a tratamentelor fitosanitare corelată cu analiza hărţilor stării de vegetație obţinute prin intermediul unei drone agricole.

INTRODUCTION

According to the concept of agriculture 4.0, progress in chemical engineering, fertilization, irrigation, soil analysis and equipment (hardware and software) have revolutionized plant production and associated systems (*O'Connor and Di Federico, 2017*). Agricultural production systems have benefited from the incorporation of technological advances developed primarily for other industries (*Whelan et al., 1997; Werner et al., 2000*).

This evolution of modern agriculture has led to the transfer of technological progress throughout the agricultural flow, such as sowing, cultivating and harvesting crops that require a wide range of instruments, equipment, machinery, chemicals and other materials (*Torressanchez et al., 2014*).

Precision agriculture (the concept of agriculture 4.0) comprises a set of technologies that combine sensors, computer systems, with the aim of obtaining improved machines that optimize production by accounting for variability, management and uncertainties within agricultural systems (*Gebbers and Adamchuk , 2010*).

From the automation of sowing works to managing crops in real time, tracking through drones plays an increasingly important role in the world of agriculture. (*Sankaran et al., 2015*). One of the fundamental technologies incorporated in the drones refers to establishing a reliable correspondence between two sets of measurements (especially the geo-referential characteristics of the captured images) (*Ma, Qiu et al., 2015; Ma, Zhao et al., 2015*).

A method to implement real-time precision farming is based on accurate information on growing crops, as well as on the state of the environment (*Zhang et al., 2002*). It is a great challenge to conduct a correct analysis of the maps obtained through an aerial monitoring system, due to local distortions caused by variations in landscape or image shifts as well as blurring of images due to camera shake (*Zhenghong et al., 2017*).

MATERIAL AND METHOD

The state of vegetation of agricultural crops for experimental researches was determined on the basis of the analysis of spectral maps obtained using an agricultural drone type air monitoring system.

Fig. 1 – Agricultural drone aerial monitoring system

In order to determine the vegetation state of agricultural crops monitored, a hexacopter FAE750H agricultural drone type aerial monitoring system, composed of a stabilization support with brushless motor and vibration damping for the Mapir Survey 3N photo camera with incorporated GPS. This Red+Green+NIR (RGN, NDVI) model sees the wave length as follows: close to infrared 850 nm, red 660 nm and green 550 nm.

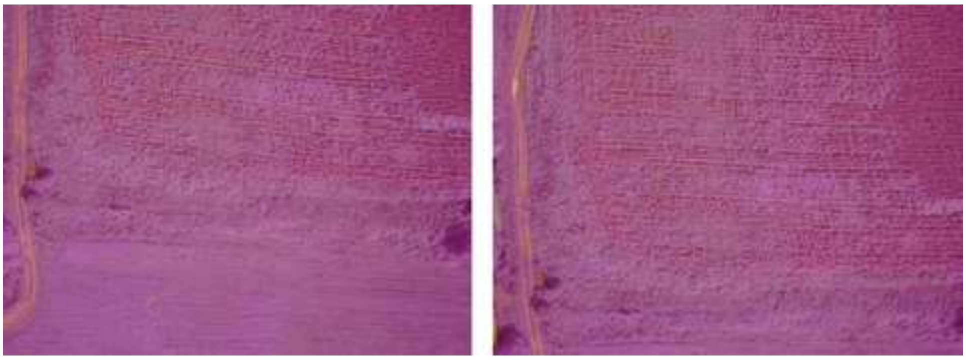


Fig. 2 – Example of multispectral images taken by MAPIR Survey 3 with integrated GPS

The digital radio station for the agricultural drone type air monitoring system has an action in the air of 3 km. also, the system also has telemetry and drone location on the map of the flight parameters on the computer through the means of Mission Planner.

Fig. 3 – Telemetry antenna for monitoring flight parameters and the location on the map through the means of Mission Planner software

During the execution of the monitoring flight on the researched crops, after processing the images captured by the MAPIR Survey 3 multispectral camera with built-in GPS, the orthophotogram of the monitored surface is obtained. Figure 4 shows an example of an orthophotogram obtained by monitoring a corn crop area.

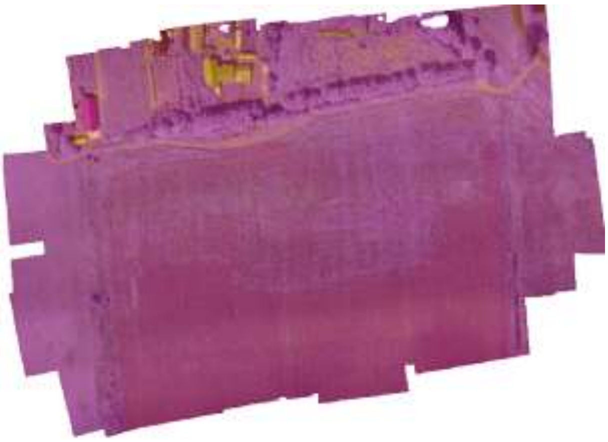
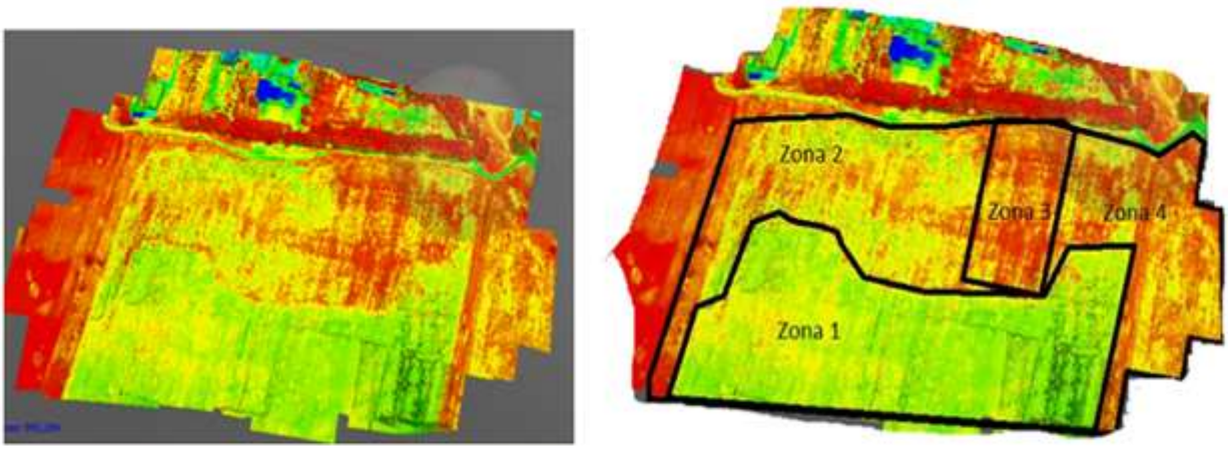


Fig. 4 – Monitored surface ortophotogram

Figure 5 presents a spectral map obtained by processing the images obtained during aerial monitoring representing the *NDVI* index (*Normalized Vegetation Differential Index*), which is a non-linear transformation of visible (RED) and near infrared (NIR) bands, being defined as the difference between these two bands, divided by their amount). The images were processed using the Agisoft Photoscan software.

$$NDVI = \frac{NIR - RED}{NIR + RED} \quad [-] \tag{1}$$



a) b)

Fig. 5 – Applying the visual-intuitive method for identifying areas with homogenous characteristics
a) initial image; b) results after applying the visual-intuitive methods

The geographic location correlation of the monitored area with the NDVI map is verified.

The intuitive visual method is used to identify areas with homogenous NVDI index for correlating them with other crop characteristics identified in the field (pest infested areas, low areas retaining water, drought areas, poorer macronutrient areas, etc.).

For each homogenous area identified will be calculated the statistic NDVI values (average, minimum and maximum value, average square deviation) for validating homogeneity and grouping parcels through the visual intuitive method.

After identifying the distinctive areas and locating their geographical position, experimental researches will be conducted to determine the causes of vegetation index variability.

RESULTS

The results of researches confirm one of the following main causes:

- Problem generated by infestation with harmful pests specific for the crop (insect invasion, rodents, fungus, weeds, etc.) – visual identification;
- The problem generated by the lack of macronutrients in the soil (nitrogen, phosphorus, potassium, calcium, magnesium, etc.) - identification by using portable analytical kits, portable spectrophotometry or taking samples and processing them in the laboratory).

CONCLUSIONS

Following the identification of ground problems for each area, the phytosanitary treatments to be applied, respectively the application of georeferenced insecticides or fertilizers, will be established. The use of phytosanitary products will be done in accordance with the recommendations from the producer.

For this purpose, georeferenced maps with the homogenous NVDI areas will be exported and on them, phytosanitary treatment paths using GPS technology will be generated.

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METHOD FOR DETERMINING THE VEGETATION STATE OF CROPS THROUGH AERIAL MAPPING USING AN AGRICULTURAL DRONE
/
METODĂ DE DETERMINARE A STĂRII DE VEGETAȚIE A CULTURILOR PRIN CARTARE AERIANĂ UTILIZÂND O DRONĂ AGRICOLĂ

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Keywords: *precision agriculture, unmanned aerial vehicle, vegetation maps*

ABSTRACT
Precision agriculture implies the use of unmanned aerial vehicles for various applications to monitor the emergence of crops, their vigour, and the characterization of crop yields. The paper presents a method for determining the vegetation state of the crops by aerial mapping using a droning crop monitoring system, processing and analysing the photographs taken after the monitoring flight found by means of a specialized software.

REZUMAT
Agricultura de precizie presupune utilizarea vehiculelor aeriene fără pilot (dronelor) pentru diferite aplicaţii în vederea monitorizării apariției culturilor, a vigorii acestora precum și a caracterizării randamentelor culturilor înființate. În lucrare este prezentată o metodă de determinare a stării de vegetație a culturilor prin cartare aeriană utilizând un sistem de monitorizare a culturilor de tip dronă agricolă, prelucrarea şi analiza fotografiile realizate în urma zborului de monitorizare find realizate prin intermediul unui soft specilalizat.

INTRODUCTION
With the end of the last millennium, the idea of accounting the internal variability has been transferred to precision farming as an agricultural concept, exploiting possibilities for improving agricultural applications and information technologies (*Stafford, 2000; Whelan and McBratney, 2000; Auernhammer, 2001*). The progress in technical development has imposed the use of miniature aircraft, the so called unmanned aerial vehicles (UAV) – drones (*Geipel, 2016*). UAVs are developed as means more and more used for the rapid and comprehensive data acquisition (*Zhang and Kovacs, 2012*). They can be used as transport platforms and can be equipped with a multitude of different sensor systems. This leads to certain advantages compared to the traditional detection using satellites (*Van Der Wal et al., 2013; Zecha et al., 2013*). Estimates of crop yields monitored before harvesting play a key role in determining input factors such as nutrients, pesticides and water, as well as planning future intensive actions such as harvesting, drying and storage (*Mourtzinis et al., 2013*). Farmers usually use different prediction methods. Gross estimates are based on the knowledge of farmers' experts. Better estimates can be obtained through destructive sampling procedures in the monitored areas (*Lauer et al., 2013*). Because sampling a representative quantity of samples in an estrogenic field is an expensive and time-consuming task, agriculture operators use more and more online systems for collecting information specific for the site, to calculate the adequate quantities of fertilizers ad to apply phyto-sanitary treatments (*Auernhammer et al., 2001, Aasen et al.,2015).*

MATERIAL AND METHOD
A method of implementing precision farming (according to the concept of agriculture 4.0) requires real-time analysis of information on growing crops and their health status.

The first stage in determining the vegetation status through the means of an agricultural drone mapping aerial system implies to perform a flight over the monitored crop.

Fig. 1 – Crop monitoring through the means of the agricultural drone aerial mapping system

After flying over the monitored crop, the photograph obtained through the means of a multispectral camera for agriculture with incorporated GPS need to be processed by undergoing the next stages:

- The files executed through the means of the multispectral camera for agriculture with incorporated GPS are copied;
- The data processing software is started (ex: Agisoft Photoscan, Pix4D, etc.);
- The photos taken using the multispectral camera are introduced in the data processing software (Figure 3);

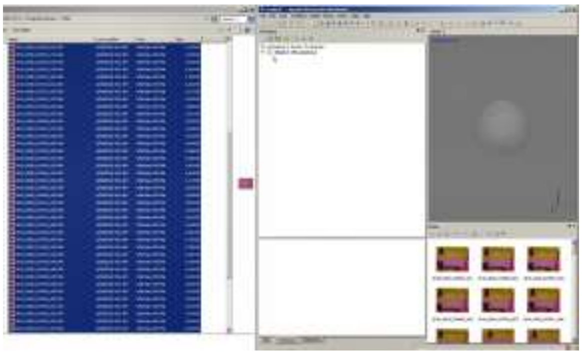

Fig. 2 – Introducing the photographs taken by the MAPIR Survey 3 multispectral camera in the Agisoft software

- Inadequate photos are eliminated;
- Photos are displayed with details;
- The quality of photos (contrast) is verified – right click on a photo - „Estimate Image Quality" – „All Cameras" menu;
- Photos will be displayed in an order of increasing quality of photos (normally only photos with a quality index between 0.6-1 are kept);
- „Show Cameras" menu is opened to how the manner of taking photos (their location);

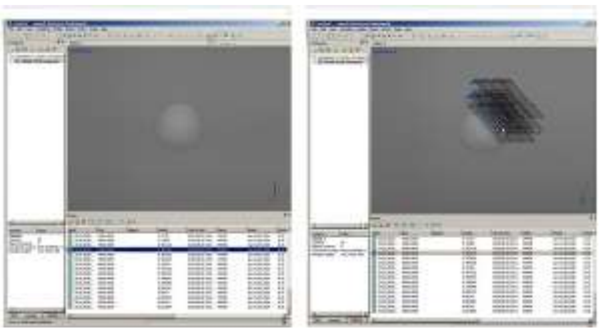

Fig. 3 – Display of the manner of taking samples (their location)

- Photos are aligned depending on their location and the horizon, because the GPS information is found in the photos;
- Photo alignment, as well as the route taken by the drone are obtained The lines represent the optical axle of the camera;

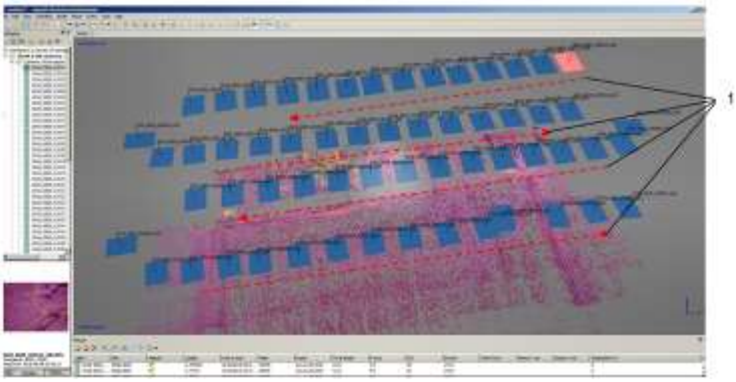

Fig. 4 – Lining photographs and the route travelled by the drone

- ''Build Dense Cloud'' menu is opened, ,,High'' quality, ,,Agressive'' filter – to filter sudden changes of altitude (example – a tall tree);
- Photos are deactivated;
- the display of the dense three-dimensional cloud is activated (Dense Cloud – contains more details);

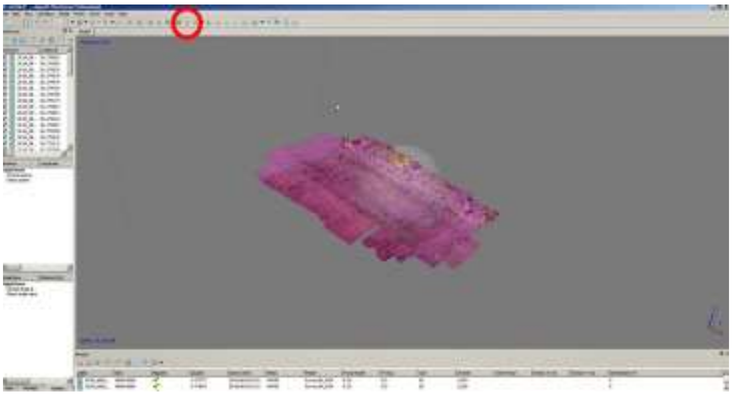

Fig. 5 - Dense Cloud display)

- transforming the Dense Cloud into a 3D. The national (Cartesian) coordinate system, "Dealul Piscului 1970'' is installed;
- ,,Workflow – Build Mesh'' is opened;

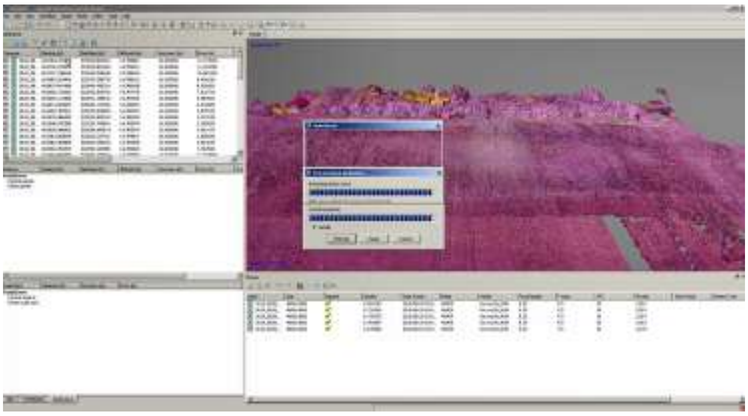

Fig.6 -,,Workflow – Build Mesh'' menu

- ,,Height field'' elevation pattern is set, which will be obtained from ,,Dense cloud'';
- The digital pattern is obtained;

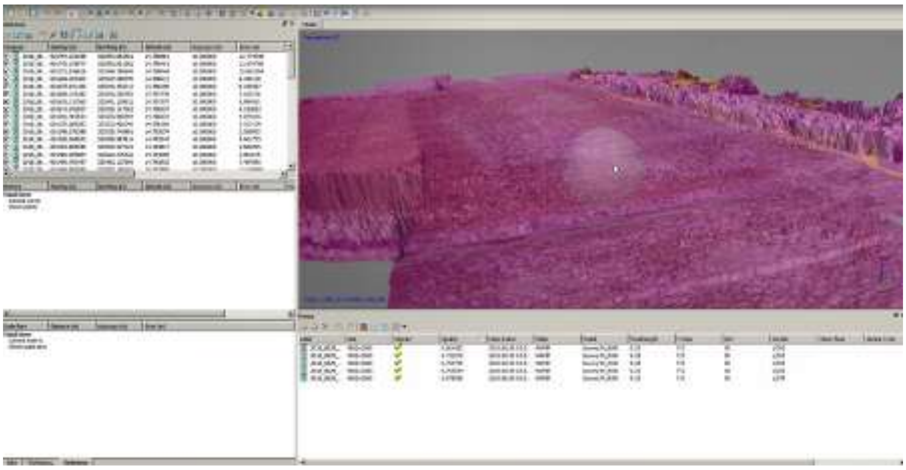

Fig. 6 – Digital model

- The pattern is saved in *psx format;
- ,,Workflow – Build Orthomosaic'' is accessed;

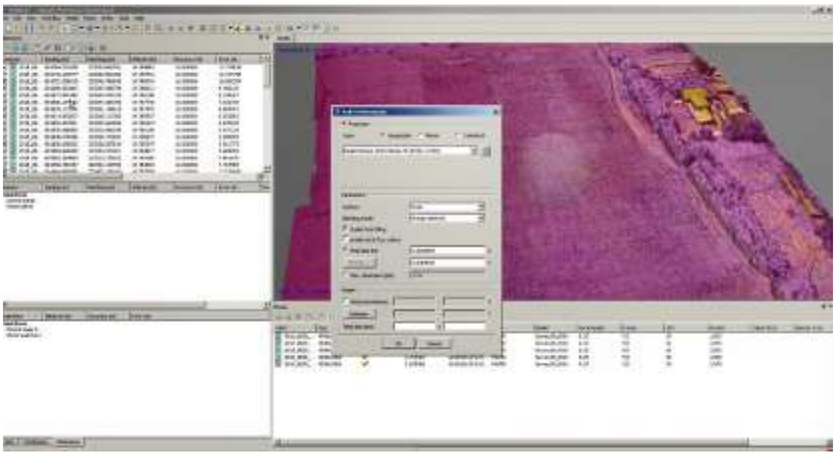

Fig. 7 - Workflow – Build Orthomosaic access menu

- Data is processed;
- The othomosaic is exported (saved);

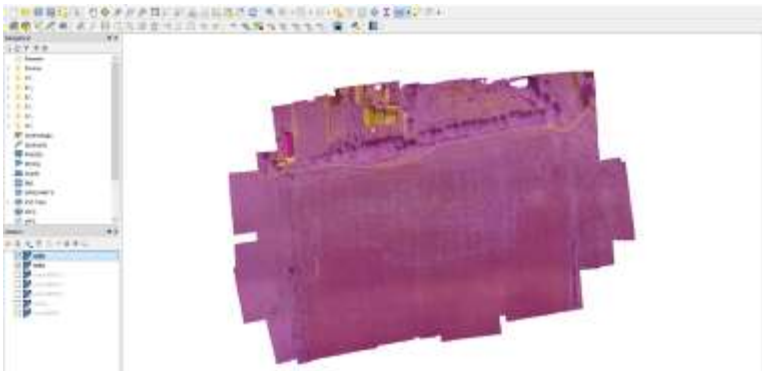

Fig. 8 – Monitored surface orthophotogram

- Obtaining the NDVI (Normalized Difference Vegetation Index) map represents a non-linear transformation of visible (RED) and close infrared (NIR) bands, being defined as the difference between these bands divided by their sum – from the “Tools – Set Raster Transform” menu.

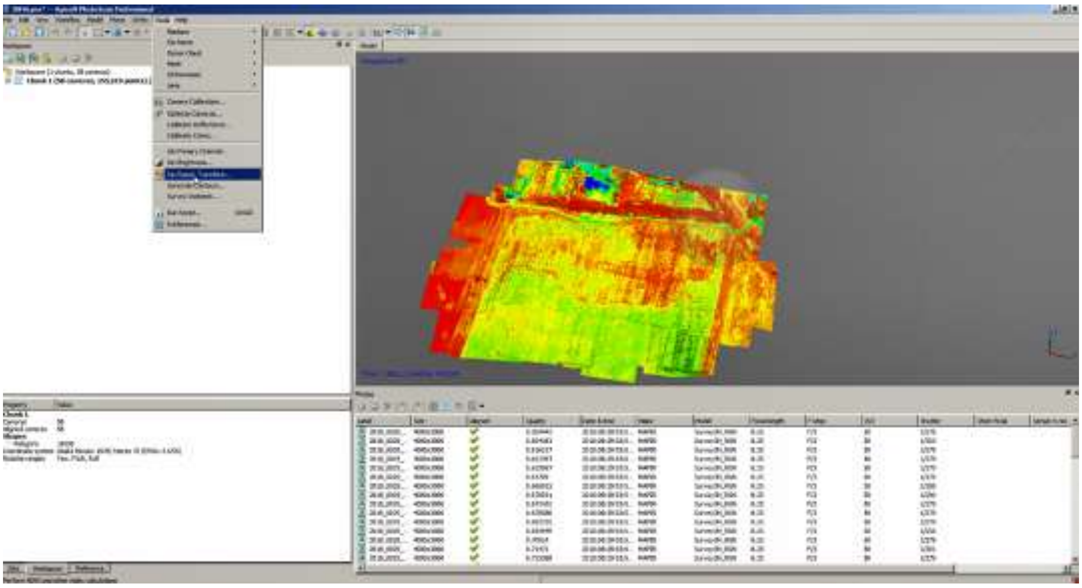

Fig. 9 - NDVI map for the monitored surface

RESULTS

The multispectral data obtained using the agricultural drone type aerial spectral monitoring system used can lead to the identification on a seemingly healthy field of stress, disease outbreak or nutrient deficiency. Detection of such problematic areas and appropriate treatment determines an increase in efficiency, yield and profit of the monitored crop.

The implementation of the spectral camera sensors of the agricultural drone type aerial monitoring system has demonstrated its practicability. A stable network and internet connexion are essential for this architecture of the agricultural drone type aerial monitoring system. Data processing and results application is also done online.

CONCLUSIONS

Results indicate the fact that an agriculture drone type aerial monitoring system, fitted with this camera system, offers the possibility to obtain exact large-scale information on the health status of crops.

After identifying problems in the soil for each zone, phytosanitary treatments, insecticides of fertilizers that need to be applied will be established georeferenced. The application of phytosanitary substances will be done complying with the recommendation from the producer.

Continuous developments in the last years in the field of precision agriculture demonstrates that research works continuously to dismantle the barriers encountered. However, agriculture operators still need to invest more time, technology and knowledge because the ratio between the economic benefits and the investments is still reduced, operators still hesitating to adopt precision agriculture.

ACKNOWLEDGEMENT

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EXPERIMENTAL RESEARCHES REGARDING THE QUALITATIVE WORKING INDEXES OF SEED DRILL MACHINE SUP-21
/
CERCETĂRI EXPERIMENTALE PRIVIND DETERMINAREA INDICILOR CALITATIVI DE LUCRU LA SEMĂNĂTOAREA SUP-21

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ABSTRACT
Sowing is an agricultural operation that consists in positioning the seeds into the soil at a depth appropriate to agro-biological requirements imposed by each crop, uniformly spread, covering them with loosen soil and afterwards, settle, compact or level the soil so that the seeds could easily germinate and develop; at the same time, a better nutritive environment and a steady humidity are ensured during the germination. The paper describes the experimental researches on qualitative working indexes of SEED DRILL SUP-21, that works in aggregate with 65 HP tractors for sowing straw cereals, especially in slope field and also, in aggregate with tractor of 45 HP designed to sowing the vegetable seeds both in modelled and unmodelled field.

REZUMAT
Semănatul este lucrarea agricolă ce constă în introducerea în sol a semniţelor la adâncimi corespunzatoare cerinţelor agrobiologice impuse de fiecare cultură, uniform repartizate, acoperirea lor cu sol afânat si tasarea sau nivelarea solului, astfel încât sa se creeze condiţii de încolţire a seminţelor şi dezvoltarea plantelor, realizându-se în acelasi timp un mediu nutritiv mai bun şi o umiditate constanta în perioada încolţirii. In lucrare sunt descrise cercetările experimentale privind determinarea indicilor calitativi de lucru ai semănătorii SUP-21 ce lucreaza în agregat cu tractoare de 65 CP la semănatul cerealelor păioase în deosebi pe terenuri în pantă şi în agregat cu tractorul legumicol de 45 CP la semănatul seminţelor de legume atât în teren modelat cât şi în teren nemodelat.

INTRODUCTION
Sowing operation is essential for obtaining high productivities for wheat, barley, oat or vegetables, therefore the current studies and researches on sowing methods and equipment, are in accordance with recent trends designed to practise a precision farming. Seeding qualitative working indexes for straw cereals can be estimated by physical values, such as: quantity of seeds to be distributed, instability of seeding rate, distribution non-uniformity per working width, etc. (*Raheman, 2016*; *Manea 2005, Marin 2009, Shaw 1997).* Any perturbation of sowing process leads to a decrease of seeding qualitative working indexes and eventually, to a reduced production. *(Karayel et al., 2006; Kocher et al., 1998; Labowsky, 2001; Muller, 1994; Parish and Bracy, 1998).*

MATERIAL AND METHOD
The seed drill SUP – 21 is designed to seed straw cereals and vegetables. It comprises the following main parts: frame, seed box, distribution apparatus, trough, tubes, plough shares, transmission gear, gear box, lifting and lowering mechanism, ring harrow, etc.

Within the laboratory tests, the following qualitative working indexes were determined: quantity of seeds able to be distributed by the seed drill with minimum flow rate, maximum flow rate and flow rate appropriate to the usual norm, required by agro-technique; apparatus non-uniformity of distribution per working width of the machine; seeding norm instability. In laboratory tests were used different types of seeds which absolute mass is given in Table 1.

Table 1

Characteristics of seeds used in experimental researches

Den.No.	Seed name	Mass of 1000 seeds (g)
1.	Peas	161.80
2.	Wheat	39.40
3.	Oat	27.60
4.	Beans	412.00
5.	Fodder raddishes	11.20
6.	Tomatoes	2.42
7.	Cabbage	3.15
8.	Dill	1.56
9.	Salad	1.16
10.	Red clover	1.13

Experiments were performed in stationary stage on the bench, for minimum, usual and maximum seeding norms, for different seed types. For big and medium sized seeds, respectively for seeds with higher absolute weight (peas, wheat, oat, etc.), samples collection was made after a certain number of rotations of distributors so that to be suitable to a surface of 200 m^2 , sown by the seed drill. For seeds with reduced absolute weight (cabbage, salad, dill, etc.) samples collection was made after a certain number of rotations of distributors suitable to a surface of 400 m^2 sown. Distributor rotational frequency was chosen so that it corresponds to an average movement speed of seed drill of 7.5 km.h^{-1}. For filling the distribution apparatus with seeds before the test, the seed drill wheel was swivelled by 3-5 times. The tests were repeated three times, by collecting the seeds separately in each apparatus, weighing being made with a precision of 0.1 grams.

Non uniformity of distribution among different apparatus was determined when the seed drill was set for an usual norm, at the rotational speed of transport wheels appropriate to an average speed of machine working in field of 7 km.h^{-1}, for a three times period. Average squaring deviation (δ_i) and variation coefficient (v_i), characterizing the apparatus distribution non-uniformity, for each repetition, was calculated with the relations:

$$\delta_i = \pm\sqrt{\frac{\sum(x_i - x)^2}{n_n}} \quad \text{(g)} \qquad (1)$$

where: x_i – quantity of seeds distributed by each apparatus (g);

x – average seed quantity distributed by each apparatus (g);

n_n – number of apparatus of distribution.

$$v_i = \pm\frac{\delta_i \cdot 100}{x} \quad (\%) \qquad (2)$$

Average squaring deviation (δ_i) of quantity of seeds from average seed quantitity per samples, distributed by each apparatus, was determined by:

$$\delta = \pm\sqrt{\frac{\delta_1{}^2 + \delta_2{}^2 + \delta_3{}^2}{3}} \qquad (3)$$

Seed distribution non-uniformity was found by the relation:

$$v = \pm\sqrt{\frac{v_1{}^2 + v_2{}^2 + v_3{}^2}{3}} \qquad (4)$$

where: v_1; v_2; v_3 – variation coefficient of distribution per repetions.

Instability of sowing norm was determined based on primary data of laboratory tests related to the determination of distribution non-uniformity according to working width. Average squaring deviation (δ_i) and variation coefficient (v_i), that characterize sowing norm instability were calculated by means of relation:

$$\delta = \sqrt{\frac{\sum(x_1^e + x_1)^2}{n-1}} \quad (\%) \qquad (5)$$

where: x_1^e – quantity of seeds distributed by all the distributing apparatus at one repetition (g);

x_1 - quantity of seeds distributed by three repetitions (g);

n – number of repetitions.

Experiments performed in laboratory-field conditions were designed to determine the qualitative working indexes and energetic indexes. The qualitative working indexes determined were the following: seed introducing depth; seeds introducing non-uniformity per working width; maintaining the distance between rows. Physical characteristics of seeds used at tests, in laboratory-field conditions, are shown in Table 2.

Table 2

Quantity of seeds distributed by seed drill per hectare

Den.No.	Seed name	Seeds characteristics			Sowing depth (cm)	Sowing norm(kg.ha^{-1})
		Mass of 1000 seeds (g)	Purity (%)	Germination (%)		
1.	Wheat	39.4	99.8	95.0	6.0	237
2.	Peas	161.8	99.4	95.0	4.0	178.5
3.	Fodder raddishes	11.20	99.2	97.3	2.0	28.3
4.	Tomatoes	2.42	99.7	94.8	2.0	2.5

Field characteristics: type of soil: forest reddish-brown; previous crop: autumn wheat; previous work: ploughing at 20-22 cm depth; loosen soil depth: 8-10 cm; soil humidity: between 0 – 5 cm depth – 14.1%, between 5 – 10 cm depth – 18.5 %, between 10 – 15 cm depth – 21.6 %. Average movement speed of aggregate tested was 4.24 km*h^{-1}; 6.28 km*h^{-1} and 8.70 km*h^{-1}.

Seed incorporation depth was determined by measuring made after the plant rising. Mesurements were made on seed drill rows in three repetitions and at three movement speeds of aggregate, measuring in each row 20 plants. Incorporation depth was given by the distance from the grain to the soil surface, and measuring precision was of 0.1 cm. In Figure 1, is shown the seeds distribution per layers of depth.

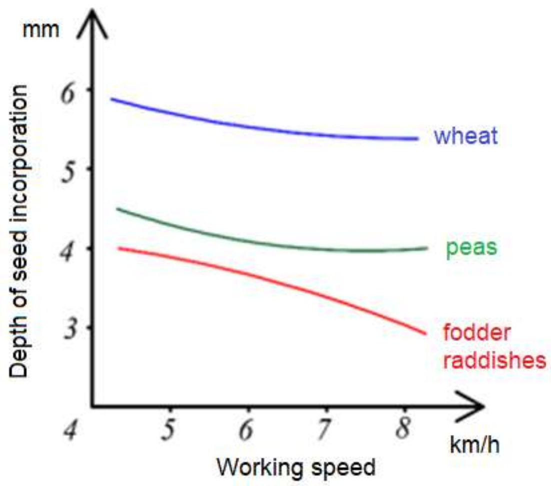

Fig. 1 – Variation of seed incorporation depth according to sowing machine working speed

Non-uniformity of working depth was determined by relation:

$$N = \frac{\sum_{1}^{n} (h_m - h_{1)}}{h_m \cdot n_b} \cdot 100 \qquad (\%) \qquad (6)$$

where:

N – degree of non-uniformity of sowing depth (%);

h_m – average depth calculated for all plough shares (cm);

h_1 – depth determined for each plough share (cm);

n_b – number of plough shares.

Energetic indexes determined within the laboratory-field conditions tests were the following: working speed; resistance force at traction; tractor skkiding; fuel consumption; traction power.

Characteristics of field in which the tests were performed: forest reddish-brown soil; previous crop: autumn wheat; previous works: ploughing at 20-22 cm, three times harrowing with GD-4; breaking degree: there were no clods bigger than 10 cm; soil humidity: between 0 – 5 cm depth – 16.3%; between 5 – 10 cm depth– 19.1 % between 10 – 15 cm depth – 22.4 %. Seed drill control: number of plough shares: 21; sowing depth: 4 – 6 cm; seed bin: completely charged or 1/2 charged.

Average value of working speed was determined by relation:

$$V = 3{,}6 \cdot \frac{S}{t} \quad (\text{km.h}^{-1}) \tag{6}$$

where:

S – space run during the test (m);

t – duration of test (s).

Force of resistance at traction was performed in laboratory with tractor endowed with a three-point tensometric device on a length of 100 m in three repetitions.

Tractor skkiding was determined based on data obtained with laboratory tractor, by means of relation:

$$\delta = \frac{n_l - n_g}{n_l} \cdot 100 \quad (\%) \tag{7}$$

where:

n_l – number of revolutions of motor wheels of tractor in work;

n_g - number of revolutions of motor wheels of idle tractor.

Power of traction was calculated based on data obtained at tests by means of relation:

$$P_c = \frac{F \cdot V}{270} \quad (\text{CP}) \tag{8}$$

where:

F_c – force of resistance at traction (kgf);

V – average working speed ((km*h^{-1})

Consumption of fuel was determined based on relation:

$$G_s = \frac{3{,}6}{t} \times \frac{V_{comb} \times \gamma}{1 + \alpha(T - 20)} \quad (\text{kg.h}^{-1}) \tag{9}$$

where:

V_{comb} – volume of fuel consumed during the test (cm^3);

γ – specific weight of Diesel oil at 20º C (g/cm^3);

α – coefficient of volumetric diffusion of diesel oil;

t – duration of test.

RESULTS

Seeds quantity that seed drill distributes per hectare determined after the tests and data processing are shown in Table 3.

Table 3

Quantity of seeds distributed by seed per hectare

Den.No.	Seed name	Norm of seeds recommended by Agro-technique per ha (kg*ha^{-1})	No. Of plough shares dependent on each machine	Distance between rows (cm)	Seed quantities ensured by seed drill per ha (kg*ha^{-1})
1.	Peas	180 - 240	21	12.5	29.8 – 1250
2.	Wheat	180 – 300	21	12.5	22.0 – 818.0
3.	Oat	120 – 150	21	12.5	18.16 – 523.3
4.	Beans	80 – 100	8	25	5.44 – 368
5.	Fodder radishes	16 – 60	21	12.5	8.22 – 743.0
6.	Tomatoes	1.5 – 7.0	4	70.0	0.856 – 68.80
7.	Cabbage	2 – 8.0	4	70.0	1.60 – 33.80
8.	Dill	1.5 – 2.0	8	25.0	1.54 – 13.60
9.	Salad	1.5 – 5.0	8	25.0	2.0 – 31.20
10.	Red clover	14 - 18	21	12.5	9.34 – 539.90

Average results of distribution non-uniformity as well as of seeding norm inconstancy of tests are shown in Table 4.

Table 4

Non-uniformity of distribution per working width

Den.No.	Seed name	Seed quantity distributed at usual norm adjusted (kg.h^{-1})	Seed norm inconstancy (%)	Average distribution non-uniformity per working width (%)
1.	Peas	178.5	0.34	4.30
2.	Wheat	183.0	0.35	4.25
3.	Oat	148.0	O.66	3.50
4.	Beans	94.40	1.51	5.0
5.	Fodder radishes	28.35	1.10	3.52
6.	Tomatoes	2.49	1.33	7.73
7.	Cabbage	4.04	2.59	2.90
8.	Dill	4.05	0.41	5.40
9.	Salad	3.28	0.37	7.30
10.	Red clover	17.01	2.82	2.55

Data regarding the incorporation depth of seeds obtained in tests are shown in Table 5.

Table 5

Seed incorporation depth

	Average sowing depth for:								
	Peas at speed of:			Wheat at speed of:			Fodder radishes at speed of:		
	4.24 km.h^{-1}	6.28 km.h^{-1}	8.70 km.h^{-1}.	4.24 km.h^{-1}	6.28 km.h^{-1}	8.70 km.h^{-1}.	4.24 km.h^{-1}	6.28 km.h^{-1}	8.70 km.h^{-1}.
Average depth	4.50	4.12	4.04	5.78	5.56	5.30	3.98	3.80	3.26
Non-uniformity degree	6.44	7.80	8.39	9.42	9.79	10.07	6.58	7.50	9.90
Adjusted depth	4.5	4.5	4.5	6.0	6.0	6.0	3.5	3.5	3.5

Values of energetic indexes determined in laboratory-field tests are presented in Table 6.

Table 6

Values of energetic indexes

Speed (km*h^{-1})	Mass of bin seeds (kg)	Sowing depth (cm)	Skkiding (%)	Resistance force at traction (daN)	Traction power (CP)	Fuel consumption (kg)
4.24	220	8.0	5.5	520	11.4	6.4
	120	4.0	3.5	435	9.90	5.9
6.28	220	8.0	4.4	502	15.3	6.9
	120	4.0	3.1	440	14.5	6.0
8.70	220	8.0	4.8	518	22.3	7.2
	120	4.0	2.6	430	19.0	6.5

CONCLUSIONS

Following the laboratory-field tests of seed drill SUP-21, the following conclusions have been drawn:

- Seed drill ensures the seed norms required by agro-technique norms for all the crops used in experimental researches;
- Non-uniformity of distribution per machine working width in case of seeds of wheat, peas, oat, beans, fodder radishes, tomatoes, salad, dill and clover has values between 2.55% and 7.73%. the maximum value allowed being of 8%;
- Seed norm inconstancy at majority of seeds tested framed between 0.34% and 2.82%, being below the maximum limit admitted of 3%;
- Results obtained after the tests have shown that for beans and peas seeds the percentage of damaged seeds is of 0.97%. , and for the rest of seeds-the damaged seed percentage is of 0.24%;
- Average incorporation depth performed by the machine for all crops, had values similar to depth settled, the differences faming within a limit of ± 15%;

- Non-uniformity of working width increases along with speed increment and frames between 6.44% and 8.39% for peas seeds; between 9.42% and 10.07% for wheat, and between 6.58% and 9.90% for fodder radish;
- Quantity of seeds left on soil surface on 1 m^2 is bigger at seeds smaller than 6.35 at fodder radishes, while for peas is of 2.65;
- Percentage of seeds non-incorporated out of the quantity to be sown per hectare frames between 0.92% at wheat and 2.50% at fodder radish;
- Resistance force at traction increases along with working width and bin charge, having values between 520 daN and 518 daN for a working depth of 8 cm and a seed charge of bin of 220 kg at working speed of 4.24 – 8.70 km*h^{-1};
- Tractor skidding has low values, not surpassing 5.5%;
- Fuel consumption has varied between 5.9 and 7.2 kg*h^{-1} depending on working speed, working depth and seed bin charge;
- Traction power situated between 11.4HPand 22.3 HP at working speed of 4.24 – 8.70 km*h^{-1} and depth of 8 cm.

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EXPERIMENTAL RESEARCHES ON QUALITATIVE WORKING INDEXES OF STRAW AND HAY BALING PRESSES
/
CERCETĂRI EXPERIMENTALE PRIVIND DETERMINAREA INDICILOR CALITATIVI DE LUCRU LA PRESELE DE BALOTAT PAIE ŞI FÂN

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ABSTRACT

Maintaining and increasing soil fertility first depend on quality and quantity of organic matter existing in soil. Soil fertility can be achieved by applying organic fertilizers (manure, compost etc.), but mostly, by vegetal waste applying, operation very easy to perform by the farmer. The paper describes the experimental researches regarding the determination of qualitative working indexes of baling presses for straw and hay.

REZUMAT

Mentinerea şi sporirea fertilităţii solului sunt condiţionate, în primul rând, de cantitatea şi calitatea materiei organice existente în sol. Aceasta poate proveni din aplicarea îngrăşamintelor organice (gunoi de grajd, compost etc.), dar cel mai la îndemâna agricultorului sunt resturile vegetale. In lucrare sunt descrise cercetările experimentale privind determinarea indicilor calitativi de lucru ai preselor de balotat paie şi fân.

INTRODUCTION

Fodder harvesting is one of the main operations in nowadays farming. The main advantage of baling machines is given by the versatility of applications, the bale quality depending on the level of working equipment and operator skills *(Borreani et al., 2006; Novákj et al., 2017)*. For obtaining efficient works, two operators ensure the utilization of baling presses *(Coblentz et al., 2009; Shito et al., 2006)*. Recently, mechanization of harvesting, handling and storing the fodder crops have importantly evolved, which led to development of different systems designed both to hay and fodder. Fodder harvesting and transport in small and medium-sized farms are accomplished by means of wheeled agricultural tractors-as energy source, used for other agricultural operations. *(Robertson et al., 1983; Voicu et al., 2010).* In order to control the yields of fodder baling presses, experimental researches were performed, by endowing the presses with weighing systems *(Rotz, 1994; Wild et al., 1999).* The tests were designed to measurements of dynamic stress, through data selection and analysis, thus obtaining the stress condition of frame and baler working parts *(Xiangping, 2003; Xu et al., 2010).*

MATERIAL AND METHOD

Baling presses aim at building parallelipiped-shaped bales from main fodder existing in agriculture (hay, cereal straw, peas, beans and soybeans) and work in aggregate with the bale collecting equipment; they perform the following operations: pick up the plants left in continuous furrow on soil, by the harvesting machines; press the matter in a pressing chamber by means of a piston for making bales; tie up the bales by two strings and transfer them into a transport mean with the bale collecting equipment.

Baling presses comprise the following main parts: frame, pick up from furrow, main feeder, pressing chamber, pressing mechanism, universal-joint-drive, knotting device and trailing equipment.

In experimental laboratory-field researches, the following qualitative working indexes were determined: bale dimension; coefficient of non-uniformity of bales; bales density; material losses; working flow; binding safety coefficient; consumption of binding material; energetic indexes.

The tests of hay and straw baling presses in aggregate with U-650 tractor were performed when pressing the cereal and hay straws disposed in continuous furrow, resulted after harvesting with combines C-12 and C-14.

Characteristics of material used in experiments are shown in Table 1.

Table 1

Characteristics of material used in experimental researches

Den.No.	Characteristic name	M.U.	Material type		
			Wheat straw harvested with:		Alfalfa hay
			C-12	C-14	
1,	Production of straw per hectare	Kg/ha	3500-4100	3500-4100	5200-6900
2.	Furrow width	cm	112-124	140-170	130-150
3.	Furrow mass per 1 linear meter	Kg	1.2-1.6	2.1-2.4	3.2-3.5
4.	Material humidity	%	8-14.2	8-14.2	23-32.0
5.	Height of furrow left by combine	cm	33	36	38
6.	Furrow height from soil	cm	18	21	16

Bale binding was made with string which characteristics are given in Table 2.

Table 2

Characteristics of string used for tiding the bales

Den.No	Technical characteristics	M.U.	Values
1.	String dimension	mm	2.3 ±0.1
2.	Solution of impregnation	-	glue
3.	Material composition	-	synthetic
4.	Max. elongation per charge of 90 kg	%	10.6
5.	Breaking load	kg	676
6.	Torsions per 1 linear m	-	58
7.	Type of wrapping	-	With cylindrical support Ø 40
8.	String unrolling	-	From the reel external part towards counterclockwise
9.	Reel dimensions - external diameter - height	mm	 220 270
10.	Reel mass	kg	9.0-9.5

Dimensions of bales were determined when pressing the wheat and alfalfa hay straws at different degrees of pressing (minimum, average and maximum) for straw productions framing between 3500 and 4100 kg.ha^{-1} and for straw productions framing between 5200 and 6900 kg.ha^{-1}. Bale length was adjusted at 100 cm. Coefficient of non-uniformity of bale size comparing to adjusted value was determined by calculation based on bale dimensions measured during tests, by the relation:

$$K_n = \frac{\sqrt{\dfrac{\sum_{i=1}^{n}(x_m - x_i)^2}{n-1}}}{x_m} \cdot 100 \quad (\%) \tag{1}$$

where:

x_i – is parameter measured value;
x_m – is parameter adjusted value;
n – number of measurements;
K_n – non-uniformity coefficient.

Bale density (γ_b) was found out by pressing the alfalfa hay and wheat straw as a ratio between the mass of 10 bales and their volume by relation:

$$\gamma_b = \frac{m_b}{v_b} \quad (kg/m^3) \tag{2}$$

where:

m_b – bale mass (kg);

v_b – bale volume (m^3).

Material losses represent the material non-collected during the work process per working width. Determination of this index was made concomitantly with determination achieved by collecting the material (straw and hay) left in furrow by the press and reporting it to mass of bales achieved on the same surface, at which the loss value was added.

Work flow was determined by reporting a certain number of bales to the time in which they were achieved. It is emphasized that the relevant values have been obtained at maximum speed at which press can work without clogging. Safety coefficient of binding was determined for each crop, by numbering the unbound bales and comparing them to total number of bales achieved by press.

Consumption of material for binding was determined by initial weighing of string reel and weighing 100 bales for each crop. By comparing the string consumed to bale mass, the string consumption was found out. Results obtained after tests performed, are shown in Table 8.

Press energetic indexes were determined in working conditions similar to qualitative working indexes determination. Energetic indexes determined during tests were: fuel hour consumption; power necessary to drive the press in aggregate with or without pick up in working and unload conditions.

Fuel hour consumption was determined by means of an apparatus mounted in feeding circuit of tractor. Based on data obtained, the fuel hour consumption was calculated and the results are shown in table 9. Power necessary to run the press was found based on fuel hourly consumption using the adjusting characteristic of the tractor. Results are shown in Table 3.

RESULTS

Dimensions of bales after performing the tests and processing the data are given in Table 3.

Table 3

Dimensions of bales after test performing

Den. No.	Specification	M.U.	Minimum pressing	Average pressing	Maximum pressing
1.	At alfalfa hay pressing:				
	- bale length	cm	97.5	98.4	98.1
	- coefficient of non-uniformity of bale length	%	2.56	2.10	1.96
	- bale width	cm	46.5	46.3	46.2
	- coefficient of non-uniformity of bale width	%	2.30	1.95	1.76
	- bale height	cm	41.7	41.5	41.0
	- coefficient of non-uniformity of bale height	%	2.05	1.80	1.68
2.	At wheat straw pressing				
	- bale length	cm	98.4	97.8	97.3
	- coefficient of non-uniformity of bale length	%	2.76	2.58	2.33
	- bale width	cm	48.8	48.1	48.0
	- coefficient of non-uniformity of bale width	%	2.23	2.18	1.63
	- bale height	cm	42.0	41.3	41.0
	- coefficient of non-uniformity of bale height	%	2.30	2.04	1.42
3.	Bale length adjusted	cm	100	100	100

Bale density after experiments and data processing, is given in Table 4.

Table 4

Bale density

Den.No.	Specification	M.U.	Values obtained for pressed bales		
			minimum	average	maximum
1.	Bale of alfalfa hay				
	- hay humidity	%	30	30	30
	- mass of 10 bales	Kg	138.5	188.0	283.0
	- volume of 10 bales	m^3	1.9	1.84	1.79
	- density of bales	kg/m^3	72.8	102.1	158.1
2.	Bale of wheat straw				
	humidity of straw	%	9.8	9.8	9.8
	- mass of 10 bales	Kg	112.6	145.3	180.1
	- volume of 10 bales	m^3	1.84	1.79	1.77
	- density of bales	kg/m^3	61.2	81.1	101.7

Results obtained after the tests performed regarding the material losses are presented in Table 5.

Table 5

Material losses when pressing the straw or hay in furrow

Den. No.	Specification	M. U.	Results obtained when pressing the straw or hay in furrow Left by	
			Combine C-12 With header of 4 m	Combine C-14 With header of 5 m
1.	Mass of losses of material resulted from press at:			
	- alfalfa hay	kg	1.10	1.20
	- wheat straw	kg	2.11	1.54
2.	Bale mass			
	- alfalfa hay	kg	83.5	85.3
	- wheat straw	kg	57.0	56.9

Results obtained after the tests performed regarding the working flow, are shown in Table 6.

Table 6

Results obtained after working flow experiments

Den. No.	Specification	M.U.	Values obtained by press at:	
			Wheat straw	Alfalfa hay
1.	Material humidity	%	9.8	30
2.	Feeding flow	$kg.s^{-1}$	2.56	3.65

Results obtained after the tests performed regarding the safety coefficient of bale binding, are presented in Table 7.

Table 7

Safety coefficient of bale binding

Den. No.	Specification	M.U.	Values obtained by press at	
			Wheat straw	Alfalfa hay
1.	Number of bales resulted out of which:		300	450
	- bond bales	pcs.	292	441
	- unbound bales	pcs.	8	9
2.	Binding safety coefficient	%	97.3	98.0

Results obtained after the tests performed regarding the index of consumption of material to bind, are shown in Table 8.

Table 8

Consumption of material to bind

Den.No.	Specification	M.U.	Values obtained by press at:	
			Wheat straw	Alfalfa hay
1.	Average mass of bales	kg	18.5	23.1
2.	Specific consumption of string	$kg.t^{-1}$	1.25	1.16

Results on energetic indexes obtained after the tests, are shown in Table 9.

Table 9

Energetic indexes

Den.No.	Specification	Mass of furrow per linear meter (kg)	Speed ($km.h^{-1}$)	Consumption ($kg.h^{-1}$)	Power(HP)
1.	Bales of wheat straw performed by press and bale collector half full	1.6	4.15	7.7	31.0
2.	Baling wheat straw performed by press and without collector	1.6	4.30	7.2	27.2
3.	Idle movement with half full collector	-	4.31	5.60	11.6
4.	Idle movement without collector	-	4.72	5.30	8.85

CONCLUSIONS

After performing the laboratory-test experiments with hay baling press, the following have resulted:

- Bale length framed between 97.5 cm and 98.4 cm for alfalfa hay and of 97.3 cm at 98.4 cm for wheat straw depending on pressing degree ;
- Coefficient of non-uniformity of bale length had values between 1.98% and 2.56% for alfalfa hay and between 2.33% 2.76% for wheat straw;
- Bale density at a humidity of 30% framed within 72.8 kg/m^3 and 158.1 kg/m^3 for alfalfa hay and 61.2 kg/m^3 and 101.7 kg/m^3 for wheat straw at 9.8% humidity;
- Mass of material losses was of 1.1 – 1.2 kg for alfalfa hay and of 1.54 – 2.11 kg for wheat straw;
- Feeding flow rate was of 3.65 $kg{*}s^{-1}$ for alfalfa hay and of 2.56 $kg{*}s^{-1}$ for wheat straw;
- Binding safety coefficient was of 98.0 % for alfalfa hay and of 97.3% for wheat straw;
- Specific consumption of string was of 1.16 $kg{*}t^{-1}$ for alfalfa hay and of 1.25 $kg{*}t^{-1}$ for wheat straw;
- Fuel consumption for baling wheat straw with press and half full bale collector was of 7.7 $kg.h^{-1}$ and with the press without collector- 7.2 $kg.h^{-1}$;
- Power necessary was of 31 HP for press and half full bale collector and of 27 HP at the press without collector.

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RESEARCH ON THE OPTIMAL DESIGN OF THE CHOPPING DRUM FROM THE FORAGE HARVESTER
/
CERCETĂRI PRIVIND OPTIMIZAREA DESIGNULUI UNEI TOBE DE TOCAT FURAJE DE LA COMBINA DE RECOLTAT FURAJE

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Keywords*: Finite Element Method, optimization, CAD*

ABSTRACT
The article presents a procedure for the design and dimensional optimization using finite elements analysis of a chopping drum from the forage harvester. The design and simulation of the forage chopper were achieved in SolidWorks. The loads resulted during the simulation were used to perform stress analysis and to optimize the chopper's parts.

REZUMAT
Lucrarea prezintă o procedură de proiectare și optimizare folosind metoda elementelor finite a unei tobe de tocat furaje de la combina de recoltat furaje. Modelarea și simularea tocatorului au fost realizate în SolidWorks. Sarcinile rezultate în urma simulării au fost utilizate pentru a realiza analiza structurală și pentru a optimiza dimensiunile pieselor tocatorului.

INTRODUCTION
In the technological process of the forage harvester, the most important working tool is the chopper, which performs the fragmentation of the feed to the required size and throws it to the exhaust system of the combine.

One of the main factors machine-building industry permanently focuses on is the reduction of the total cost of the fabricated component. Usually, another important objective is the mass reduction of the entire product, but this decrease in mass may mean lower performance of the chopper due to lower inertia force.

Obviously, the final machine component must meet the functional requirements without diminishing its safety. Computer-aided design (CAD) is the use of computer systems (or workstations) to aid in the creation, modification, analysis, or optimization of a design. CAD software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create a database for manufacturing (*Narayan, Lalit, 2008*).

FEA as applied in engineering is a computational tool for performing engineering analysis. It includes the use of mesh generation techniques for dividing a complex problem into small elements, as well as the use of software program coded with FEM algorithm (*Logan, 2001*).

MATERIAL AND METHOD
CAD software SolidWorks was used for designing the forage chopper. The chopper's parts were created using a set of simple commands, such as Extruded Boss/Base or Shell but also using ”Helix” and “Curve Pattern”. Each part was modeled independently, then they were assembled using Solidworks Assemblies.

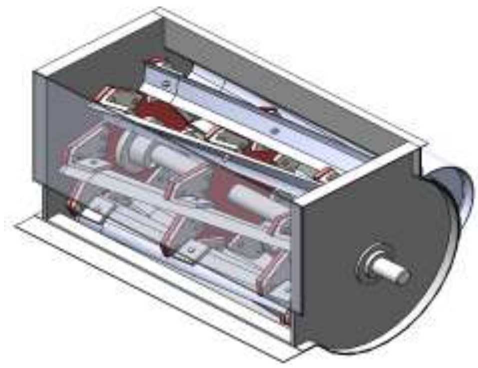

Fig. 1 - The assembly of the chopper

In order to simulate the movement of the chopper, SolidWorks's Motion Analysis module was used.

A 960 rpm motor was attached to the chopper. Also, the maximum force of 75N acting on the length of 10 mm was attached to the left of the knife.

In order to determine the behavior of the chopper under the maximum shear force and engine speed, the Simulation module in SolidWorks was used.

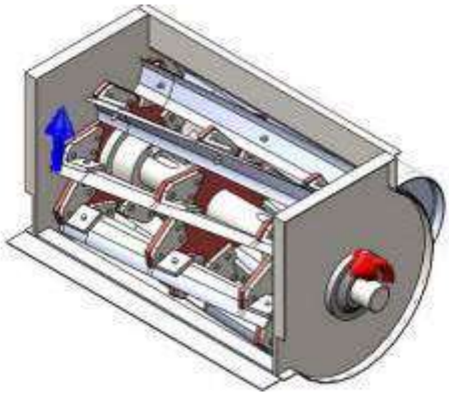

Fig. 2 - The chopper with the motor and force attached

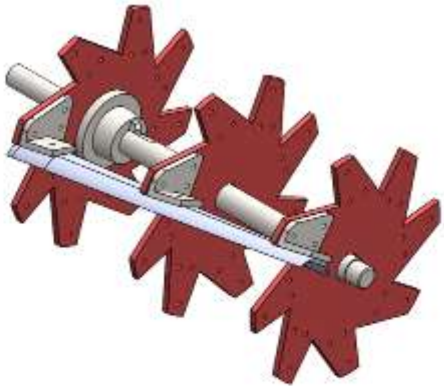

Fig. 3 - Parts to be studied

Before the analysis, the properties of a carbon steel (Plain Carbon Steel) were attributed to the parts.

Table 1

Carbon steel's properties

Properties	Unit	Value
Density	kg/m3	7800
Tensile strength	MPa	220.59
Elasticity module	MPa	210000

The pieces were meshed with high-quality parabolic tetrahedron elements, with knots both at the corners and at the middle of each edge. The discretization was finer in areas where higher stresses are expected (Figure 4).

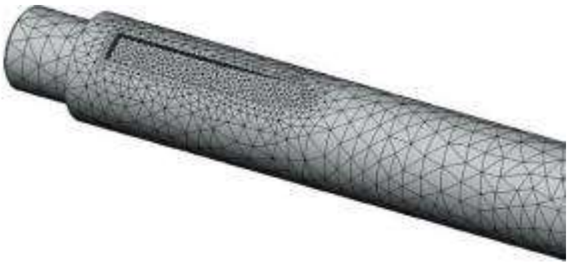

Fig. 4 - Discretization of the shaft

Three situations were analyzed:

1. When the maximum force acts on the left of the knife;
2. When the maximum force acts on the middle of the knife;
3. When the maximum force acts on the right of the knife.

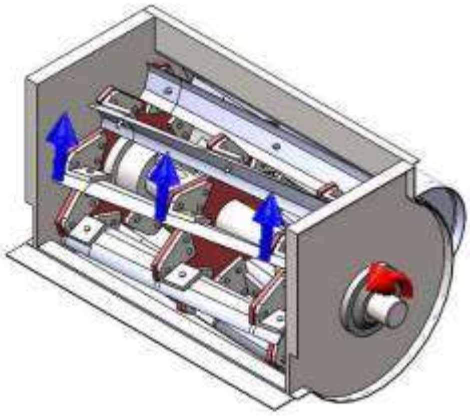

Fig. 5 - The analyzed situations

The analysis of the three situations revealed that the maximum stress occurs when the force acts on the left of the knife.

Based on the results of the analysis, the parameters to be used in the optimization procedure have to be defined. The procedure must configure the minimum mass components so that the maximum Von Mises stress does not exceed 110 MPa.

Table 2 shows the dimensions that can be modified as well as their upper and lower limits.

Table 2

The variable dimension of the studied parts

Dimension	Initial value (mm)	Inferior limit (mm)	Superior limit (mm)
Shaft diameter	70	35	70
Shaft end diameter	54	30	54
Key length	70	50	70
Key thickness	20	12	20
Key height	12	8	12
Flange centre hole diameter	70	50	70
Flange exterior diameter	150	130	150
Flange thickness	20	12	20

RESULTS

The resulted stress for the studied parts are presented in Figure 6.

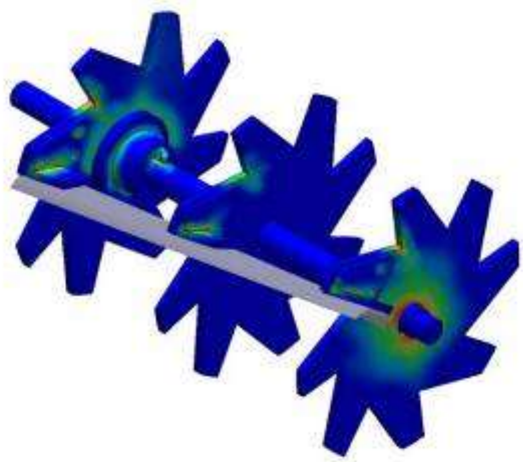

Fig. 6 - Stress in the parts

Table 3 shows the maximum stresses for the studied parts.

Table 3

The maximum stresses for the studied parts

Part	Maximum stress [MPa]	Tensile strength [MPa]
Shaft	36	220.59
Key	25	220.59
Flange	22	220.59
Rossette	23	220.59
Knife holder	27	220.59

The optimization process was completed in 126 iterations. Maximum stress values increase close to the set one without exceeding it except for a few scenarios.

Table 4 shows the dimension values that changed during optimization.

Table 4

Dimensions after the optimization procedure

Dimension	Initial value (mm)	Final value (mm)	Difference	
			Absolute (mm)	relative (%)
Shaft diameter	70	40	30	42
Shaft end diameter	54	35	19	35
Key length	70	50	20	29
Key thickness	20	12	8	40
Key height	12	8	4	33
Flange centre hole diameter	70	40	30	42
Flange exterior diameter	150	120	30	20
Flange thickness	20	15	5	25

The mass characteristics of the initial and optimized tree are shown in Table 5.

Table 5

Shaft's mass

	Initial chopper	Optimized chopper
Mass (g)	105848	78913

CONCLUSIONS

From this study it results that CAD software can be successfully used to perform analysis on the distribution of stresses and deformations in moving parts of agricultural machinery, in order to optimize their construction.

By optimizing the design using SolidWorks, a significant drop in the blade weight has been achieved, but this drop-in mass can mean lower chopper performance due to lower inertia.

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RESEARCH ON THE OPTIMIZATION OF THE RETRACTABLE FINGER AUGER FROM A COMBINE HARVESTER / *CERCETĂRI PRIVIND OPTIMIZAREA TRANSPORTORULUI ELCOIDAL DE LA COMBINA DE RECOLTAT CEREALE*

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Keywords*: optimization, CAD,* retractable finger auger

ABSTRACT

The paper presents research on optimizing the conveyor with retractable fingers to improve the amount of material transported by it. Initial equipment parameters were entered into an analysis program to calculate an optimal configuration.

REZUMAT

Lucrarea prezintă cercetari privind optimizarea transportorului cu degete escamotabile pentru a îmbunătăți cantitatea de material transportată de către acesta. Parametrii inițiali ai echipamentului au fost introduși intr-un program de analiză pentru a calcula o configurație optimă.

INTRODUCTION

Nowadays, combine harvesters are equipped with massive headers capable of harvesting large amounts of vegetable material. A very important component of the header is the retractable finger auger. For a better flow manufacturers use large diameter augers with fingers displayed on the full length of the auger.

Optimization is a way to get the best result in the given circumstances. It plays a vital role in machine design, because mechanical components must be designed in an optimal way. In designing components, optimization helps in many ways to reduce materials costs, provide a better component performance, increase production rates and many other parameters (*Narayan, 2008*).

CAE (Computer-Aided Engineering) encompasses software tools used by engineers to solve tasks such as stress resistance analysis of designed components/assemblies, simulation of operation, product optimization in the virtual model phase, simulation of the manufacturing process, planning, diagnosing project issues, etc. (*Das and Pratihar, 2002*)

MATERIAL AND METHOD

The angle α between the direction of the part that gives the finger eccentricity and the vertical axis influences the flow of material carried by the fingers.

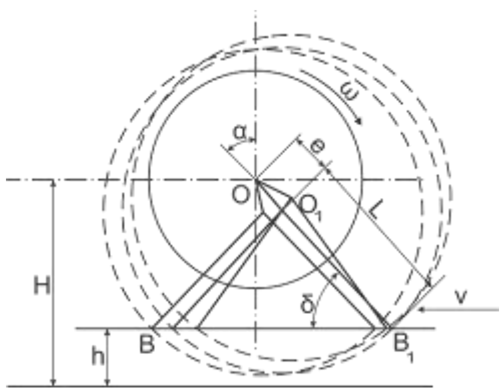

Fig. 1 - The simplified model of the mechanism

L-finger length; R- drum radius; e-eccentricity; H - the distance between the center of the drum and the platform; h - the height of the material layer; δ - the angle between the finger and the surface of the vegetal material layer; ω - the angular velocity of the drum; v - speed of advancement

The angle δ between the retractable finger and the upper face of the material layer increases with the α angle, and the surface where the finger acts on the plant material decreases. When α decreases, δ decreases and the finger's surface increases.

From the image it results:

$$A = \frac{1}{2}\pi L^2 - L^2 acrsin\frac{H-h-ecos\alpha}{L} - (H-h-ecos\alpha)\sqrt{L^2-(H-h-ecos\alpha)^2}$$

The arrangement of the fingers on the drum also influences the performances of the drum with retractable fingers. The analyzed drum has 12 retractable fingers.

If b is the distance between the fingers, the transport width is 11b.

The mass of the material carried by the fingers is equal to:

$$M = 11b * \rho * 4A$$

where ρ is the density of the material

From this it results:

$$M = 11b * \rho * 4 * (\frac{1}{2}\pi L^2 - L^2 acrsin\frac{H-h-ecos\alpha}{L} - (H-h-ecos\alpha)\sqrt{L^2-(H-h-ecos\alpha)^2})$$

The above relationship was used in the drum parameter optimization procedure.

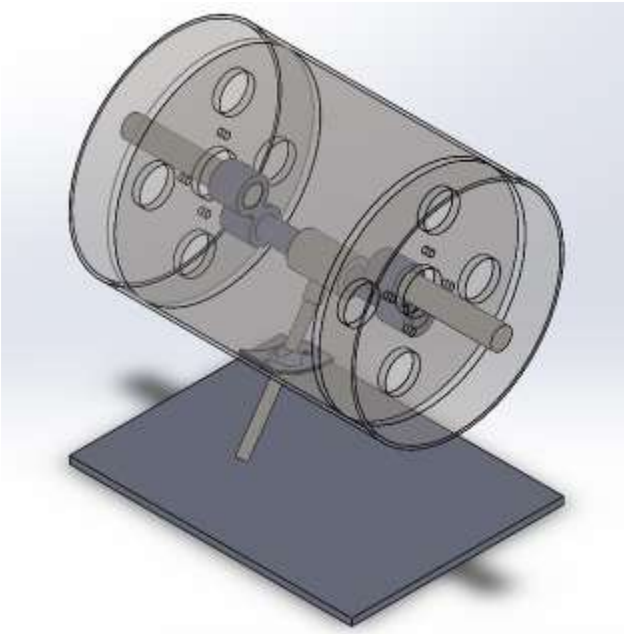

Fig. 2 - The simplified model of the mechanism

The parameters that influence the amount of material carried by the retractable fingers were optimized. The analyzed drum has the following initial parameters: finger length L = 175 mm; drum radius R = 120 mm; eccentric length e = 50 mm; the distance between the platform and the origin of the drum H = 225 mm, the height of the material layer h = 70 mm and the angle α = 30 °.

Vegetable material was selected as dried wheat with a density of ρ = 30 kg / m^3.

The above relationship was entered into the optimization procedure in the software Ansys. The value obtained for the initial parameters is 2.125 kg.

	A	B	C	D
1	ID	Parameter Name	Value	Unit
2	Input Parameters			
3	Design Assessment (A1)			
4	P1	L	175	
5	P2	H	225	
6	P3	a	20	
7	P4	e	50	
8	P5	R	120	
9	P6	h	70	
*	New input parameter	New name	New expression	
11	Output Parameters			
12	Design Assessment (A1)			
13	P8	Geometry Volume	13744	mm^3
14	P7	Masa material	2.1255	
*	New output parameter		New expression	
16	Charts			

Fig. 3 - The initial parameters of the equipment

General	
Expression	((1/2*3.14*P1*P1-P1*P1*asin((P2-P6-P4*cos(P3))/P1)-(P2-P6-P4*cos(P3)*sqrt(P1*P1-(P2-P6-P4*cos(P3)*(P2-P6-P4*cos(P3))))))/1e6)*11*0.065*30*4
Usage	Expression Output

Fig. 4 - The relation for the vegetable material mass in Ansys

The objective of optimization is to configure the parameters of the equipment so that the mass transported by the fingers is maximum.

For the analysis, some conditions have to be met. The finger length must be greater than the sum of the drum radius and the eccentricity, $L>R+e$, so that your finger comes out of the drum at any point. Also, for the finger to not hit the casing, the following condition must be imposed: $e\cos\alpha+L<H$.

8	Parameter Relationships			
9	Name	Left Expression	Operator	Right Expression
10	P1 >= P5+P4	P1	>=	P5+P4
11	P4*cos(P3)+P1 <= P2	P4*cos(P3)+P1	<=	P2

Fig. 5 - Ansys optimization conditions

Table 1

Parameters to be analyzed, as well as their lower and higher limits

Parameter	Initial value	Lower limit	Higher limit
L (mm)	175	170	180
H (mm)	225	220	228
α(º)	20	10	40
e (mm)	50	47	53
R (mm)	120	115	125

RESULTS

The procedure was set to 100 iterations from which to find 10 optimal options. The procedure was completed within 2 hours.

Table of Schematic B2: Optimization , Candidate Points

	A	B	C	D	E	F	G	H	I
1	Reference	Name	P1 - L	P2 - H	P3 - a	P4 - e	P5 - R	P7 - Output Parameter	
2								Parameter Value	Variation from Reference
3	◉	Candidate Point 1	177	227	12	49	123	★★★ 3.271	0.00 %
4	○	Candidate Point 2	173	226	12.5	53	117	★★★ 3.2701	-0.03 %
5	○	Candidate Point 3	178	227	31	53	122	★★★ 3.23	-1.25 %
6	○	Candidate Point 4	177	227	19	49	116	★★★ 3.2254	-1.39 %
7	○	Candidate Point 5	178	228	38	50	116	★★★ 3.2246	-1.42 %
8	○	Candidate Point 6	176	225	25.5	52	123	★★★ 3.2226	-1.48 %
9	○	Candidate Point 7	173	227	31.5	53	116	★★★ 3.2096	-1.88 %
10	○	Candidate Point 8	175	226	38	52	122	★★★ 3.2016	-2.12 %
11	○	Candidate Point 9	176	223	31	51	117	★★★ 3.1923	-2.40 %
12	○	Candidate Point 10	179	228	31.5	48	125	★★ 3.1485	-3.74 %

Fig. 6 - The best 10 options

From the figure it can be seen that the transported mass of material after optimization is 3.271 kg, with a 53% increase from the initial value of 2.125 kg.

Table 2

Parameter values before and after the optimization procedure

Parameter	Initial value	Final value	Difference	
			absolute	relative (%)
L (mm)	175	177	2	1.1
H (mm)	225	226	1	0.4
$\alpha(^{o})$	20	12	8	40
e (mm)	50	49	1	2
R (mm)	120	123	2	2.5

CONCLUSIONS

From this study it results that analysis programs can be successfully used to optimize the parameters of agricultural machinery, in order to improve their performance.

Parameters of the retractable finger auger influence the amount of material transported. Following optimization, the mass of transported material increased by 53%.

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NOISE REDUCTION TO GENERATOR SETS INTENDED TO OPERATE OUTSIDE BUILDINGS
/
REDUCEREA ZGOMOTULUI LA GRUPURILE ELECTROGENE DESTINATE SĂ FUNCŢIONEZE ÎN EXTERIORUL CLĂDIRILOR

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Keywords: *generator sets, noise sources, noise reduction*

ABSTRACT

Generator sets are equipment generating noise and, implicitly, noise pollution. To meet the limits of European regulations on the permissible sound power level for generators intended to operate outside buildings, a series of constructive measures are required to reduce the noise emitted.

REZUMAT

Grupurile electrogene constituie echipamente generatoare de zgomot şi implicit de poluare fonică. Pentru a se încadra în limitele impuse de reglementările europene referitoare la nivelul de putere acustică admis pentru generatoarele destinate să funcţioneze în afara clădirilor, sunt necesare o serie de măsuri constructive care să reducă zgomotul emis.

INTRODUCTION

Noise pollution is one of the dangerous invisible pollutants, which is why many international organizations consider noise to be a “real and present danger”.

As nowadays particular attention is paid to environmental issues, excessive noise is considered to be a form of pollution which, in the long run, can cause a reduction in hearing. Consequently, noise levels must be maintained below certain limits specified by national and international regulations.

Like many other types of rotating machines, power generators (generating sets) produce noise and vibrations, whether they work continuously or only occasionally in case of a failure (stand-by). This is the reason why generators’ noise levels should be reduced often in order to fall within the limits stipulated by the regulations.

Generating sets are equipment that generates and supplies electricity. A petrol or diesel-fuelled engine moves the rotor of an alternator that produces voltage at the terminals of its coiling.

Generating sets may have two operating modes (*globaltech-tools.blogspot.com*):

- continuous operation - when there is no possibility of connecting the consumers to a power distribution network;
- intervention mode in case of failure (stand-by) - as independent auxiliary sources used when a primary power supply network drops.

Generating sets can be classified according to:

- the usage regime (prime and stand-by);
- power;
- feeding (petrol or diesel);
- the electrical parameters of the supplied energy (single-phase, three-phase);
- mobility (fixed, mobile);
- soundproofing degree (with or without a soundproofing case).

MATERIAL AND METHOD

One of the most important parameters of a generator is the noise level (dB or L_{WA})

The main noise sources of the generators are (Figure 1):

- 1 - engine noise - due to mechanical and combustion forces;
- 2 - the noise produced by the exhaust of the engine gas;

- 3 - cooling fan noise - resulting from the noise of the air moving at high speed over the engine and radiator. The noise value varies with the speed and volume of the moving air as well as the design and deformation of the fan blades.
- 4 - the noise of the alternator - caused by cooling air;
- 5 - induction noise - caused by current fluctuations in windings and generating mechanical noise;
- 6 - structural/mechanical noise - caused by the mechanical vibrations of different components and structural components that are radiated as sound.

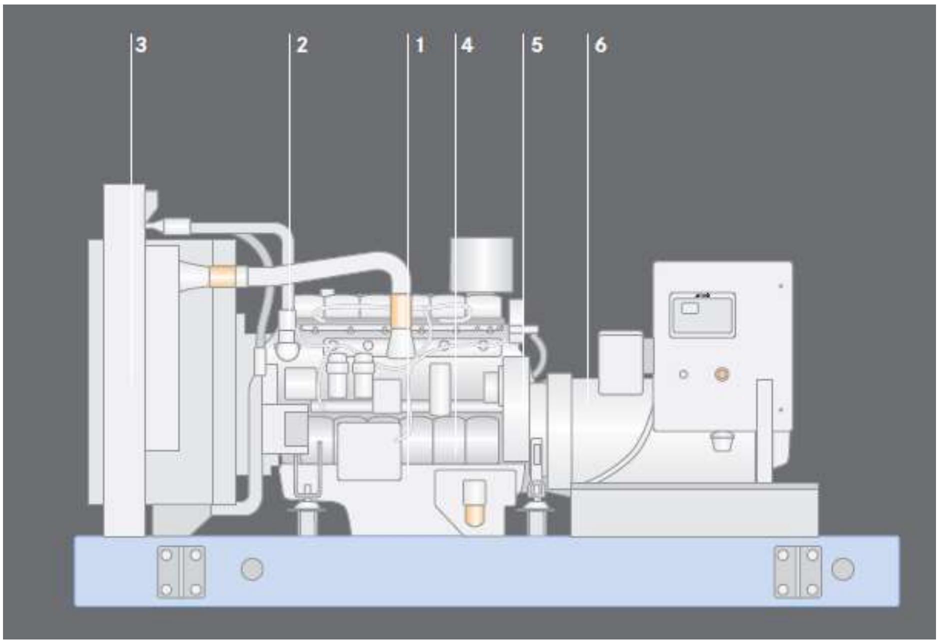

Fig. 1 - Noise sources (*www.mtuonsiteenergy.com*)

In our country, the noise level (acoustic power) issued by generating sets intended to operate outside buildings is governed by GD 1756/2006 transposing Directive 2000/14/EC.

For generators with a power of less than 400 kW, the allowable sound power level shall be calculated according to the primary power (P_{el}) using the following formulas (*GD 1756/2006*):

$95+lgP_{el}$ = dB (A) if P_{el} is less than 2 kW or more than 10 kW;

$96+lgP_{el}$ = dB (A) if P_{el} is between 2 and 10 kW.

Generating sets with a power of more than 400 kW are only subjected to noise level marking.

It should be specified that the permissible sound power level represents the sound power level, A-weighted, in dB, compared to 1 pW as defined in EN ISO 3744:1995 and EN ISO 3746:1995 respectively: 10 times the logarithm with base 10 of the ratio between the acoustic power emitted by the tested sound source and the reference sound power that is 1pW (10^{-12} W) (*EN ISO 3744:1995; EN ISO 3746:1995*).

Since the sound power level of equipment varies greatly from the measurement method used, the directive specifies the methods to be used for this type of equipment.

To obtain accurate sound values, measurements must be made in the free field, namely a field in which the reflections at boundaries are negligible in the frequency domain of interest. The measuring surface may be a hemisphere or a parallelepiped with a measuring distance of 1 m.

RESULTS

From a constructive point of view, most of the generators are provided with a metallic enclosure that ensures both the group soundproofing and its protection from external factors. Additionally, noise reduction can be achieved by various methods including the following (*Aaberg D.*; *www.cliffordpower.com; www.mtuonsiteenergy.com)* (Figure 2):

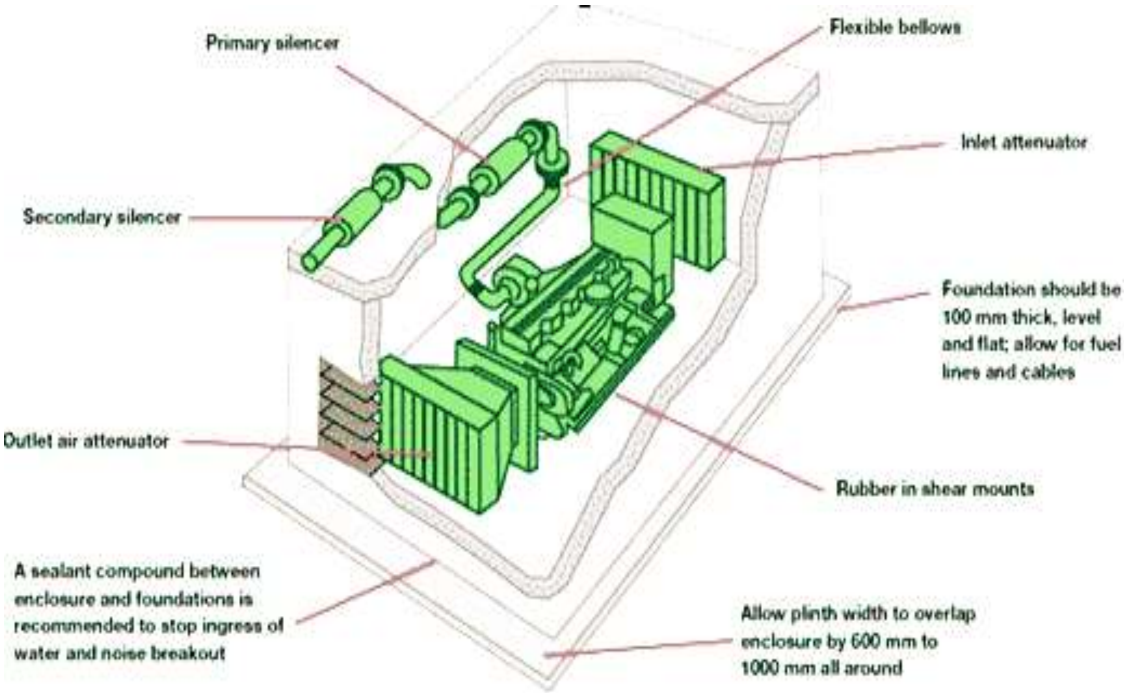

Fig. 2 - Typical installation showing noise control measures (*Aaberg D*)

Noise barriers - the enclosure can be made of steel, stainless steel, aluminum or carbon steel. Their mass and stiffness reduce the transmission of noise. When the enclosure walls do not provide sufficient stiffness due to the use of a thinner sheet, reinforcement ribs may be included. Noise pathways through door cracks, access points to the exhaust system, fuel or electrical cables are eliminated. All access ways should be fitted with rubber gaskets to minimize the sonic waves that may occur in these areas.

Vibration isolation - vibratory equipment creates sound pressure waves in the environment. All connecting points such as radiator air outlets, exhaust ducts, fuel and cables require flexible connections to effectively reduce noise and vibration transmission.

Cooling air noise mitigation - Cooling air movement is a source of high frequency noise, but its flow limitation is detrimental to cooling efficiency. Installing baffle sound attenuators can help reduce the noise produced by cooling air when moving through the engine and radiator. It is also possible to place insulating materials that attenuate the noise inside the enclosure, the pipes and the holes.

Noise dampers - can be made of laminated steel or stainless steel that prevents corrosion. The so-called “industrial” dampers can reduce the noise by 12 to 18 dB (A).

Acoustic insulation - Noise-absorbing materials can be used to cover the walls of the enclosure and the air ducts. It is recommended that they be resistant to oil, water, fuel, battery fluid and coolant, be fireproof, wear and abrasion resistant and easy to clean. However, these materials do not have to limit or hinder the flow of cooling air through the generator, generating overheating and reducing performance.

CONCLUSIONS

Generating sets (power generators) are equipment that generates and supplies electricity, but at the same time there are sources of noise pollution. The main noise sources of the generators are due to the engine, cooling fan, alternator, exhaust of the engine gas, current fluctuations, or mechanical vibrations of the various components.

In order to reduce the level of noise emitted by generators intended to operate outside buildings so that they do not exceed the sound power level regulated at European and national level, a series of constructive measures can be taken, including: soundproofing enclosures, noise barriers, noise dampers and attenuators, acoustic and vibration isolations.

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WEED CONTROL METHODS FOR ORGANIC VEGETABLE CROPS / *METODE DE COMBATERE A BURUIENILOR DIN CULTURILE ECOLOGICE DE LEGUME*

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ABSTRACT

Organic vegetable crops are part of niche crops that can provide farmers with high incomes. Controling weeds in these crops is an extremely important work, constituting today a real challenge for vegetable growers because only non-chemical methods are accepted in the organic farming system for plant protection. Physical weed control is mostly used, which is based on the application of several techniques, the most used being mechanical and thermal control.

The paper shows a short synthesis of current non-chemical methods and technical devices used in integrated weed management in organic vegetable crops.

REZUMAT

Culturile ecologice de legume fac parte din culturile de nișă, care pot asigura fermierilor venituri ridicate. Combaterea buruienilor din aceste culturi este o lucrare deosebit de importanță, constituind astăzi o adevărată provocare pentru legumicultori, deoarece în sistemul de agricultură ecologică pentru protectia plantelor sunt acceptate numai metode non-chimice. Se utilizează mai ales combaterea fizică a buruienilor, care se bazează pe aplicarea mai multor tehnici, cele mai folosite fiind combaterea mecanică și cea termică.

Lucrarea prezintă o scurtă sinteză a metodelor non chimice actuale si a dispozitivelor tehnice utilizate în sistemele de gestionare integrată a buruienilor din culturile ecologice de legume.

INTRODUCTION

The organic farming system must be seen as an integral part of sustainable development strategies and as a viable alternative to conventional farming, as it can provide, in particular: less contaminated air, water and agrifood products, safe working conditions for farmers, biodiversity preservation, fertile and healthy soil, nutritional quality of organic products, food security, environmental protection, reduced use of non-renewable resources, economic benefits (*Brumă, 2015*).

With regard to organic farming, Romania is ranked 7th in the top led by Poland, of the 23 Eastern European countries analyzed by FIBL Switzerland. On the other hand, in recent years Poland and Romania registered a decline in certified surfaces ecologically (*Mediafax 2018*).

The so-called minor crops produce over € 60 billion a year, which represents more than 20% of the EU's total agricultural output (*Pannacci et al., 2017*). These include fruit and vegetable crops, plus seed, spice, medicinal and aromatic plant crops. Among these niche crops, organic vegetable crops are also found.

According to some authors, the physical combating methods for plant protection fall into two basic types: active and passive. Active methods consist of using a certain form of energy for destroying, injuring, inducing stress in crop pests or eliminating them from the environment, having immediate effect during application. Passive methods, on the other hand, cause changes in the environment and have a more sustainable effect. Depending on the energy used, the physical methods are classified as: mechanical control, thermal control, electromagnetic control, pneumatic control, etc. In the case of weed control in organic crops, they include: manual weeding, hand pulling, mowing, thermal and mechanical methods (*Panneton et al., 2001*).

Also, in organic agriculture, weed control is achieved by applying certain measures / practices which, depending on the moment and the manner of application, can be preventive and curative (*Roman et al., 2008*). Preventive practices are necessary for long-term effective management of weeds (*Gabe et al., 2014*), preventing them from emerging and multiplying. They consist of: crop rotation, application of fertilizers, use of competitive species and varieties, germination bed preparation methods, irrigation / drainage systems, as well as the harvesting method (*Walsh et al., 2013*).

The curative methods keep under control the weeds already in the crop, using mechanical and thermal weed control equipment, which constitute the traditional non-chemical physical means for organic crops (*Shaner and Beckie 2014*).

Thermal combat is achieved through heat transfer from the specific equipment to weeds, by foliar contact, aiming at the destruction of their vital parts after a short period of time (*Nadzeikienė et al., 2009*). In order to be effective, heat treatments should lead to an increase of the internal temperature in weeds, between 55 °C and 70 °C, for a period of approx. 0.1 s. Therefore, the amount of heat transferred between the thermal control equipment and the target organism, as well as the duration of exposure to the treatment are important parameters. (*Ascard et al 2007*). The effectiveness of the treatments also depends on the stage of weed development, the young ones being much easier to destroy. Heat exposure determines the expansion of intracellular water, followed by cell membrane rupture, the primary effect being plant drying together with other chemical decompositions (*Peerzeda & Chauhan 2018*).

Over the past few years, concerns about the worldwide growth of weed populations resistant to herbicides, the low availability of active ingredients for minor crops (vegetables), the multiplication and development of organic farms have stimulated the development of new non-chemical weed control methods (Harker & O'Donovan, 2013).

In this brief analysis, it is not possible to address the many aspects of weed management, so the focus will be on new developments in non-chemical (mechanical / thermal) and intelligent weed control technologies, especially in vegetable crops.

MATERIAL AND METHOD

Soil heating is a promising, preventative ecological method for controling weeds in niche crops, that bring high incomes, such as vegetables and flowers.

Ecostar SC 600 selfpropelled machine (*Celli Spa.*) (fig. 1) is used for disinfecting the soil with steam and zeolite type (potassium hydroxide and carbon oxide) ecological substances, using the Bioflash system (fig. 2). The machine is destined to be used in greenhouses, solariums and on the field, being equipped with rubber tracks for improving manoeuvrability and reducing soil compaction. It is fitted with horizontally placed steam generator, for reducing height. The disinfection section placed in the back can be displaced transversally, giving the possibility to conduct the treatment in the inferior and lateral parts of a tunnel greenhouse. The speed of a rotary cutter is of 40-60 rot min^{-1}. The machine is fitted with an automated and ergonomic command and control system, with a biaxial joystick controlling the movement and the speed. Due to the hydrostatic transmission, a continuous range of speeds between 60-6000 m h^{-1}.

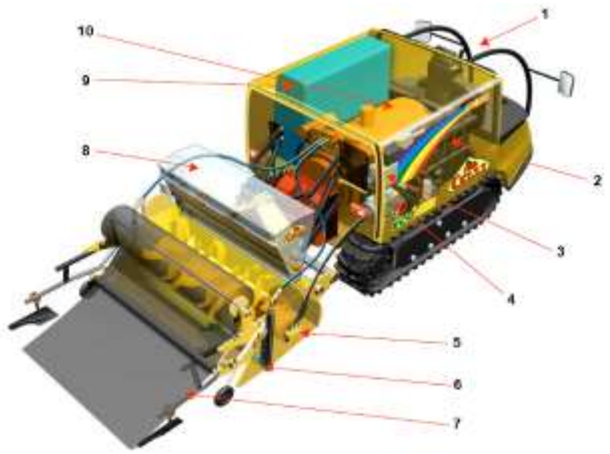

Fig. 1 – Ecostar SC600 Equipment (Celli Spa)
1-drive joistick;2 –Diesel engine; 3- electric generator; 4-hydraulic transmission; 5- hydraulic rotating hoe; 6-steam injection bar; 7- plastic film mulch system;8-bunker for exothermal reactive;9-water tank; 10-boiler.

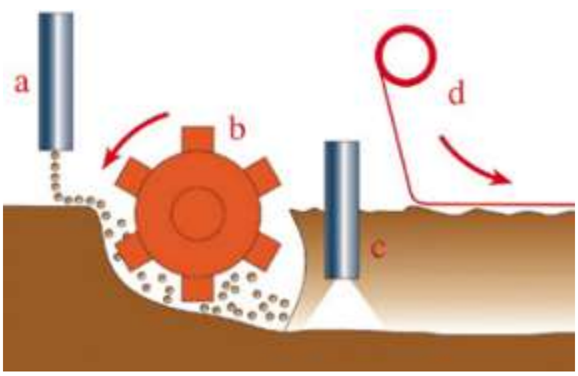

Fig. 2 –Bioflash system diagram (Celli Spa)
(a) substance distribution; (b) soil incorporation with a rotating hoe;(c) steam injection; (d) treated soil mulching.

The remote-control system allows driving without the operator on board. During the experiments, all the main components of the self-propelled machine (the rolling system, the rotary cutter hydraulic motors and the exothermic compound distribution system) were controlled electronically by a control card and its related software. (*Peruzzi et al., 2011*).

The technical characteristics of the machine are presented in Table 1. (*Peruzzi et al., 2011*).

Table 1

Technical characteristics of Ecostar 600

Characteristic	**Measurement unit**	**Value**
Equipment type	-	Self-proppeled
Power source	-	Thermal engine
Engine power	kW	44
Cubic capacity	cm^3	2.068
Fuel consumption	kg h^{-1}	11
Running system	-	Rubber tracks
Sleight dimensions (length x width x height)	m	1.9x0.32x0.52
Transmission type	-	Hidraulica
Speed	m h^{-1}	60-6000
Exothermal substances bunker capacity	m^3	0.23
Water tank capacity	m^3	0,6
Steam generator type	-	Electric
Electric motor power	kW	2.5
Steam flowrate	kg h^{-1}	600
Steam pressure	MPa	1.18
Working width	m	1.6
Overall dimensions (length x width x height)	m	3.8 x 1.6 x 1.5
Equipment weight	kg	3000

The Ecostar SC600 machine (Figure 3) was tested using several types of steam injection bars to obtain different steam and heat distribution in the soil. Thus, it was equipped with: standard bar for Bioflash systems, which injected steam at a 200 mm depth; double bar, designed to have a more uniform distribution of steam in the treated soil and to reach deeper layers; carter bar, for surface treatments. During the experiments, a mix of the standard bar and the carter bar was used, with different ratios of steam distribution between the surface and the deep area. During the steam treatment, exothermic substances (CaO and KOH), applied in different doses (0, 1000, 2000, 4000 kg ha-1) were tested with or without plastic film mulching (*Peruzzi et al., 2011*).

Following the experiments, soil temperature was measured using a dedicated system. The measured temperatures were divided into four "Classes" (T<40 °C; 40 °C < T < 60 °C; 60 °C <T < 80 °C; T > 80 °C). The amount of time each class persisted in the soil was recorded, along with the highest, average and final temperature (after 3 hours), in order to compare the effects of different treatments. A parameter - thermal addition (ΣT) was calculated as the sum of individual temperatures (measured every minute) for 3 hours after the treatment, including the temperature levels, duration and length of heating (*Peruzzi et al., 2011*).

The machine was also used to test the effect of five different systems of steam injection (surface or deep steam injection bar and three mixed systems at different steam distribution ratios between the surface and the deep bar: 1:2; 1:1 and 2:1) on an artificial infestation of Brassica juncea and on the natural weed seedbank. Treatments were performed using only steam or in combination with exothermic substances (CaO, KOH) applied at doses of 1000 and 4000 kg ha-1 (*Peruzzi et al., 2012*).

In order to evaluate both weed control and crop yield after applying different doses of steam in the soil strips together with exothermic substances, a prototype machine (Figure 4) using the Bioflash system (Figure 2) was built, for applying strips. The machine, being towed, operated in aggregate with a 135 HP tractor, from which the hydraulic system and the electric generator were actuated. It was made of a two-wheeled pneumatic chassis that supports: the steam generation system, the steam application system and an exothermic compound (Bioflash system), the electrical system and the hydraulic system. The machine was coupled to the tractor via a drawbar. The application system for steam and exothermic compound was obtained by modifying a rotary cultivator with 12 units. Each unit acted on a width of 0.18m, being covered by a carter, on which the steam injection bar was placed.

The rotary cultivator (with 30-60 rpm min^{-1} speeds) was divided into three parts, each equipped with four units and a hopper for the exothermic compound. Each hopper was equipped with an adjustable metering unit, a measuring device and the four exhaust tubes, the system being driven by an electric motor. The steam obtained with a fast generator (Diesel type) was applied in 12 strips of 0.18 m, with 4 units grouped for each of the three ridges of 1.28 m width, resulting in a total working width of 4.58 m. In one day after using the machine, it was sown in the middle of the steam-treated strips. The tests were conducted in a carrot crop, organically grown under real field conditions, in order to study the effect of different doses of steam on the crop and on a natural weed seed bank over the entire growth cycle (*Raffaelli et al., 2016*).

Fig. 3 –Ecostar SC600 Equipment (*Celli Spa*)

Fig. 4 – Machine for soil disinfection in strips (prototype) (*Raffaelli et al. 2016*)

Hot water and steam are very effective in destroying annual weeds, some perennials ones, and permeable seeds close to the soil surface (*Banks and Sandral 2007*).

Hot water is effective in thermal combating when being used especially against young weeds. The water flows gravitationally, possessing other important properties (Table 2) appropriate to this method (*Kristoffersen et al., 2008; Heatweed Technologies AB*). If the energy is correctly transferred to the weeds, their cellular structure is destroyed in a tenth of a second, then the roots are also dying. *Heatweed* equipment provides a stable water temperature of 98-99 ^{o}C, with the possibility of operating with vehicles, trailers, etc. They are intended to be used in areas with dense weeds: stadiums, parks, squares, etc., ensuring protection of surrounding plants due to low water pressure (*Heatweed Technologies AB*).

Table 2

Water characteristics

Thermal agent	Specific heat (kJ/kg^{0}K)	Thermal conductivity (W/m ^{0}K)	Energy density (kJ/kg)
Hot air (100^{0}C, 1 bar)	1,01	0,03	101
Hot water (100^{0}C, 1 bar)	4,18	0,682	418
Steam (100^{0}C, 1 bar)	2,08	0,025	2675

The main technical characteristics of the XL140 (*Heatweed Technologies SB*) destined for large surfaces (Figure 5) are: 1.4 m working width; 34 l / min water consumption; 98-99.6 °C water temperature; 0.5-2.5 km / h working speed (depending on degree of weeding); 2 Diesel / BioDiesel burners; hydraulic transmission, 7x20cm application system with independent sections, 800 l tank volume, burner tank volume 105 l.

Because weeds and crop plants have similar biometric data, there is a problem of crop protection. Thus, the Hydra - Boom (*Weedtechnics*) system employs two heads of application of the Rowtech 55 (*Weedtecnics*) saturated steam and hot water mixture for organic horticultural farms. These conical heads follow the shape of the jet, retain the heat and protect the crops. Their main technical characteristics are: diameter 0.55 m, height 0.23 m, flow rate 4-19 l / min, weight 3.5 kg. The Hydra-Boom system is mounted in front of the tractor, with the position of the Rowtech 55 applicators being hydraulically controlled from the cabin. They also have the ability to easily follow the field (Figure 6).

Fig. 5 – Equipment XL140 (*Heatweed Technologies*)

Fig.6 –Hydra-Boom System (*Weedtechnics*)

The effect of controlling weeds with two types of steam (wet and overheated) obtained using electricity is studied. For this, an innovative self-propelled chassis with the possibility of speed control, steam pressure and application width (*El-Sayed & El-Hameed 2017*) was used.

Mechanical control of weeds between rows without damaging the cultivated plants or their roots can be achieved with brush-type cultivators destined for use in vegetable growing, medicinal plants crops, etc. The technical characteristics of Fobro Hoe Brush are shown in Table 3. (*Baertschi Agrartecnic AG*).

Table 3

Technical characteristics Fobro Hoe Brush (AGB)

Tip Fobro Hoe Brush	**Type 500**	**Type 760**
Working width	1.5 m - 2,7 m	1.5 m - 2 m
Wheel track	adjustable	adjustable
Weight (according row on_iguration)	from 300 kg	from 600 kg
HP required	from 20 HP	from 50 HP
Diameter of Brush-Disc	500 mm	760 mm
Plant protector tunnel clearance	22 cm	33 cm
Tunnel width	6,10,14 cm	6 cm or 14 cm
Minimum row spacing	12 cm	12 cm
Power source	PTO 540 rpm or hydraulic	PTO 540 rpm or hydraulic

Fobro Hoe Brush equipment (Figure 7) consist of rotating brush units to which the fixed ones are added (fig. 8). The hairs of the brushes are made of durable and flexible materials that allow action near crops, protected by tunnels. The brushes do not move or scratch the ground like other devices, and the weeds dry quickly because the flexible wires pull them out of the root and affect the protective layer.

Fig. 7 – Fobro Hoe Brush cultivator (*AGB*)

Fig. 8 –Fobro Hoe Brush tunnel cultivator detail (*AGB*)

In general, mechanical methods for weed control between rows in vegetable crops are based on traditional spring harrows and cultivators, but new devices such as finger-weeders, torsion-weeders and intelligent weeders have emerged. (*Peruzzi et al., 2017*)

An automatic / intelligent weed control system has to achieve: guiding the mechanical devices, detecting and identifying weeds, eliminating them and eventually mapping. At this moment, only four companies sell automatic weed control machines: Robovator (Frank Poulsen Engineering ApS - Denmark); Robocrop (Garford Ltd. UK), IC Cultivator (Machinefabriek Steketee BV - The Netherlands) and Removeed (Costruzioni Meccaniche Ferrari -Italia).

The Robocrop In Row cultivator is equipped with a hydraulic driven disc mdule for each crop row. As the cultivator advances on the row, the rotating disk controlled by a video image analysis system detects the location of the plants in the crop and rotates for correct alignment of the cut so as to remove the weeds between the rows and the plants one at a time (Garford Ltd). The Robocrop InRow cultivator has been tested to evaluate the effectiveness of weed control and soil loosening in salad, celery, radicchio, bok choy (obtained from seedlings), and in the cultivation of bok choy salad crops directly sown in the field. The cost of using the rotating cultivator in the two types of crops was also evaluated (*Fennimore et al., 2014*).

RESULTS

After testing the Ecostar EC 600, it was found that at a working speed of 150m h^{-1} the operating time was very high (20% was lost for auxiliary operations, eg: recharging). The advantage of Bioflash is that despite the relatively long working time, it has no toxic effects on crops. The tested system allowed to obtain higher temperatures compared to steam applications (in average + 17%), obtaining different results depending on the type of active compound and speed. Regarding thermal addition, CaO led to higher values compared to KOH (+ 7%) for the same rate of application. The higher dose for both active compounds led to a higher value for thermal addition (+ 10%) compared to lower doses. In terms of temperature classes, CaO applied at a dose of 4000 kg ha^{-1} led to temperatures above 60 °C for 50 minutes. In addition, for CaO applied at a dose of 1000 kg ha^{-1}, a temperature persistence time similar to the one KOH applied in high dose was obtained. The significant effect of soil heating due to the use of plastic mulch has been highlighted by the persistence time of the four different soil temperature classes. Mulching limited heat loss and allowed higher thermal addition (+ 30%) on treated parcels, compared to uncovered soil (*Peruzzi et al., 2011*).

Also, the use of a single steam injection bar (surface or standard depth application) was more effective in achieving a high soil temperature and the holding time at a 100 mm depth, compared with mixed injection systems (*Peruzzi et al., 2011*).

For the machine prototype that applies the steam in strips using the Bioflash system, the best results for the temperature induced in the soil, over 60 ºC at a depth of 25 mm, were obtained by applying a dose of CaO of 4000kg / ha and a maximum dose steam of 2.78 kg / m^2 (Figure 9). The authors recommended a steam dose of at least 2.3 kg / m^2 at a working speed of 240m h^{-1} for a gradual satisfactory seed bank reduction in the soil, although economically it would have satisfied a dose of 1.9 kg / m^2 (*Raffaelli et al., 2016*).

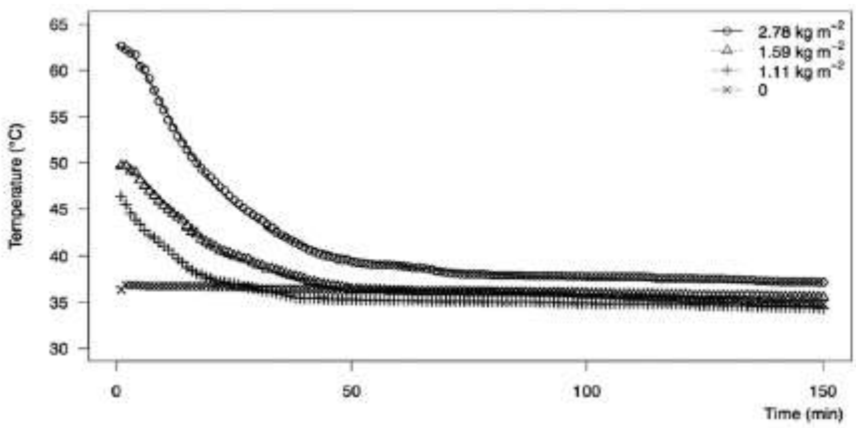

Fig. 9 – Soil temperature variation in strips depending on the time and steam dose applied (*Raffaelli et al. 2016*)

Due to its thermal conductivity properties, hot water can transfer 23-27 times more energy than hot air or steam. A study conducted at the University of Copenhagen shows that after the hot water treatment of a weed infested surface, their least regeneration occurs (Figure 10), even at the lowest treatment frequency (*Heatweed Technologies*).

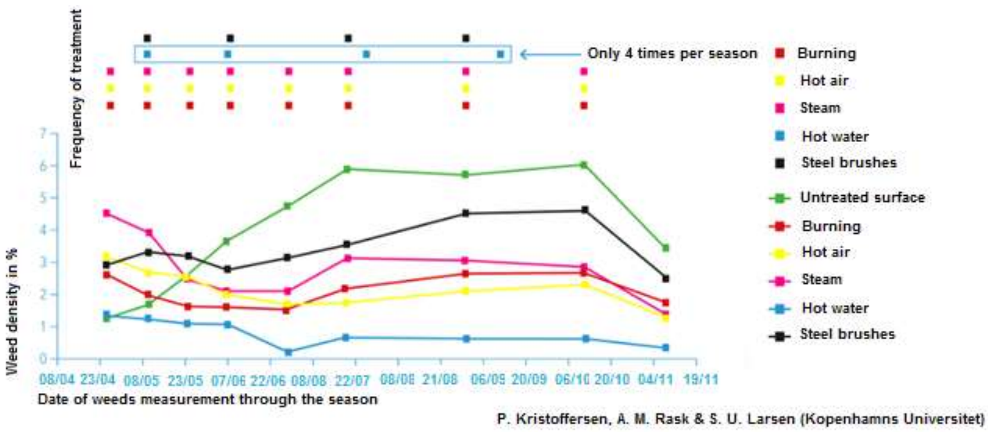

Fig. 10 – Weed density variation depending on the treatment applied (*Heatweed Technologies*)

Using the innovative chassis, for the same experimental conditions (working speed, pressure, application height), the results obtained in combating weeds using superheated steamed were superior to those obtained combating using wet steam. They were expressed through several indices, the most important of which was the weed extermination rate and their chlorophyll content, determined by: 2 and 3 days of treatment, as well as by weed regrowth determined after 1, 2, 3 weeks after treatment. (*El-Sayed & El-Hameed 2017*).

In general, for niche organic crops, treatments with traditional hoe with rigid shanks or brush-weeder for inter-row weed control, combined with finger-weeder for intrarow weed control, seems to be the better weed control strategy. For this type of crops obtained by sowing, characterized by small distances between the rows, is recommended to use high precision cultivators.

Robocrop rotating cultivator was in general more effective than the standard cultivator, concerning weed density as well as times consumed for removing weeds between the plants on the row, which is executed manually. It behaved well in the transplanted crops, especially in salad crop, where plants were bigger than weeds. In crop sowed using Robocrop achieved a thinningof 22-28%, compared with manual thinning and standard hoeing, therefore yield and net profits were lower.

CONCLUSIONS

In non-chemical weed management in organic vegetable crops, physical and mechanical weed control plays a fundamental role. The type of machine that can be used for this depends on the plant type, the cultivation technology, the size of weeds and the type of soil. For these methods of weed control, the development and adoption of efficient precision farming technologies can be a solution. Intelligent camera-based systems, capable of guiding mechanical and / or thermal devices contribute to increasing the working width and speed, which implies financial benefits.

The protection of vegetable plants against thermal destruction represents an important and seldom crucial factor in the technological process of chemical weed control, therefore different techniques need to be created and adpted, adequate for each type of crop. The study and development of weed control using hot water in organic vegetable crops, combined wih mechanical ones, in one pass, could constitute an important premise for achieving efficient equipment.

The preventive and curative control methods adopted, together with low tech, low cost or intelligent equipment, should be used within an integrated weed and pest control system in organic vegetable crops, in order to achieve an efficient weed management.

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INSTRUMENTS FOR ONGOING TRAINING, BOOSTING INNOVATION AND RAPID TECHNOLOGICAL TRANSFER OF RESEARCH RESULTS SPECIFIC TO AGRICULTURE, FORESTRY AND FOOD INDUSTRY
/
INSTRUMENTE PENTRU FORMAREA CONTINUĂ, STIMULAREA INOVĂRII ŞI TRANSFERUL TEHNOLOGIC RAPID AL REZULTATELOR CERCETĂRII, SPECIFICE DOMENIULUI AGRICULTURĂ, SILVICULTURĂ ŞI INDUSTRIE ALIMENTARĂ

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Keywords: *ongoing training, technological transfer, innovation, keysectors: agriculture, forestry, food industry.*

ABSTRACT

Motto: "Do not value a man that today is not being wiser than he was yesterday." Abraham Lincoln.

In this paper is presented the manner in which the objectives of Strategy of Education and Professional Training in Romania were applied during 2016 – 2020. The strategy aims at dissemination, promoting and increasing the level of professional training of human resources. Therefore, this article is based on specialty papers in the professional training field, webpages of authorized Centres of training/specialization/perfecting, authorized by National Authority for Qualifications, both in country and abroad and aims at developing innovative instruments for ongoing training.

REZUMAT

Moto: "Nu pune mare preţ pe un om care nu este mai înţelept astăzi decât a fost ieri." Abraham Lincoln.

In lucrare se prezintă respectarea obiectivelor Strategiei Educaţiei şi Formării Profesionale din România pentru perioada 2016 – 2020, care îşi propune diseminarea, promovarea şi creşterea nivelului de pregătire profesională a resursei umane. Astfel, pentru întocmirea acestui articol s-au consultat lucrări de specialitate din domeniul formării profesionale precum şi dezvoltarea de instrumente inovative pentru formarea continuă, cărţi de specialitate, pagini web ale Centrelor de formare/specializare/perfecţionare autorizate de Autoritatea Naţională pentru Calificări, etc., atât din ţară cât şi din străinătate.

INTRODUCTION

One component of the market economy is represented by labour market. Labour market is the economic and social environment where manpower bidders and requesters meet. Performances of labour market depend on correlation of education and initial professional training tenders with labour market requests. Labour market is also defined in terms of competences. Competence reflects the capacity of a person to cope with the requirements of a certain workplace. The technical skills should be doubled by key competences, necessary at each workplace, such as: communication, collaboration, team work, building partnerships, initiative, creativity, possibility of solving the relevant issues, taking responsabilities, efficiently using the resources, identifying the information sources and capitalizing them.

The main components of labour market are labour request and manpower supply. The major form in which the imbalance of labour market manifests is the unemployment. By excluding a long period of time the manpower from labour market, it deprofessionalizes, both by loosing professional competences and deteriorating the attitude towards work, in general. Labour market has changed during the economic transition, being in continous transformation. One of its main characteristics is the reduced number of working people. The unemployment growing tendency made that occupancy becomes a major concern in Romania, starting from early 1990; this concretizes in law regulations and creation of institutions specialized in occupancy.

The paper presents a general view on continuous professional training, defines the legislative framework, the suppliers, the training tender and the main responsible institutions in the field. This way, the participation to ongoing training is presented: professional categories – employees and unemployed persons, by analyzing certain aspects related to training activity of companies, organized by National Agency for Occupancy or activities developed within national programmes related to human resources.

At the same time, the expectations of employees upon training, are presented, at the same time with the main aspects concerning the manner in which courses are organized (informing the participants, tender, duration), motivation, contents and level of satisfaction of trainees, investigating the categories of obstacles and impact and future needs of training (competences aimed, participation intent, conditions of organization preferable).

MATERIAL AND METHOD

Romanian system of ongoing professional training is designed and organized according to a specific legislative framework, which analysis enables to efficiently approach the different aspects of ongoing professional training and propose eventual recommendations in the field.

This paper will present the regulations on ongoing professional training, both those adpted at E.U. and at internal level. The programme regulations and policies referring to employees professional training are emphasized together with their main goals; on the other hand, the general aspects of normative documents (laws, governmental decisions, orders, etc.) will be presented.

1. NATIONAL AND EUROPEAN POLICIES WITHIN TECHNOLOGICAL DEVELOPMENT PROCESS

1.1. Regulations on ongoing professional training at national level

1.1.1. National strategy for ongoing professional training, elaborated according to European Strategy for Occupancy establishes a series of directions of action, among which we mention [1]:

- Drawing up lifelong learning policies in compliance with labour market development and requirements;
- Development of a structured system of ongoing professional training, transparent and flexible, with an appropriate funding degree and a strong involvement of social partners, aiming at enhancing occupancy, adaptability and mobility of manpower;
- Increasing the participation level in lifelong learning process up to 7% in 2010, for adult population (age group of 25-64 years);
- Promoting a high-quality training tender and ensuring, by training investment , of benefits at personal/ individual and social level.

1.1.2. Long and medium term strategy for ongoing professional training (approved by HG (Governmental Decision) no. 875/2005) aims at: boosting labour market transformation; facilitating the mobility between different activity sectors; increasing the degree of awarness of importance of ongoing learning, motivational degree related to development of knowledge and skills; involvement of all social actors in FPC (continous professional training) process. Strategy establishes the following strategic objectives [2]:

- Increasing the participation to FPC and enabling the access for all categories of persons to lifelong learning, by the following directions: acknowledgement by employees, employers and other relevant actors of FPC benefits;

- Development of public and private investments concerning FPC and making them efficient by creating a flexible and transparent FPC system, based on competences, integrated within National Qualification Authority; improving the network of information, counseling and professional orientation; ensuring assessment / validation and acknowledgement of previous expertise / learning, including the skills acquired within non-formal and informal learning context;

- Enhancing quality and efficiency of FPC through a result-oriented management, by: reinforcing the institutional structures and partnerships in FPC; implementation of mechanisms related to quality ensurance; performing studies, analyses and statistics for FPC; adapting the legal framework for elaborating and implementing the new system of FPC.

1.2. Regulations in the field of ongoing professional training at European Union level

EU policies in the field of professional training represent landmarks in elaborating of regulations, policies and specific directions by each member state. The most significant European policy documents in the field will be presented below [3].

1.2.1. Lisbon Declaration (March, 2000) has settled a series of objectives for EU Member States, namely to substantiate a society and an economy based on knowledge by adapting and improving education and professional training systems.

1.2.2. European Commission Memorandum regarding the lifelong learning (adopted in October, 2000) has stipulated a series of key regulations aiming at orienting the future actions in the field: guarantee to universal and ongoing learning access for competences training and improving; achieving of superior investments in human resources; encouraging innovation in teaching and learning; valorization of non-formal and informal learning; rethinking the orientation and councelers, focussing on high quality information access and lifelong learning opportunity counseling; home domicile proximity learning, offering lifelong learning opportunities, as close as possible to beneficiaries, within their own locations and supported by TIC equipment [4].

1.2.3. „**Copenhagen Declaration**" (Declaration of European Ministers of Education and professional training and European Commission, agreed in November, 2002, on stregthening the European cooperation in professional training) has established the following priorities related to boosting the education and initial and ongoing professional training systems: European dimension, transparency, information and counseling, acknowledgment of competences and qualifications, ensuring training high-quality[5].

1.2.4. European Council from March, 2005 has redefined, as fundamental action priority of EU and each Member State the increment of investments in human resources by ensuring better education and training systems according to current competence requirements, and as forefront direction- growing and improving the investments in research and development in view of forming the European Knowledge Area[6].

1.2.5. European Strategy for Occupancy (Luxemburg, November, 1997 with subsequent modifications) has offered orientation and ensured the coordination of priorities related to occupancy policies at EU level, adopted by all Member States. Global objectives of strategy are: reaching by 2010, an average of general rate of occupancy of 70%; increasing occupancy rate of women up to 60%. Strategy establishes as prioritary a bigger investment in human capital and lifelong learning, namely improving the following domains: specific educational policies, costs and responsabilities, training offer, learning methods and professional training, endowment and technologies, rate of participation in lifelong learning. Analysis of European and national policies on ongoing professional training allows to identify the correlation between EU programme regulations and those adopted in Romania. European regulations represented the framework and landmark for elaborating the national policy directions in professional training, objectives and action fields established at European level but adapted according to Romanian needs and priorities. Both at European and national level, there is a focus on ongoing professional training. It is not only a method for employees personal development , but also a superior investment in human capital boosting, with high impact on increasing labour and life standard. Thus, the priorities aim at concepts as: ongoing learning; valorization of non-formal and informal learning; acknowledgment of competences and qualifications; assuring training quality; increasing adaptability and enabling mobility; involvement of all social actors; improving information, counseling and professional orientation; increasing the participation to training; development of supplier market of ongoing professional training[7].

RESULTS

Paper is designed to identify the training needs of human being by using a complete set of instruments and suitable methods.

Following a rigurous and conclusive analysis of training needs, the ongoing training programmes will offer the possibility of assimilating general and specific competences according to individual training needs.

1. ANALYSIS OF TRAINING NEEDS (ANF)

1.1. Goal, structure, target group

Present study aims at offering a complete set of instruments and suitable methods in order to prepare, implement and use the results of an analysis of training needs (ANF).

ANF goal is that to identify the current level of competences and/or the individual competence level in a certain period, related to main domains of their professional activity and strategic development objectives of employer.

Analysis of training needs can be described as:

- **an instrument of ongoing institutional and professional development** that, after identifying the competences to develop, represents a basis for designing the *individual plans of training/ development* and for identification of relevant section of *development plans;*
- **methodology of research** implemented at institutional or extended level, for collecting, analyzing and assessing data on personnel training needs and for establishing the current stage of professional skills of organization members.

In terms of sustainable development in the field of techniques appropriate to ongoing learning for agriculture, forestry and food industry,the innovative instruments used are in compliance with the following:

- *programmes of institutional development,* are generally based on an analysis of needs with larger covering area; thus, analysis of training needs becomes integral part of analysis of institutional development needs;
- *assurance of system quality,* that includes the component of ongoing improvement of knowledge, skills and aptitudes of individual;
- *system of assessing the performance,* that at its turn, is integral part of quality assurance system.

Main stages of ANF process: **Preparation** – analysis of training needs within individual development context; **Implementation** – manner in which the training needs analysis is organized at employer's level.

1.2. Processing of data, analyses and reports.

Each stage aims at providing a clear description of activities to be undertaken for successfully achieving the training needs analysis. As a general rule, there are three *primary instruments of using the information,* each of them having advantages and disadvantages, namely questionnairies, interviews and focus-groups.

2. TYPES OF TRAINING INSTRUMENTS IDENTIFIED BASED ON TRAINING ANALYSIS IN AGRICULTURE, FORESTRY AND FOOD INDUSTRY

When preparing and providing training modules, the training instruments used should ensure the interactivity between trainees and trainers. The following **types of training instruments for ongoing training,** were identified:

2.1. Questionnaire (Figure 1):

TRAINER is not alaways involved in analysis of training needs at the first two levels. In most cases, he/she receives a task notebook with training subjects already established or based on an ANF report. All these documents must be studied by the trainer.

In order to better knowing the trainees and consequently adapting the training programme, the TRAINER can achieve ANF at level of training beneficiaries and/or at the level of employer. The most used method is based on questionnaires:

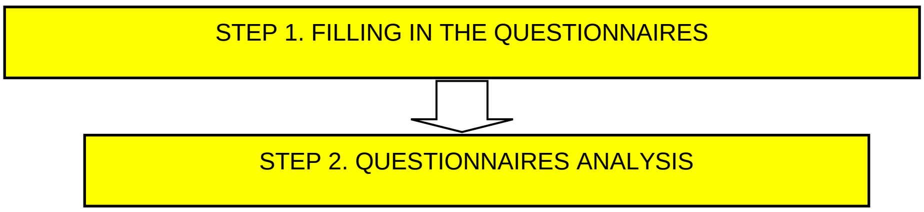

Fig. 1 – Questionnaire, as an ongoing training instrument

a) it comprises at least the following information categories:
- about the trainee: profession, position, education level and last school graduated, professional expertise, age;
- about trainee workplace: name, categories of beneficiaries with which he/she works, responsabilities;
- about participation to other courses of permanent training, namely which courses and when?;
- about subjects in which he/she is interested/ for which he/she wants to be prepared ;

b) is concisely and accessible drawn up;
c) allows to future trainee to be accustomed to training activity to which he/she will participate (a short referrence to questionnaire goal will be made);

2.2. Interview (Figure 2):

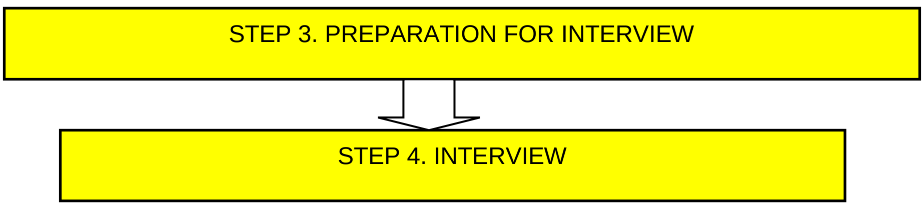

Fig. 2 – Interview, ongoing training instrument

- is a set of questions (sometimes, named protocol) that one person addresses to another;
- may be organized face to face, by phone or by electronic communication means;
- usually, the interviewed person may identify in a certain manner;
- may contain several types of questions, although the open questions are prefered;
- may be longer or shorter, but should not last more than one hour.

2.3. Focus - group:

- is a set of of questions that one person addresses to a small group of persons;
- usually is organized face to face;
- may vary as size, although the optimum number is between four and eight persons;
- seldom, the focus-group persons are identified either formally (by surname and Christian name), or informally (only by Christian name);
- may last longer or shorter time, but should not last more than two hours.

Table 1 presents the advantages and disadvantages of different approaches.

Table 1

Advantages and disadvantages of training instruments

Instrument	Advantages	Disadvantages
Direct observation	One member of personnel or a certain unit can be assessed on the spot-evaluation will be more precise and will not be influenced by intermediary agents	This method may have negative connotations because of historical/cultural reasons. Practice may differ by country.
Questionnaires	One person answers the questions according to his/her own rhythm. Results can be kept confidential. Methods of qualitative and quantitative evaluation may be used.	In this case, the written answers might not be useful, because of negative connotations . It might exist a lack of expertise for making an objective assessment: seldom, they are considered as quantitative studies.
Consultings with personnel occupying key positions	It is possible to obtain the opinion of persons that work directly with him/her (person about whom we gather information) or who supervises him/her.	Opinions may be affected by points of view, interpersonal affinities/ disenssions
Focus-groups	Events structured can give a balanced contribution within a structured environment	People may be reticent when they must talk about such a subject, for fear of consequences.
Tests	Individual skills can be tested.	This practice might be delusive and even dangerous, because of inappropriate adaptation of test to population specific from respective country.
Analysis of one fragment of paper	Allows to assess the written work, and consequently, the general performance.	It can be non -representative for general activity, especially having in view the current shortage of information systems and reticence of keeping written notes.

2.4. Training modules

Modules are comprised in series of courses that aim at training complex skills. Information will be gradually supplied in order to be suitably assimilated. Sessions of at most three days, with homogeneous groups of participants should be organized. Modules allow to supervise participants evolution, tests should be practical with focus on vocational streams and less on information. It is well to make many case studies, exercices, role playing and simulations. Training modules can be organized as workshops aiming at reaching a specific goal.

2.5. Courses

Courses comprise training activities of several days (5-6), and when issues are complex, of 6 hours per day. The courses aim at accumulating information or creating specific skills with clear goals as training result.

Courses goal:

1. Making the agricuture employees aware of advantages and opportunities of obtaining a qualification necessary to their professional development;

2. Improving the access to services of assessment, validation and certification of professional competences acquired otherwise than formally;
3. Supporting the agriculture employees in view of their qualification through validation and certification of professional competences acquired otherwise than formally.

2.6. eLearning Platform

Certain knowledge may be supplied by electronic systems of e-learning. The advantage consists in the fact that all the employees may access the system. The platform e-learning, achieved within the project should be used for assessment and improving the knowledge specific to agriculture, forestry and food industry. When any changes appear in one of fields above, this system can be successfully used. Thus, we are sure that all the personnel of the institution has got minimum knowledge for ensuring an appropriate operation.

A new approach of ongoing professional training for agriculture and food industry personnel through an online platform and its free access by persons interested by means of an Internet navigation browser, is designed. Platform online will be based on modern training principles and will be designed to develop flexible careers by pursuing the online interactive courses. It will be used during the training process within a school, university or company, being designed both to Computer Assisted Learning – CAL and distance training-Computer Based Learning.

Online platform will offer a suitable support to all factors responsible in the domains of decision, control,planning, prognosis, following and predicting the training activity. This system will allow to define many types of users, classified by access prerogatives: trainees, trainers, training managers (Course coordinators), managers, system managers.

Online platform will comprise sub-modules (Figure 3) with roles and characteristics/features well defined, without overlapping their functionalities. Using components designed to a single functionality,as well as an arhitecture based on services for communicating between sub-modules, will contribute to an increased flexibility and extended application.

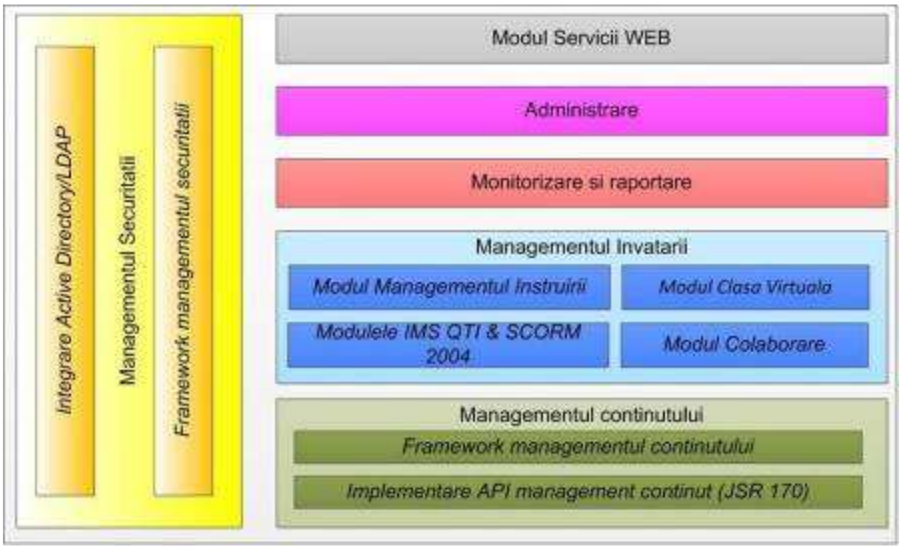

Fig. 3 – Platform sub-modules [8]

3. Importance of occupations, education or training finalized by qualification

Qualifications aim at developing a series of key skills transferable, in order to support the ongoing learning process.

Within the agriculture rehabilitation, agricultural mechanics play an important role. Agriculture needs qualified employees able to surpass the subsistence stage. It is time to recover and give to agriculture its due importance. It is bad that young people qualification for agriculture trades was neglected, especially that of *agricultural mechanic.* Therefore, it is essential that Ministry of Agriculture and Ministry of Education, but especially the county decision factors analyze and take the appropriate measures for a modern agriculture training according to European Union standards.

Those who practise the ***occupation of agricultural mechanic*** ensure:

- Control, maintenance, current and important reparations of agricultural machines and equipment which the enterprise where they work is endowed with;

- Assess the technical state, maintain, repair, supervise the agricultural machines, such as tractors, combines and irrigation equipment;
- Inspect and monitor the equipment, read the reports of inspection and ensure the dialogue with clients for finding out the type, location and diagnosis of malfunction;
- perform capital reparations of equipment, machines endowed, taking into account the provisions specific to each type;
- perform current reaparations of machines for ensuring their appropriate functionality;
- perform the machines running after capital reparations on specific installations (testing benches), or directly on the field;
- re-assemble machines and equipment after reparations or testings and make the necessary adjustments;
- take the advice of the manufacturer and supplier in order to make the periodical checkings according to procedures specified;
- establish the order and frequency of checking of parts, sub-assemblies and aggregates;
- inspect and test the new machines and equipment for checking their suitablility to relevant standards and provisions.

Those who practise the ***occupation of farmer and worker in agriculture, forestry and fishing*** ensure:

- soil preparation works;
- sow, plant, apply phyto-sanitary treatments by spraying insectices and pesticides;
- fertilize and harvest the field crops;
- plant fruit trees, trees and shrubs;
- harvest vegetables and flowers;
- pick berries and medicinal plants;
- breed, take care of or hunt animals for meat, milk, fur, skin;
- cultivate and harvest different aquatic species;
- store and process agricultural products and valorize them towards trading companies or buyers.

Those who practise the ***occupation of wine grower and fruit tree grower*** ensure:

- planning, organization and practising the agricultural works for tree and shrubs growing;
- ensure the seeds and fertilizers necessary;
- establish the wine and fruit tree varieties to cultivate, plant and maintain them ;
- harvest the fruits, such as fruit trees and walnut trees, tea and coffee trees, wine, cranberries shrubs, cocoa tree and rubber tree, and collect their sap, for selling or supplying the purchasers, specialized enterprises or markets;
- store and process the wine and fruit trees products.

Those who practise the ***occupation of miller*** ensure:

- receiving, storing and transport of raw matters in order to their subsequent preparation for grinding, sifting and ensuring high quality lots, packaging them for storing and delivery;
- perform the activity within the automated and non-automated units, knowledge and skills being appropriately assessed;
- process cereals, using specific equipment for obtaining different products;
- ensure the grinding technology, occupation that involves also the capacity of exploitation, utilization and maintenance of specific equipment;
- suitable organization at workplace.

Following a case study performed in rural environement, namely Vâlcea county, it has found that the priority options for most of interviewed persons (approximately 55 %) refer to **Agriculture worker** (35%): culture of cereals and plants, vegetable growing, fruit trees, wine growing, horticulture, baskets and brooms, others.

CONCLUSIONS

Participation of employees in ongoing professional training is most appreciated and is supported by employers through different mechanisms: evaluation of training needs, funding support for participating to perfecting courses, elaboration of development strategies related to employees competences enhancing, organization of departments of human resources and even, in case of some of them, of training centres.

By capitalizing the results mentioned, the following effects will be obtained:

- Creation of premises for respecting the principle of sustainable development, because, by enhancing the skills of ongoing learning in agriculture, forestry and food industry, new competences will be created, (currently deficit competences) on labour market by subsequently presenting the techniques specific to ongoing learning, designed to project works, for the employees in the field. This will lead to teaching better skilled people able to face the present and future challenges and act with resposability towards the future generations;
- Increasing the competitiveness by extending the activity domain of Professional Training Centres;
- Increasing the competitiveness by extending the services offered by Professional Training Centres of INMA by a new service based on specific innovative instruments.

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TRENDS REGARDING GRAINS TRANSPORT IN GRAIN SILOS AND MILLS
/
TENDINȚE PRIVIND TRANSPORTUL CEREALELOR ÎN SILOZURILE DE CEREALE ȘI ÎN MORI

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ABSTRACT

Milling is known from very ancient times, its evolution following human society as well as its technical and economic development. The importance of work transport in the chain of technological processes in milling is undeniable, both in terms of manual labour and its replacement, and regarding the aim of increasing productivity in the respective production processes, lifting and transport operations being integrated into the chain of technological processes. The paper describes the main types of conveyors used in grain silos and mills, the transport of grains being one of the basic operations.

REZUMAT

Morăritul este cunoscut din timpuri foarte vechi, evoluția sa urmând societatea umană precum și dezvoltarea tehnico-economică a acesteia. Importanţa transportului uzinal în lanţul proceselor tehnologice din morărit este de necontestat, atât în ceea ce priveşte munca manuală şi înlocuirea ei, cât şi prin scopul urmărit de creştere a productivităţii în cadrul proceselor de producţie respective, operaţiile de ridicare şi transport fiind integrate în lanţul de procese tehnologice. In lucrare sunt descrise principalele tipuri de transportoare utilizate în silozurile de cereale și mori, transportul de cereale constituind una din operațiile de bază.

INTRODUCTION

The mechanization of production processes, especially those with a large volume of work and hard works, the automation and the creation of flexible manufacturing systems, all aiming at increasing productivity, reducing manufacturing costs, providing qualitative and technical - functional indices optimized for manufactured products, cannot be obtained without the contribution of the lifting and transport equipment. *(Mercier, 2018*; *Milton and Pawsey 1988; Munteanu et al., 1995)*. In the food industry, in most cases, transport equipment is an integral part of the technological lines, contributing within the technological flow to the smooth deployment of the technological operations necessary to obtain the finished product. *(Gordon, 1985; Hosseini, 2017; Morejón et al., 2014).* Unlike the loads in pieces that are characterized by geometric shapes with distinct dimensions, number, weight, the bulk materials are characterized by a series of parameters: granulation, density, specific weight, slope angle, internal friction coefficient. *(Cordain, 1999; Costin, 1988)* For the displacement of the bulk or packaged loads, as well as of the loads in pieces horizontally, vertically, in the same plane or space, in the food industry, transport systems are used mainly to ensure the continuous movement of the bulk loads or of loads in pieces in one direction, the displacement being carried out at a constant or near-constant speed. *(Cordain, 1999; Costin, 1983; Ziegler, 1995).*

MATERIAL AND METHOD

The bulk materials consist of granules of different sizes, the granule having an irregular shape characterized by the dimensions of the parallelepiped circumscribed thereto. The largest dimension expressed in millimetres a_{max} is taken as the basis. Unlike the loads in pieces that are characterized by geometric shapes with distinct dimensions, number, weight, the bulk materials are characterized by a series of parameters:

- the characteristic granulation of bulk material is:

$$a¢ = 0,8 * a_{max} \quad \text{(mm)} \tag{1}$$

If the fraction between 80% and 100% of a_{max} is less than 10% of the total weight of the material and:

$$a' = a_{max} \quad \text{(mm)} \tag{2}$$

if the fraction above represents more than 10% of the total weight.

In Table 1, the bulk materials are classified according to the characteristic granulation, expressed in millimetres.

Table 1

Characteristic granulation for different materials

Category	Characteristic granulation *a' (mm)*
Lump materials	*a'* > 160
Medium sized piece materials	6 - 160
Small sized piece materials	10 - 60
Grain materials	0.5 - 10
Powder materials	*a'* < 0.5

➢ specific weight and volumetric weight. The specific weight of a bulk material is the ratio of the weight and volume of a granule of material. The volumetric weight of a bulk material is the ratio of the weight of the free bulk material (uncompacted) and the volume occupied by it. Depending on the volumetric weight, γ expressed in tf/m^3. Table 2 shows a classification of the bulk materials by volumetric weight. The ratio between the weight of the compacted bulk material and that of the uncompacted bulk material is called the compaction coefficient. For different materials, this coefficient ranges from 1.05 to 1.52.

Table 2

Classification of materials by volumetric weight

Category	Volumetric weight (γ tf/m^3)	Examples of materials
Light materials	γ < 60	flour, hay, straw, malt
Medium weight materials	0.6 – 1.1	barley, rye, wheat, sugar
Heavy materials	1.1 - 2	salt
Very heavy materials	γ > 2	99.7

➢ slope angle. Natural slope angle ϕ represents the angle between the cone generator of bulk material, which is freely deposited on a horizontal flat surface and this surface. It has a constant value for a particular material.

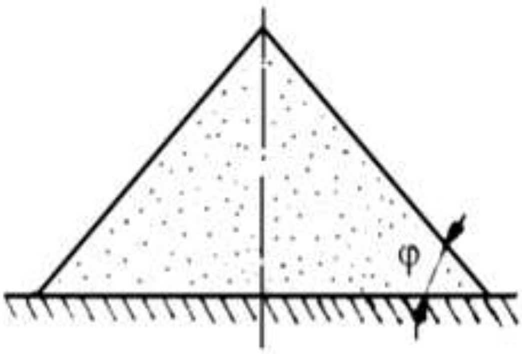

Fig. 1 – Natural slope angle [11]

Installations with flexible traction working part, mainly belts, chains or cables, include: belt conveyors, belt elevators, friction elevators, load-bearing chain conveyors, chain and pallet conveyors, chain and scraper conveyors, chain and trolley conveyors, chain elevators, suspended conveyors.

The choice of the type of installation for a well-defined process depends on the physico-mechanical properties of the load, the direction and the length of the route on which the load is moved, the nature of the working environment, the technical and economic parameters of the process.

RESULTS

Choosing the optimal conveyor is influenced by several factors:

- nature of the product transported;
- transport distance;
- capacity and speed of transport.

From the point of view of the carrier, the transport installations are classified into:

- mechanical installations;
- pneumatic installations.

Considering the location of the transport installations, they can be:

- fixed;
- mobile.

Considering the working position, the transport installations are divided into:

- vertical transport installations. This category includes:

  - elevators used to transport small and powdery loads as well as those in pieces vertically or in a direction inclined to the horizontal at an angle of 70°, when level differences are high.

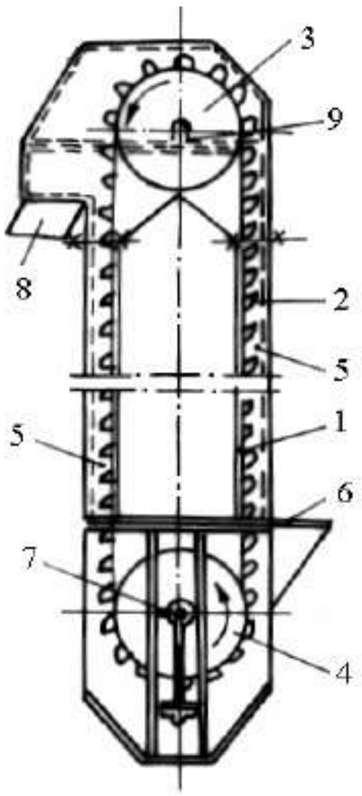

Fig. 2 – Kinematic scheme of a bucket elevator
1- bucket belt; 2,5 – buckets; 3 – leading pulley; 4 – winding drum axle;
6 – charging hole; 7 – winding device; 8 – discharge hole

- Gravity installations are continuous transport installations where the movement of the load occurs in the direction of lowering it under the action of gravity, being the cheapest and most widespread transport system in the mills. For individual loads, if the vertical lowering is required, the helical inclined plane is used, while for moving loads horizontally, flat or rolled inclined planes are used. For bulk materials, gutters or inclined tubes are used.

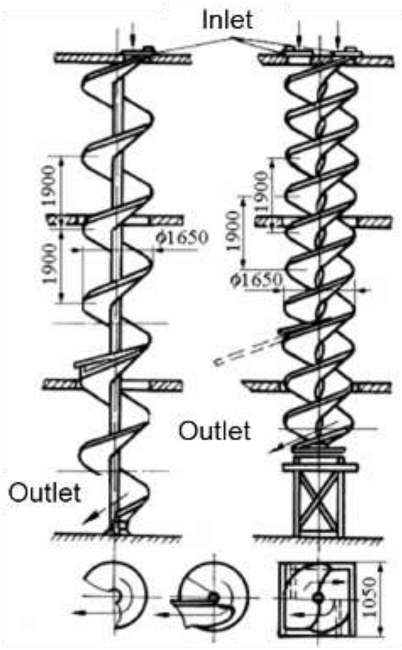

Fig. 3 – Helical inclined plane

➢ horizontal transport installations. This category includes:

belt conveyors with the conveyor belt as main element. It consists of materials with higher physical and mechanical properties: cotton-reinforced rubber belts, artificial (viscous) textile reinforcement, glass or synthetic fibre reinforcement or steel fibre inserts.

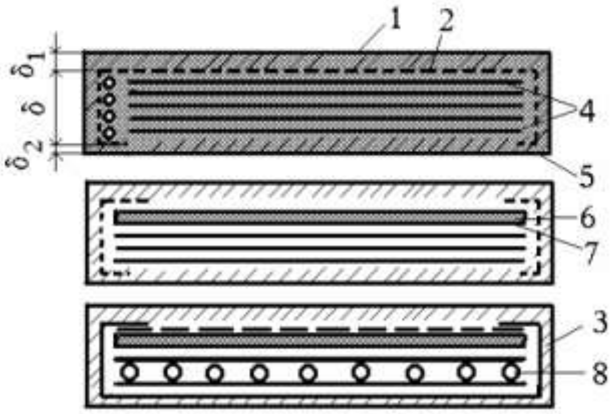

Fig. 4 – Sections of rubber textile belts

1- rubber cover as working surface; 2 – protection fabric (it may be missing);
3 – traction resistant layer; 4 – textile inserts; 5 - rubber layer with supporting surface role;
6 – wire mesh; 7 – asbestos layer; 8 - metallic cables

chain conveyors. In this type of conveyor the load comes in direct contact with the chain, the latter being both a traction part and a load carrier. From a constructive point of view, they do not differ much from the other types of chain conveyors, the basic component sub-assemblies being the same and with the same functional role.

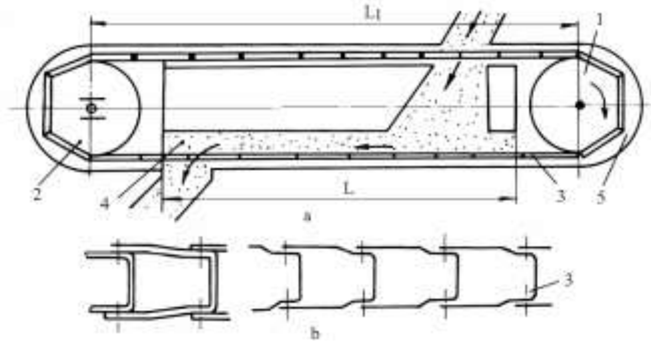

Fig. 5 – Chain pallet conveyor

- pneumatic conveyor used for the transportation of dry granular or powdery materials. It is not recommended for large grain materials as it becomes uneconomical due to high energy consumption. The normal grain size of the material to be transported is 3-4 mm, reaching a maximum of 80 mm. For full exploitation of the transport installation, the particle size should not exceed 0.3-0.4 of the pipe diameter. The transport is made on pipes with diameters of 70-200 mm, the air pressure in the installation being $(6\text{-}8).10^5$ N / m^2.

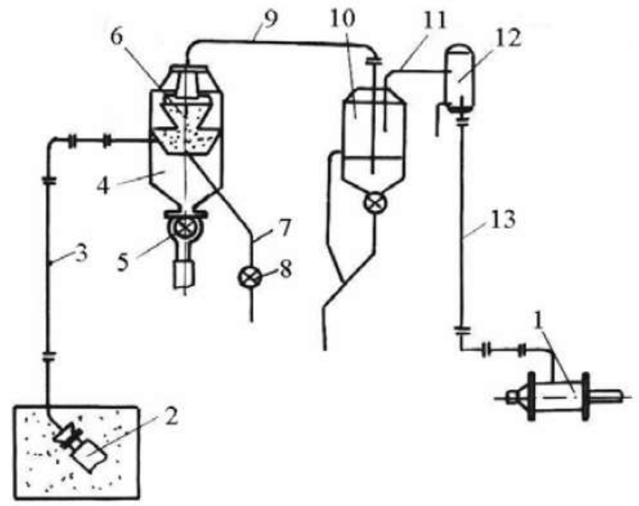

Fig. 6 – Pneumatic suction conveyance installations

1- fan; 2 – suction hose; 3,7,9,11,13 – pipe; 4 – material separator; 5,8 – cell wheel; 6– cyclone; 10 – wet filter; 12 – water separator

CONCLUSIONS

Transport installations and equipment used in the food industry are subject to relatively heavy working conditions.

The continuous diversification of technological processes leads to the adoption of modern transport solutions.

The correct operation of these installations cannot be carried out without good professional qualification, without thoroughly knowing the instructions issued by the supplier regarding their exploitation.

During the operation of the transport installations an optimal maintenance and repair activity must also be organized taking into account the following main objectives:

- maintenance of transport installations and equipment in good working order, which means that the maintenance and repair operations are designed to preserve or restore the equipment's capacity for as long as possible;
- minimizing the costs of interruptions caused by damage, stagnation, etc.;
- improving the performance of parts or subassemblies by providing optimal operating conditions by increasing their operational endurance and safety.

ACKNOWLEDGEMENT

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DOSING AND WEIGHING METHODS USED IN THE MILLING TECHNOLOGY / *METODE DE DOZARE ȘI CÂNTARIRE UTLIZATE ÎN TEHNOLOGIA MORĂRITULUI*

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ABSTRACT

The paper presents a synthesis of dosing and weighing methods used in milling technology. The dosing system is a complex assembly of pneumatic, hydraulic, electrical, electronic mechanical components that performs dosing operations. Even in the complex dosing systems with a high degree of automation, the mechanical and pneumatic components have functional roles of high importance. In general, operations involving direct action on the processed material are made exclusively of mechanical mechanisms or components, but also the operation of dosing control and regulation are often performed by mechanical systems, the electronic ones having the role of supervision and fine-tuning.

REZUMAT

Lucrarea prezintă o sinteză în ceea ce privește metodele de dozare și cîntărire utilizate în tehnologia morăritului. Sistemul de dozare reprezintă un ansamblu complex de componente mecanice pneumatice, hidraulice, electrice, electronice, care realizează operații de dozare. Chiar și în componența sistemelor complexe de dozare, cu un înalt grad de automatizare, componentele mecanice si pneumatice au roluri funcționale de maximă importanță. De regulă, operațiile ce presupun acționare directa asupra materialului prelucrat sunt efectuate în exclusivitate de mecanisme sau componente mecanice, însă si operării de comandă și reglaj al dozării sunt efectuate de multe ori de sisteme mecanice, cele electronice având rolul de supraveghere și reglaj fin.

INTRODUCTION

Milling has got its origins since ancient times. People discovered that the fruits of some plants are edible and began to cultivate them. With the development of cereal products, appeared the problem of obtaining finished products by crushing the grains to be used as food. Today, storage and milling of cereals is considered to be one of the oldest industries. According to archaeological studies, cereal conservation and the flour production from grains has been known for a long time. Thus, archaeological research in Pompey shows that in the 1st century, B.C. there were complexes made up of mill and bakery, (*Banu C., 1998, Damian V.,1992*). The production of cereal flour was at first a domestic preoccupation. Among the first tools used for this purpose were the hand mills, known from the Neolithic period and which have been preserved to some peoples until today.

As the time passed, the tools evolved, the Arab mill appeared, then the Roman one made of two conoid stones, thus increasing the contact surface, and the upper mobile piece, depending on its size, could be operated either by the power of the arms (manually), or animal or water power. At the same time, the idea of sifting the milled products, using perforated skins or reed netting, appeared, (*Buium Ghe., 1999, Costin I,1988*). Then, due to the complicated processing of stones for the Roman mill, people went back to the discoid form, like the Arab mill, which, with small modifications, is nowadays used as the millstone.

With the increase in the size of the stone, the operation is predominantly made with water. In Romania, the first certification of water mills dates back to the 18th century on the Jiu Valley. Later, wind power is used for this purpose, windmills being less widespread than water ones, especially in Dobrogea.

Over time, milling develops quite a lot. With the emergence of advanced equipment (the mill roller – 17th – 18th centuries, the centrifugal sieve and the elevator in the 18th century, the plane sifter, the cylindrical separator, the semolina machine in the 19th century) the first industrial mills developed in our country too.

In 1853, George Assan opened in Bucharest, using machinery from Vienna, the first industrial mill driven by a steam machine. In 1912 there were over 50 mills in Romania with a total capacity of 3,400 t/day.

After 1950, the sector boomed through developments, refitting and modernization with equipment from foreign firms, and then the construction of milling equipment was internally assimilated. As a result of external collaborations and especially through the assimilation of new milling machines from OCRIM - Italy, modern mills with the capacity of processing wheat over 200 t/24h were built in Cluj, Iasi, Bacau, Constanta.

After 1975, the execution of modulated mills, built according to type projects, was carried out. By modulating the grinding capacities at 120 t/24h, for the grinding of the wheat, according to projects realized at I.S.P.C.A.I.A. Bucharest, a series of modern mills were built in Târgu-Mureş, Slobozia, Râmnicu Vâlcea, Bârlad, Focşani, Zalău, Bistriţa, Galati.

However, the post-December period registered a revival of the milling sector due to the refit of existing mills with worldwide state-of-the-art machinery, produced by Bühler, OCRIM, and the emergence of the highly dynamic private sector that created a competition.

Mill is in fact a complex industrial plant that aims at transforming cereals, especially wheat, rye and corn into finished products such as flour and corn flour. Now milling in Romania means small, medium, very flexible private mills, medium and large modernized mills with very good results, alongside old out-dated mills that are struggling, (Cristea L.., 1998, Leonte M.,1992).

Dosing always targets bulk material mass, so that quantitative material extraction is associated with material mass determination, even if the method itself is based on the volume of extracted material. The dosing systems aim at dividing the mass of material, defining two main categories of dosing procedures:

- dosing procedures by measuring the material flow;
- dosing procedures where the material flow measurement method takes into account other parameters such as filling volume, Coriolis force, radiation absorption.

MATERIAL AND METHOD

In the weighing technique, the mass is indirectly measured by mass effects such as inertia, impulse, radiation absorption and heat transfer, as shown in Table 1.

Table 1

Methods of measuring masses and mass flows of material [Sirbu S., 2004]

Effect generated by the mass	Variable measured	Destination
Gravitational acceleration	Weight force $F_G = m \cdot g$	Scales, gravimetric dosing procedures
Centrifugal acceleration	Centrifugal force $F_z = m \cdot \left(\frac{v^2}{r}\right) = m \cdot \omega \cdot r$	Bulk solids flowmetres (with deflection gutter)
Coriolis acceleration	Coriolis force $F_c = 2m \cdot \omega \cdot v$	Bulk solids flowmetres (Coriolis flowmeter)
Impulse force	Impulse force $F_I = \dot{m} \cdot \Delta v$	Bulk solids flowmetres (with deflection plate)
Radiation absorption	Intensity reduction $\left(\frac{I_m}{I_0}\right) = \exp(-\mu \cdot m)$	Radiometric dosing device

The most accurate methods of measuring masses are *gravimetric methods*, because the only value measured by these transducers is weight force. Their application extends to bulk materials and fluids, weighing being done by 2 methods: by mass addition or by mass extraction.

Gravimetric measurement methods may be discontinuous (by portions) or continuous, the latter being used for quantities ranging from a few grams/hour to 100 t/hour, mainly for bulk materials.

Compared to gravimetric dosing by discontinuous measurement, in the case of dosing by continuous gravimetric measurement additional errors appear due to belt conveyor velocity and the geometry of the conveyor belt loading device. The weighing errors in feeder dispensers (gutters, tubes) are amplified by the conveyor platform and its speed, (*Ola D. et all, 2004, Ola D. et all, 2006*).

The advantage of weighing scales with weight extraction is that many of the errors that influence the weighing process are avoided because in this case the weight is the main measurement variable.

Measurement procedures that do not use weight determination for mass dosing are less precise because they bring important additional errors, especially from the variation parameters of the dosing material properties.

Dosing of bulk materials by centrifugal forces or by impulse depends on the physico-mechanical properties of the dosing materials: the natural slope angle, the internal friction coefficient, the friction angle and the flow rate. The main application field of these methods is for material flows higher than 0.5 t/h. Measuring meters should be calibrated for each type of dosing material.

Radiation dosing of material flow, sometimes called erroneously “nuclear weighing”, is based on the radiation absorption phenomenon by the exposed material, thus determining the specific loading of the conveyor belt. Calibration is required for each type of dosing material. This method is suitable for large material flows, as it is found in belt conveyor installations, but is not suitable for weighing due to limited precision.

Weighing systems of gravimetric meters are defined by the following elements: system shape and construction, mechanical construction, weighing sensor type.

The mass of material dosed at a given moment by the gravimetric dosing equipment is determined by measuring at very short intervals the weight force exerted by the dosed material on a weighing cell underneath the weighing vessel, which transforms the weight force of the material dosed in an electrical signal, which can then be easily measured and displayed on a screen or listed on a printer, (*Ola D. et all, 2004*).

In principle, *electromechanical weighing equipment and devices* consist of a load element, a weighing cell and an electronic display indicator. After loading is applied, the weight is indicated immediately.

The *weighing cell* is therefore an electromechanical sensor that transforms the weight force exerted by the mass into an electrical signal proportional to the value of the weighted mass.

The characteristics of *electromechanical weighing devices* are mainly determined by the weighing cells, characterized by the weighing device resolution and the conditions in which it is used.

Weighing devices used in industry or trade the calibration of which can only be verified at two to three years may deviate from the accuracy between 10^{-1} and 10^{-4} in case of less ideal environmental conditions. These require weighing cells with stability as long as possible.

The most common weighing principles are those with force transducers (by deformation), force transducers with electromagnetic voltage compensation and tuning fork and vibrating wire transducers.

RESULTS

Discontinuous weighing methods with strain gauge transducers in which the weight force enters the weighing cells can be determined with strain gauges. In the strain gauges the electrical resistance of a conductor changes under the influence of an elongation. According to Figure 1 by this elongation the length ***l*** of the conductor increases by fraction ***dl*** and the diameter ***D*** is reduced by ***dD***. The resistance of the conductor before the elongation is:

$$R = 4gl / \pi D^2 \tag{1}$$

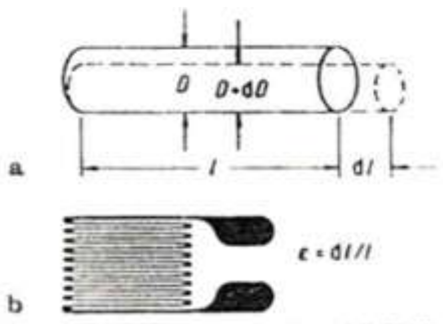

Fig. 1 - Elongation measurement, (*Rapeanu R. et all, 1965*)

a – elongation of a wire (conductor), b – foil type strain gauge

By elongation the resistance becomes:

$$R + dR = \frac{4}{\pi} \cdot \frac{(g + dg)(l + dl)}{(D + dD)^2} \tag{2}$$

For differential variations *dg, dl* and *dD* result the relative variation of resistance:

$$\frac{dR}{R}=\frac{dl}{l}-2\frac{dD}{D}+\frac{dg}{g}=\frac{dl}{l}\left[1-2\frac{dD/D}{dL/L}+\frac{dg/g}{dl/l}\right]. \qquad (3)$$

The relative variation of length e=dl/l is called elongation and the relative variation of the diameter ε_q=dD/D is called transverse elongation. The ratio of negative transverse elongation is called the Poisson coefficient:

$$\mu=\frac{-\varepsilon_r}{\varepsilon}. \qquad (4)$$

With these magnitudes the relative variation of electrical resistance becomes:

$$\frac{dR}{R}=\left[1+2\mu+\frac{d\cdot g\cdot l}{\varepsilon}\right]\varepsilon=k\cdot\varepsilon. \qquad (5)$$

The factor k represents the sensitivity of the strain gauge. Using the volume $V=\pi\cdot D^2\cdot l/4$ is calculated the relative variation of volume:

$$\frac{dV}{V}=\frac{dl}{l}+2\frac{dD}{D}=\frac{dl}{l}(1-2\mu) \qquad (6)$$

Since under the influence of traction an increase in volume is achieved in any case, the Poisson coefficient can at most be equal to 0.5. The measured values of the Poisson coefficient are approximately between 0.15 and 0.45.

The typical embodiment is presently in the form of a foil-type strain gauge (Figure 1) for limited ambient temperature. If applied to a cross-section bar A the traction force or the compressive force F, there is obtained a mechanical stress σ, Figure 2a. According to Hooke's law, this stress produces within the elastic interval a proportional elongation (E is the elastic modulus: Ɛ=σ/E).

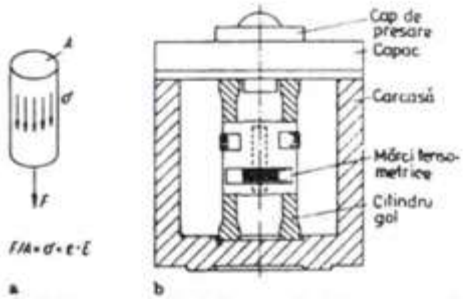

Fig. 2 - Force measurement by strain gauges (*Sarbu S. et all., 2004*)
a – elastic deformation of a bar, b – load cell (weighing cell) with strain gauges (Siemens)

On the load cell with strain gauges in Figure 2b are bound two strain gauges in the direction of force and two strain gauges perpendicular to this direction on a hollow cylinder, which is pressed by the measuring force. In the ideal case, the strain gauges in the direction of force undergo a length deformation:

$$\varepsilon_l=F/(AE) \qquad (7)$$

And the strain gauges perpendicular to the direction of force undergo a smaller transverse deformation, namely:

$$\varepsilon_q=-\mu\cdot\varepsilon_1$$

where F is the measuring force, A - the cross-sectional area of the cylinder under compression, E – eastic modulus, μ - the Poisson coefficient.

In this case, the resistance of the two strain gauges in the direction of force decreases, and the resistance of the two strain gauges perpendicular to it increases. The four strain gauges are mounted in a bridge circuit within the potentiometric measuring method, which ensures that the needle deviation is read so that the maximum sensitivity is achieved. At the same time is obtained, with an adequate sizing, a decrease in the temperature dependence of the output signal through the differential principle (suppression of the creep distortions). To estimate the elongation obtained in the elastic range, we accept for steel an elastic modulus E = 200 kN/mm and an admissible tension effort σ_{adm} = 500 N/mm. Hence the elongation is calculated:

$$\varepsilon = \sigma_{adm} / E = 2{,}5^{0} /_{00} = 2{,}5 \text{ mm/m}$$

Fig. 3 - Section through a weighing cell with resistive transducer

The change in resistance for grille transducers (wire or foil) metal (constantan or nichrome) transducers is about 20%. For semiconductor transducers, the change in resistance is much higher because the *k* factor has values ranging from – 169 to 180. Semiconductor weighing cells are rarely used for weighing devices. There are several types of resistive weight measuring transducers, which has determined the appearance of the different models shown in Figure 4.

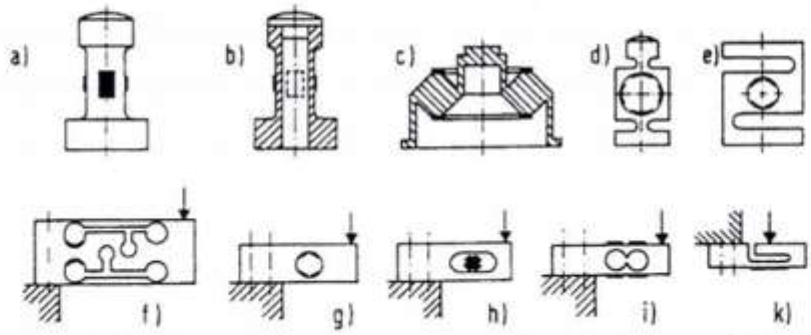

Fig. 4 -Typical forms of electro-resistive transducers and maximum measurement capability

a – compression cylinder (5 – 1000 t), b – compression cylinder (1-10 t), c – high rotation ring (60 kg – 1000 t), d – compression ring (1-10 t), e – two-arm bar (with force return 20-500 kg), f – LC platform (5-500 kg), g – bar with arms (simplified) S-type (50 kg-5t), h – bending bar (10 kg -1t), k – bar with a force return arm (5-100 kg)

Weighing cells with electromagnetic force transducers in which, the weight force to be measured is transformed into an electric current. Electromagnetic force transducers are usually integrated into high precision weighing devices without being clearly separated from signal processing electronic circuits, or integrated into the weighing device as a weighing method without having their own indicator.

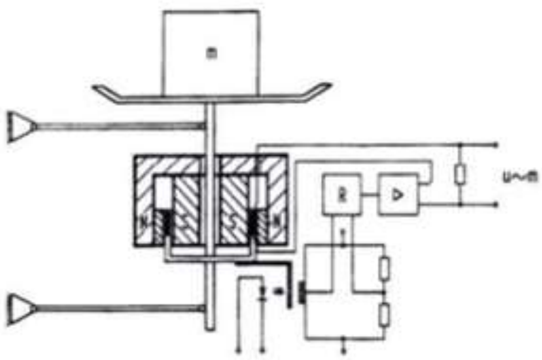

Fig. 5 - The basic structure of a measuring cell with an electromagnetic force transducer

m – mass, u – output current to poles, N – North, S – South, R – control interface.

Weighing cells with a mechanical resistance force transducer function due to the natural frequency of a vibrating mechanical resonator that changes according to the change in voltage or load. If the rod of the transducer vibrates vertically like a metallic conductor in the direction of the magnetic field, then a current is induced that is proportional to the amplitude of the frequency.

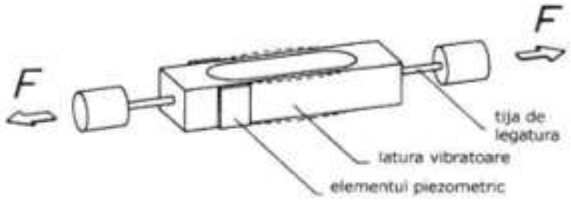

Fig. 6 - Force transducer with tuning-fork load cell

In the case of mechanical loading element of tuning fork type, the two parallel arms that are connected to the ends vibrate in a direction opposite in resonance. The side vibration mode of the separate elements corresponds to the vibration mode of a tuning fork. A new resonance frequency occurs if the loading element is stressed with an elongation or compression force. Vibration impulse and reciprocal reception of vibration signals is taken over by two piezoelectric elements placed near the vibration nodes of the tuning fork type element.

Weighing cells with magnetoelastic effect transducers are transducers for measuring the weight force that produces the modification of the magnetism of some cross-wrapped, gravity-induced coils.

Stressing the load cell leads to a distortion of the magnetic field of the coil passed through by the current and thus there is a change in the magnetism of the crossover coils which are fixed at angles of 90º to each other.

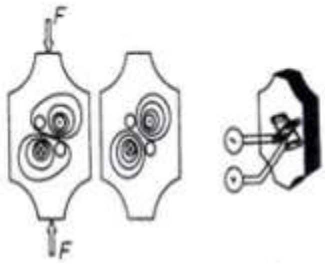

Fig. 7 - The principle of a magnetoelastic force transducer

Due to robust construction, high signal strength and low internal resistance, magnetoelastic cells are indicated in harsh environments and with electrical disturbances, such as grinding mills.

Weighing cells with transducers with optical interference device where the weight of materials is measured by arc deformation using high precision displacement measurement methods. The basic structure of a force sensor with optical interference system is shown in Figure 8. A fork-shaped arc is deformed by weight and the change of its opening is measured by a Michelson interferometer.

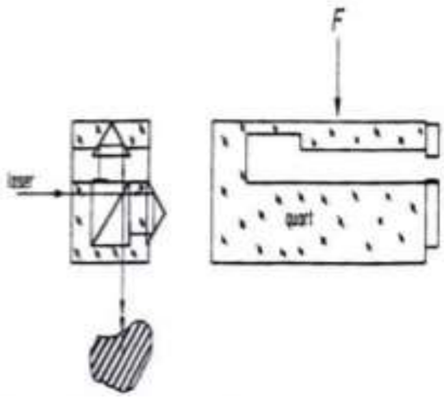

Fig. 8 - The principle of a transducer for measuring force with optical interference device

Compared to measuring the local deformation of an arc, this method measures the entire deformation path, being a high precision method (40 nm). For the same measurement value, the deformation and maximum elongation of the material should not be as high as in the case of the elastic element devices.

The deformable element under force action is made of quartz that has a very low temperature dependence. The residual error is corrected by a temperature sensor connected to the weighing machine's computer. The hysteresis and elongation phenomena are both very small. Due to the very low material inertia, these weighing devices are suitable for very fast measurements.

Continuous weighing method is applied to determine the flow rate of continuous flow during bulk products transport, being the most common when bulk solids are dosed, and is achieved by using *gravimetric debimeters* with deflector plates or devices based on the Coriolis effect.

Because there is no static weighing at the time of continuous weighing, it is necessary to adjust the feeding speed and weighing ranges to obtain high measurement accuracy.

CONCLUSIONS

Traditionally, cereals are considered as raw material base for flour and groats production, with more than 40% of national annual production being used for this purpose. As the basic raw materials in the milling and bakery industry, the cereal group includes: wheat, rye, barley, rice, oats, corn, millet, sorghum (being part of the Gramineae botanical family) and buckwheat (all belonging to the Polygonaceae family) all of them having common anatomical and physiological features, commonly referred to as materials (agricultural products), starchy, due to high starch content. To these is added corn, a plant of the weeding plants group, which is mainly used for the production of groats.

Weighing systems can be referred to as dosing devices, dosing and measuring systems, consisting of measuring or dosing assemblies and dosing installations, so named according to the dosing material and the degree of compaction thereof, and depending on the different dosing solutions, based on different operating principles. Thus, dosing devices are important parts of the manufacturing process, the dosing assemblies constituting a combination of different dosing devices, while dosing installations are those multi-component systems provided with dosing devices.

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CONSIDERATIONS ON HEMP CULTIVATION TECHNOLOGY / *CONSIDERAȚII ASUPRA TEHNOLOGIEI DE CULTIVARE A CÂNEPEI*

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Keywords: *technology, hemp, fiber, seed*

ABSTRACT

The paper presents some aspects regarding the technology of hemp cultivation (Canabis Sativa as its specialty designation), this plant having the greatest capacity of industrialization among all the technical plants: nothing is thrown away, everything is capitalized and the products obtained are of an outstanding variety, starting from the ordinary rope until the medicinal or cosmetic substances, vehicles or construction materials.

REZUMAT

Lucrarea prezintă câteva aspecte privind tehnologia cultivării cânepei (Canabis Sativa, ca denumire de specialitate), această plantă având cea mai mare capacitate de industrializare între toate plantele tehnice: nimic nu este aruncat, totul este valorificat, iar produsele obținute sunt de o varietate excepțională, pornind de la coarda obișnuită până la substanțe medicinale sau cosmetice, vehicule sau materiale de construcție.

INTRODUCTION

Hemp (*Cannabis sativa*) is an annual herbaceous plant belonging to Cannabaceae family; it is of 2-3 m tall being able to reach up 5 m, exceptionally. Its stem is unbranched and it has long lanceolate leaves with toothed edges and dense, semi compact inflorescences (Figure 1).

Fig. 1 - Hemp for spinning [5]

Hemp cultivation history is very old, being remembered since early neolithic (12000 years ago) as a source of obtaining textile fibers, oil, food, but also as the environment where ancestral religious practices were developed or as medicinal herb. Each part of hemp has a different use and is processed accoding to it. Term of cannabis, from which the Romanian word “cânepă” comes, has its origins in a Scythian or Thracian word. Greeks imported it first and afterwards Romanians and, thus it was known by Occidental civilizations. The word is very old having Indo-european roots. Ancient Oriental people (Acadiens, Babylonians and Assyrians) also knew the word as qunnabu. The original meaning was the smoky, demonstrating the ancestral habit of using the plant in recreational and practical goals.

Traditionally, the hemp was the raw material for obtaining oil, wax, resin, rope and cord, textile fibers for clothing and rough fibers for sacks and knitting, animal foddering and vegetal fuel. (fig. 2). At those above, the industrial processing ads the cellulose, from which paper, chipboards for furniture industry, artificial silk, insulating down for plasterboards, can be obtained.

Fig. 2 - Traditional harvesting of hemp [6], [8]

Hemp is one of the oldest plants cultivated in Romania (over 2000 years), being mainly used for fibers designed to clothes. Hemp stems coming from local growing and wild hemp contain 10-12% fibers, and improved varieties- 26-32%. Fiber content within stems is influenced by each variety, technological and soil and climate conditions. Fibers have a series of valuable characteristics related to resistance (to traction, torsion, friction, rotting process), extension capacity (elastic and plastic), spining capacity, bigger length than fibers of sisal, jute, manila or cotton, that make them useful in various domains: textile industry, manufacturing industry, vehicle industry (*Tabara, 2009*).

MATERIAL AND METHOD

Hemp requires a gentle and humid climate (corn area). Seeds germinate at 2-3 °C, but a uniform springing is performed at over 8 °C. In optimum conditions, when soil temperature is of 8-10 °C, hemp germinates after 7-9 days, and at 20-24°C the germination takes place after 5-7 days, depending on soil humidity. A great attention should be given to groundwater depth, which must be at least below 1m, because puddles can damage the crop. Excessive weeds in areas where hemp is cultivated can also risk to stifle the springing plants.That is why, the weeds should be destroyed by any means immediately after the harvest of plant, insisting on doing so up to the preparation of germinating bed. Weeds like creeping thistle (*Cirsium arvense*), couch grass (*Agropyron repens*), vilfa stellata (*Cynodon dactylon*) or Johnson grass (*Sorghum halepense*) and lamb's quarters (*Chenopodium album*), are difficult to control.

The best precursor crops are vegetables and then, straw cereals. Hemp may be cultivated after beet or potato crops, but the fertilization doses will be increased by 15-25%, because the soil remains deprived of nutrients. At its turn, the hemp is a good precursor culture for most of crop plants, as it leaves the soil structured, deases and pests free. The growing rhythm of fiber hemp is rapid and it enables the weeds destroying, thus reducing the stock of weeds in the soil. The fiber hemp or seed hemp cultures are good precursors for autumn cereals and autumn fodder crops (alfalfa, rape, fodder, cereals) as they clear the field in August and early September and soil works can be appropriately performed. Furthermore, the hemp powerful swiveled root extends deeply into soil, mobilizing the nutritive elements and giving increased resistance to draught. Maize should not be used as precursor crop, as the same pests attack hemp, namely European corn borer (*Ostrinia nubilalis*), foddering plants after which the vegetal debris remain and the field is infested by wireworms (*Agriotes sp.*) , sunflower, that has commum deseases and pests as hemp, like white mold (Sclerotinia sclerotiorum) and broom-rape (*Orobanche sp.*). Although, in the opinion of certain authors, the hemp behaves very well as single crop and it is preferable not to be cultivated in the same field and neither in neighbouring ones for avoiding to be attacked by hemp moth (*Grapholitha delineana*), that produces important damages, in certain years up to 25-30%.

Hemp is a pretentious plant concerning the soil content in nutritive substances. The main fertilizer appropriate to ecological hemp is the manure. 30-40 t/ha of fermented manure will be applied in heavy and cold soils like black soil, excessive watering soil or brown soil. Better results are obtained when the manure is applied to precursor plants in a quantity of 40-50 t/ha. The manure should be combined with 40-60 kg/ha P2O5 . Manure and phosphatic fertilizers will be performed in summer or autumn, along with the basic plower. Organic fertilizers should be compulsory applied in surfaces destined to ecological hemp cultivation. Phosphorus fertilizers applied to hemp for seed mostly compensate the unfavourable action of chemical fertilizers with nitrogen and potassium and positively influence the stem anatomical parts and seed formation, thus increasing the oil content and production. Phosphorus fertilizers are applied in quantities of 40-60 kg/ha s.a., during autumn or before preparing the germinating bed as complex fertilizers. Generally, Romanian soils are well supplied with potassium. Potassium fertilizers applying is necessary to be done on soils having below 15 mg K2O/100 g , when it is compulsory to apply 40-60 kg/ha K_2O. In the fields fertilized in previous years with organic fertilizers, the potassium fertilizers are not more necessary. Potassium is applied in autumn, before the basic plowing or in spring as complex fertilizers. Nitrogen fertilizers act on the general development of plants enabling the stems and seeds growing. The doses of nitrogen fertilizers applied are of 120-150 kg/ha s.a. depending on each zone, soil type and precursor plant. After vegetables, the nitrogen quantity should be reduced approximately by 20 kg/ha s.a., and in case of precursor plants with large consumption of nutritive substances (beet, corn, potato), the quantity is increased by 20 kg/ha s.a. The nitrogen fertilizers are applied in spring, before preparing the germinating bed, but they can be also applied as little fractions, in a percentage of 15-20% out of total dose when the seed hemp mechanical hoeing is performed. When complex fertilizers (rich in nitrogen) were not applied in autumn, then complex fertilizers should be applied in spring when preparing the germinating bed. The nitrogen dose is completed by an additional share to the necessary one, previously planned. A great attention should be given to uniformity of fertilizers spreading, that, if it is not appropriate, can determine a non-uniformity of plants growing and development and, implicitely a worse quality and diminished production (*Brian and Mahmoud, 2016; Tabara, 2005, 2009*).

RESULTS

Sowing. Hemp seed must have a minimum purity of 96 % (without broom-rape seeds) and minimum germinating capacity of 80 % (positive production increments are obtained when the germinating is over 90 %). The seed from previous year should be used. Seed material is treated with fungicides (Criptodin 3kg/t). Sowing is performed when at 5-6 cm soil depth, the temperature has stabilized at +8…+9°C (practically before the corn sowing). In case of early sowing, the plants endure low temperatures, so their growing is slowed down and they do not reach the normal height and damages determined by fleas are bigger. When sowing is delayed, the moth can attack, the growing time is shortened and plants prematurely blossom. When the sowing period is failed, the stems and fiber production are diminished. The most appropriate distance between rows is of 12.5 cm. The sowing machine used is SUP-17. Sowing depth is 3 – 4 cm. In lighter soils or during draught spring, it can reach 5 – 6 cm. After sowing, the harrowing is performed for making rows less visible, thus limiting the damages produced by crows, pigeons,etc.

Crop preparation works. In medium well structured soils and for an ideal preparation of soil (lack of weeds), hemp can be viable without any other preparation works. Though, there are cases when crops should undergo maintaining measures. If sowing is performed in loosen field or during draught spring, an immediate rolling should be performed after the sowing. When crust appears during the sowing till springing, then the harrows or ridged rollers should be used. After springing, the perennial weeds with vegetative multiplication (thistle, milk thistle,etc) are controlled by weeding. Fleas control is performed during the springing time or by applying Lindatox. The hemp moth (Grapholita delineana), is controlled not only by rational crop rotation, but also by chemical treatments with Decis or Sumithion. One warning treatment and other two subsequent ones, at 12-15 days, are made, [2,3].

Like any other plant, hemp has the male and the female part. It is very important to determine in field which part is the male and which the female in order to remove the male part from the crop, because pollination is not recommended. After being pollinated the plant has no more grains. A charge of maximum maxim 2% male per hectare is allowed. Male parts are manually removed. Differences between male and female parts:

- ✓ Male plant is higher;
- ✓ Has bigger inflorescence;
- ✓ Flowers are white;
- ✓ Flowers appear more rapidly at males than at females, [2, 3, 9].

Fig. 3 – Hemp [2, 3, 9]
1,2-male hemp (of summer); 3,4-female hemp (of autumn)

Hemp comprises three parts that can be used:

1. Seeds can be used to prepare different food, oils and medicinal products.

2. Fibers have all sorts of industrial uses (starting from clothing till vehicles) – they form the middle layer of the stem and are covered by a thin protective layer.

3. Woody core remained after extracting the fibers, represents the part (together with lime) used in constructions (although we have found information according to which it is possible to use the whole stem in buildings – meaning that fibers and woody core should not be separated).

Harvesting –is made during two phases both for fiber hemp and seed hemp. For fiber hemp, first, the plants are cut and left in field to dry and in the second phase the leaves are shaken and plants are tied up in bunches of 20-25 cm diameter, that are transported to retting processing plants. For seed hemp, the plants are cut and left to dry for 7-8 days. Threshing of inflorescences is performed with the ceral combine. Threshed seeds are immediately cleaned, conditioned and dried. [11]

Knitting hemp is harvested at the end of blossoming of male plants, when the pollen does not shaken any more. Premature harvesting diminishes the fiber productions as well as plant technological characteristics (mostly its resistance) that are lower. Harvesting delay is also very harmful. The most important losses are determined by stems damaging. At the same time, the fiber is less fine, becomes rough and breakable. In certain areas, hemp is manually harvested. Stems are cut at 4-6 cm height by sickle or special hooks, left on soil as bunches of 15-20 cm thickness, spread to dry.

When the upper part is getting yellow, the hemp bunches are reversed on their other part and dried for more 2-3 days (totally, drying lasts till 4-8 days). After that, the leaves are shaken (leaves should be removed, because chlorophyll depreciates the hemp fiber by staining during retting process and retting processing plants do not receive stems with leaves) and bunches are bound twice if they surpass 100 cm and once, if they are short. [7]

Fig. 4 - Hemp harvesting machine [14]

Mechanized harvesting is performed with special machines. The cut stems are left on soil as a thin layer (approximately perpendicular on machine forward direction). After having dried, the process is similar to manual harvesting, namely: leaves shaking and binding as bunches. Productivity of machines for this procedure without binding device is of 4-5 hectares/shift. In order to use special machines with binding device, the hemp leaves should be removed. Generally, there are recommended the treatments of 100-150 liters of solution per hectare, made by air means spraying.

Treatments are performed in the morning up to 10 a.m. or in the evening after 5 p.m. The treatment is done when the leaves and male stems become green-yellowish (10-15 days since the beginning of pollen shaking, namely 10-12 days before harvesting or the blossoming period end). The moment is also chosen in accordance with weather report, as rains over 5 mm that appear in the first 4-6 hours after the treatment could impede the efficacity of products used. It is also to be noticed that the treatment delay till chrolophyll degradation does not ensure the defoliation.

Premature treatment, when male plant leaves are green, may depreciate the fiber, and production is reduced. When treatments are appropriately performed, the defoliation lasts 10-12 days, usually in a percentage of 90-100%. In some cases, magnesium chlorite may be also used for defoliation, 15-17 kg/ha in 200 de l of water, that produces drying and leaves removing within 5-6 days. After the defoliation, the machines directly harvest in bound bunches, that are put in hoods for being dried, and machine productity in this case is of 1.5 Ha/shift.

HempFlax, a Dutch company established since 1994, is designing, developing and patententing equipment specialized in hemp cultivation, offering an innovating combine able to perform three different harvesting operations at the same time, namely hemp seeds, stems and leaves harvesting. [2,3]

Fig. 5 - Combine of harvesting hemp seeds, stems and leaves [2, 3]

CONCLUSIONS

Hemp is one of the oldest plants cultivated in our country (over 2000 years), being mainly used for fibers in clothing industry. Hemp stems coming from local growing and wild hemp contain 10-12% fibers, and improved varieties- 26-32%. Fiber content within stems is influenced by each variety, technological and soil and climate conditions. Fibers have a series of valuable characteristics related to resistance (to traction, torsion, friction, rotten process), extension capacity (elastic and plastic), spinning capacity, bigger length than fibers of sisal, jute, manila or cotton, that make them useful in various domains: textile industry, manufacturing industry, vehicle industry. [3].

Hemp is another agricultural plant that is cultivated either for fibers, or in mixed purposes, for fibers and seeds. Seed contains 32 – 35 % oil. Hemp long fibers resistant to water action are used to manufacture strong and durable fabrics. The hemp oil is edible and is used in industry. The cakes resulted after extracting the oil, being rich in fats and proteic substances are used as concentrate products to farm animals foddering. The multiple materials resulted after the primary processing of stems are used for heating the plastic greenhouses.

The oldest proof attesting the hemp utilization is a piece of fabric discovered in Mesopotamia, 10,000 years ago. The oldest paper of hemp fiber registered comes from China, 2 millennia ago. The first Diesel engine has been designed to use vegetal oils mostly based on hemp. This is a non-toxic and bio-degradable bio-oil for Diesel engines. In 1930, Henry Ford has produced a car manufactured in a percentage of 70% from hemp (as raw material used). Great artists (Rembrandt, Van Gogh, Gainsborough) paintings have been made on hemp canvas, using water colours extracted also from hemp.

Until 1989, Romania owned the first place in Europe as regarding hemp crop-cultivating 56-70% out of total production and the fourth place in the world *(45,000 ha),* but in 1994 it reached only 800 ha. The hemp crop advantages and the outstanding characteristics of its fiber make necessary to revive this interesting domain.

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STUDY ON SENSITIVITIY OF THE MAIZE HYBRID RUSE 424 AND ITS PARENT FORMS TO HERBICIDES USED AGAINST SORGHUM HALEPENSE
/
ПРОУЧВАНЕ ЧУВСТВИТЕЛНОСТТА НА ЦАРЕВИЧНИЯ ХИБРИД РС 424 И РОДИТЕЛСКИТЕ МУ ФОРМИ КЪМ ХЕРБИЦИДИ ИЗПОЛЗВАНИ ЗА БОРБА С БАЛУРА

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Keywords: *maize, herbicides, resistance, productivity.*

ABSTRACT

Between 2008 – 2010, in the experimental field of Institute of Agriculture and seed science "Obraztsov Chiflik" Russe on the soil type of highly leached chernozem was tested the resistance of corn hybrid RS 424 and its parent forms - lines 61/31 and 302/12 to the herbicides Titus 25 DF and Mistral 4 CK administered in an optimal dose once and twice in a system. The experience is based on Shannin's perpendicular method, with a plot size of 10 m² (Shanin, 1977).

Line 61/31 shows a higher sensitivity to herbicides. Both lines studied are more tolerant of twice-treatment with herbicides.

РЕЗЮМЕ

През 2008 - 2010 год. в опитното поле на ИЗС „ Образцов чифлик" Русе на почвен тип силно излужен чернозем е изпитана устойчивостта на царевичен хибрид Рс 424 и родителските му форми - линии 61/31 и 302/12 към хербицидите Титус 25 ДФ и Мистрал 4 СК приложени в оптимална доза еднократно и двукратно в система. Опитът е заложен по перпендикулярния метод на Шанин, с големина на реколтната парцела 10m2 (Shanin, 1977).

Линия 61/31 показва по-висока чувствителност към хербицидите. И двете проучвани линии са по-толерантни към двукратното третиране с хербициди.

INTRODUCTION

Maize is one of the main food and feed crops in our country. It produces high yields of grain (*Tomov, 1984, Tsankova et al., 2006*). The plasticity of culture allows it to be grown in all regions of the country without exception (*Tomov, 1984*).

The creation and implementation of new corn hybrids as well as their cultivation under different agro-ecological conditions is the subject of a number of scientific experiments (*Genov and Genova, 2005, Genova and Genov, 2005, Ivanov, 2011, Petrov and Angelova, 2005, Valchinkov et al., 2003; Valchinkov et al., 2005, Yordanov, 2006*).

The selection of the most suitable for each region hybrids according to the conditions and the breeding technology, leads to the desired results and the providing of stable yields (*Angelov et al., 1995; Epinal et al., 2001*).

The production of high quality and stable yields of maize is directly dependent on the plant protection. The propagation and wide spread of perennial rhizome weeds in arable land creates serious problems for maize growing. The main reasons for the spread of these weeds are: glaw in agro-technology (terms, ways and depth of treatments, use of rototillers and disk harrows, lack of science-based crop rotation), inappropriate use of herbicides etc. (*Tonev, 2000*).

The monoculture cultivation of maize also has a beneficial effect on the spread of the perennial species of weeds such as Sorghum halepense, Cirsium arvense, Convolvulus arvensis, etc. For this purpose, it is necessary to constantly test new means of controlling weeds in specific soil type and climatic conditions, according to the genotype of the crop (*Ilieva and Sabev, 1995; Ilieva and Sabev, 1997; Ilieva, 1995*).

The aim of the present study is to establish the sensitivity of corn lines 61/31, 302/12 and Ruse 424 hybrid to the johnson grass control herbicides rimsulfuron and nicosulfuron applyed in optimal doses once and twice throughout vegetation.

MATERIAL AND METHOD

Between 2008-2010, in the experimental field of Institute of Agriculture and Seed science "Obraztsov Chiflik" – Rousse on the soil type of highly leached Chernozem, with low humus content (1.98%), low content of N and P2O5 and well stocked with K_2O, there was conducted field experiment with maize after Shannin's perpendicular method, with plot size of 10 m^2 (*Shanin, 1977*). The hybrid Rousse 424 and his parental forms - lines 61/31 and 302/12 were studied. The sowing was done in an optimal period (in the first decade of April), at a density of 5500 plants/ da (*Popov and Pavlov, 1966*).

Maize has been grown without cultivation between rows after his predecessor - wheat, when fertilized with N10 P8, as phosphorus fertilizers (superphosphate) are introduced with the main autumn treatment of the soil, and the total amount of nitrogen fertilizer (ammonium nitrate) – was applied before sowing.

The application of herbicides (Titus 25DF and Mistral 4C) was done with sprayer pump at a working solution of 20 l/da, in phase 4-5 leaf of the culture in optimal doses, once and twice at an interval of 14 to 20 days (Table 1). For the whole maize growing season, a control plot was maintained weed-free, with two cultivations between rows.

Table 1

Variants of the experiment

	Variants	Doses - herbicides, g/da (ml/da)	Doses - active substance, g/da
1	**Control- untreated**	-	-
2	**Titus 25DF (250 g.kg^{-1}rimsulfuron)**	3+2	0.75+0.50
3	**Titus 25DF (250 g.kg^{-1}rimsulfuron**	5	1.25
4	**Mistral 4CK (40 g.l^{-1} nicosulfuron)**	100+50	4+2
5	**Mistral 4CK (40 g.l^{-1} nicosulfuron)**	150	6

The following indicators were examined for the realization the aim of the survey: phytotoxicity of herbicides on the 7th, 17th and 30th days after herbicides application of the logarithmic scale of (1-9 balls) of the EWRS, at Ball 1 - no damage and at Ball 9 - the culture is completely destroyed, seed yield (kg.da^{-1}).

Statistical analysis of the results was performed by the method of dispersion analysis for yields, and the differences between the variants were established by Duncan multiple range test with software Statgraphics Plus.

RESULTS

Climatically the experimental field of the Institute belongs to the area of moderate continental climate. Agro-meteorological conditions during the survey period (2008-2010), in terms of temperature sums and sums of rainfalls by months differ as in the individual years both as compared to multiannual average values (climatic norm) for the years 1896 – 2005.

2010 year is characterized with higher soil moisture (Figure 1). Measured rainfalls in April (38.4 mm) and May (81.7 mm) have created favorable conditions for germination, growth and development of maize plants. Precipitation in June (81.5 mm) turned out crucial for the formation of the yield. In the temperature relationship 2010, for the whole maize growing season, is characterized by temperatures (589.6 °C), around the norm (572.2 °C). With higher temperature sums of 779 ^{0}C compared to the multiannual rate - 739.8^{0}C, is August, which are characteristic of global warming observed in recent years.

2008 and 2009 are moderately beneficial for maize. The sum of rainfall in 2008 in April (51.6 mm) and May (58 mm) are close to the climatic norm (51.1 mm and 66.2 mm). In 2009, the amount of monthly rainfall for the same period was 12.7 mm (April) and 29.8 mm (May), which are respectively 25% and 45% below the multiannual rate (51.1 mm and 66.2 mm).

The temperature sum for the period from April to September is 590,30 ^{0}C (2008) and 596,18 ^{0}C (for 2009) at a multiannual rate of 572,23 ^{0}C. Extremely high temperatures and the significant water stress did not have a negative impact on the development of corn.

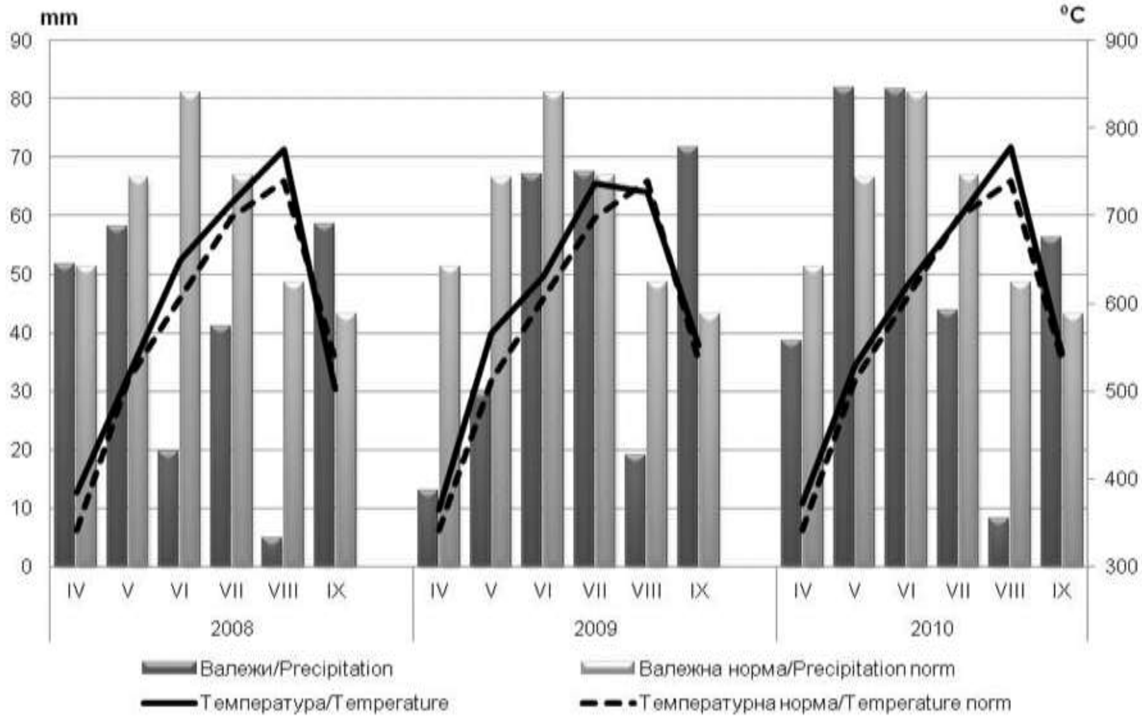

Fig. 1 - Average monthly air temperatures and precipitation by months for period 2008 - 2010

On average, over the three-years period, the highest sensitivity to the herbicide Titus 25 CF indicates line 61/31, where plant's death rate is from 14.6% to 25.0% with the use of Titus 25 DF administered at the optimal dose, once in growing period (Table 2).

In the experiment with the herbicide Mistral 4 CK, the percentage of dead plants is 10.4% twice administered and 20.8% in a single application. Line 302/12 shows a slightly higher resistance to the applied herbicides Titus 25DF and Mistral 4CK, administered in optimal doses, both alone and in a system, as the percentage of dead plants ranges in variants from 10.9% to 21.3%.

Both lines show a higher tolerance to two-fold treatment with herbicides in a system. The most tolerant, during the research period, was the Ruse 424 hybrid. Compared to parental forms, the percentage of dead plants varies from 2.1% to 10.6%.

The statistical analysis of the experimental data of the Ruse 424 hybrid and its parental forms, proves the basic dependencies between the tested factors. The dispersion analysis showed that between the factors being compared (emerged and dead plants), there were proven differences at a test factor of 0.01%.

Table 2

Effect of herbicides Titus 25DF and Mistral 4CK on the growth of maize lines 61/31, 302/12 and hybrid Rousse 424

Variants	Number of plants emerged	Number of plants perished	%	LSD after the method of Duncan
		61/31		
Control - untreated	**47**	**0**	0	a
Titus 25DF (250 g.kg^{-1}rimsulfuron)	**48**	**7*****	14.6	b
Titus 25DF (250 g.kg^{-1}rimsulfuron	**48**	**12*****	25.0	b
Mistral 4CK (40 g.l^{-1} nicosulfuron)	**48**	**5*****	10.4	b
Mistral 4CK (40 g.l^{-1} nicosulfuron)	**46**	**10*****	20.8	b
		302/12		
Control - untreated	**47**	**0**	0	a
Titus 25DF (250 g.kg^{-1}rimsulfuron)	**46**	**5*****	10.9	b
Titus 25DF (250 g.kg^{-1}rimsulfuron	**48**	**9*****	18.8	b
Mistral 4CK (40 g.l^{-1} nicosulfuron)	**47**	**6*****	12.8	b
Mistral 4CK (40 g.l^{-1} nicosulfuron)	**47**	**10*****	21.3	b

Variants	Number of plants emerged	Number of plants perished	%	LSD after the method of Duncan
Hybrid Rousse 424				
Control - untreated	**47**	**0**	0	a
Titus 25DF (250 g.kg^{-1}rimsulfuron)	**47**	**1*** **	2.1	c
Titus 25DF (250 g.kg^{-1}rimsulfuron	**49**	**3*** **	6.1	c
Mistral 4CK (40 g.l^{-1} nicosulfuron)	**47**	**5*** **	10.6	c
Mistral 4CK (40 g.l^{-1} nicosulfuron)	**48**	**2*** **	4.2	c

Legend: *, **, ***, for LSD <0.5; 0.1; 0.01. All non-star variants have no significant difference with the untreated variants. The values in a column, followed by different letters (a, b, c, etc.), differ significantly in P <0.05

From the phenological observations performed on the 7th, 17th and 30th day after treatment (Table 3), in the maize hybrid Rousse 424 and line 302/12, no visible signs of phytotoxicity were observed in both herbicides Titus 25DF and Mistral 4CK, administered in optimal doses. The herbicides show good selectivity (EWRS scale ball 1) to the maize hybrid Rousse 424 and line 302/12.

For line 61/31, is observed sensibilisation to the herbicides Titus 25DF and Mistral 4CK, which is expressed in tumor-like formations (ball 3-5 on the EWRS scale), which leads to the suppression of the plants and some of them will die.

Table 3

Selectivity of the herbicides of 61/31 and 302/12 maize lines and Rousse 424 hybrid

Herbicide / Day of report		7th day	17th day	30th day
RM 61/31				
Titus 25DF	3+5 g.da^{-1}	4	4	3
	5 g.da^{-1}	5	5	4
Mistral 4CK	100+50 ml.da^{-1}	5	3	2
	150 ml.da^{-1}	3	1	1
302/12				
Titus 25DF	3+5 g.da^{-1}	1	1	1
	5 g.da^{-1}	1	1	1
Mistral 4CK	100+50 ml.da^{-1}	2	1	1
	150 ml.da^{-1}	1	1	1
Rousse 424				
Titus 25DF	3+5 g.da^{-1}	1	1	1
	5 g.da^{-1}	1	1	1
Mistral 4CK	100+50 ml.da^{-1}	1	1	1
	150 ml.da^{-1}	1	1	1

During the survey years, corn has realized its productive potential by the amount of grain yield to varying degrees under the influence of the factors studied (climate and herbicides). The grain yield of corn lines 61/31 and 302/12 is presented in Tables 4 and 5.

The negative influence of the herbicides on the number of plants, their growth and development affected the yield of seeds (Table 4). A greater reduction in yield was observed with the use of herbicides – applied twice, whereas the decrease in line 61/31, which appeared to be more sensitive, was 21.0% compared to the control variant. On line 302/12 there was no reduction in yield compared to the control. When applying Mistral 4 CK twice, the 61/31 line again showed a higher sensitivity, with a reduction in yield compared to a control of 29.0% and 302/12 line - 8.0%.

The trends in seed yield are also maintained in the data on the influence of the single herbicides used on the lines 61/31 and 302/12 (Table 5). The yields obtained in variants range from 198 kg.da^{-1} to 277 kg.da^{-1} depending on the herbicide used. As a result of the chemical treatment, the yield was reduced by an average of 2.0% to 26.0% compared to the control (K). In both ways of administered the herbicides - twice and in a system and once, are not found proven differences in the values of the indicator - seed productivity.

The Rousse 424 hybrid exhibits a higher degree of resistance to applied herbicides than the tested lines. On average, for the period of the experiment the Ruse 424 hybrid, the highest yield was obtained at the administration of the herbicide Titus 25F administered twice - 693 kg.da^{-1} (Table 6). The increase in yield compared to the control (612 kg.da^{-1}) is 13.0%, which is not statistically proven.

In all variants, there was a positive or negative difference in seed yield which was minimal and there was no statistically significant difference between the herbicide application variants and the control variants.

Table 4

Grain yield (kg.da-1) of maize inbred lines, treated with herbicide Titus 25DF and Mistral 4CK, applied twice

Inbred lines	Treated with herbicid				Economic control				% compared to economic control	significance
	2008	2009	2010	Average for the period	2008	2009	2010	Average for the period		
Titus 25DF										
61/31	165	250	221	212	105	427	269	267	79	n.s.
302/12	248	339	311	299	88	423	338	283	106	n.s.
Mistral 4CK										
61/31	48	360	161	190	105	427	269	267	71	n.s.
302/12	128	398	258	261	88	423	338	283	92	n.s.

gDp5% = 223
gDp1% = 318
gDp0.1% = 460

Table 5

Grain yields (kg.da-1) of maize inbred lines treated with the herbicides Titus 25DF and Mistral 4CK, applied once

Inbred lines	Treated with herbicid				Economic control				% compared to economic control	significance
	2008	2009	2010	Average for the period	2008	2009	2010	Average for the period		
Titus 25DF										
61/31	201	336	148	228	105	427	269	267	86	n.s.
302/12	247	355	228	277	88	423	338	283	98	n.s.
Mistral 4CK										
61/31	127	362	104	198	105	427	269	267	74	n.s.
302/12	180	357	136	224	88	423	338	283	79	n.s.

gDp5% = 223
gDp1% = 318
gDp0.1% = 460

Table 6

Grain yield (kg.da-1) from the Ruse 424 hybrid, treated with the herbicides Titus 25DF and Mistral 4CK, applied twice and once

Herbicides	Treated with herbicid				Economic control				% compared to economic control	significance
	2008	2009	2010	Avarage for the period	2008	2009	2010	Avarage for the period		
Two application										
Titus 25DF	760	718	600	693	492	760	583	612	113	n.s.
Mistral 4CK	561	626	439	542	492	760	583	612	89	n.s.
One application										
Titus 25DF	662	729	439	610	492	760	583	612	100	n.s.
Mistral 4CK	653	747	314	571	492	760	583	612	93	n.s.

gDp5% = 269
gDp1% = 382
gDp0.1% = 553

CONCLUSION

Mean for the study period, line 61/31 shows a higher sensitivity to the used herbicides. In the variants, treated with Titus 25 DF at the optimal dose, the death rate was 25.0% and Mistral 4CK - 20.8%.

Line 302/12 shows a higher resistance to the applied herbicides Titus 25DF and Mistral 4CK administered at optimal doses, both alone once and in a system. Percentage of the dead plants is varying from 10.9% to 21.3%.

Both lines show a higher tolerance to two-fold treatment with herbicides in a system.

The grain yield obtained from the two inbred maize lines treated with the herbicides Titus 25DF and Mistral 4CK is lower than the untreated control of the respective genotype. A higher yield of 6.0% compared to the control was reported only for line 302/12, of the variant with a double application of Titus 25 DF.

The Rousse 424 hybrid exhibits a higher degree of resistance to the used herbicides applied once and in a system.

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AN OVERVIEW OF HAZELNUT HARVESTING MACHINES WITH DIFFERENT DESIGNS
/
FARKLI TASARIMLARA SAHİP FINDIK HASAT MAKİNALARINA GENEL BİR BAKIŞ

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ABSTRACT

Many factors (topography, soil characteristics, planting technique etc.) affecting the applicability of mechanical harvest in hazelnut. Today, many of these factors have been developed to overcome the adverse effects. As a result, there are differences in mechanical harvesting techniques applied to different production regions around the world. Information was given about hazelnut harvesting machines which have different collecting units designed and manufactured in order to reduce harvest expenses and labor force requirement which are important in hazelnut production cost with this study.

ÖZET

Fındıkta mekanik hasadın uygulanabilirliğini etkileyen birçok faktör bulunmaktadır (Topoğrafya, toprak özellikleri, dikim tekniği vb.). Günümüzde, olumsuz etkilerin üstesinden gelmek için bu faktörlerin birçoğu geliştirilmiştir. Sonuç olarak, dünya genelinde farklı üretim bölgelerinde uygulanan mekanik hasat tekniklerinde farklılıklar bulunmaktadır. Bu çalışma ile fındık üretim maliyetinde önemli olan hasat giderlerini ve işgücü ihtiyacını azaltmak amacıyla tasarlanmış ve imal edilmiş farklı toplama ünitelerine sahip fındık hasat makineleri hakkında kısaca bilgi verilmeye çalışılmıştır.

INTRODUCTION

The hazelnut (*Corylus avellana L.*), one of the world's major nut crops is one of the most important agricultural products in Turkey (*Yıldız T., 2016*; *Selvi K.Ç. 2017*), since as agricultural products it has relevant nutritional and economic value *(Zambon et al, 2017).* The traditional harvesting method consists in collecting hazelnuts from ground and a preliminary accurate selection is then needed to avoid stones, ground, brunches, leaves, etc. *(Delprete and Sesana, 2014).* In recent decades, advanced technology and the latest results of scientific research have been largely applied in agriculture in order to improve the quality of products and to increase productivity *(Bachche S., 2015).* This situation has increased the use of mechanization in hazelnut harvest rapidly instead of traditional harvesting methods.

Mechanical harvest of nuts include such as, ground preparation, dropping of fruits, stacking of dropped fruits, collecting and cleaning process. In Italy, Spain and USA, which produce hazelnuts economically, the mechanical harvest has been widespread by the amount of planting technique and land topography allowed. In Italy, Spain and USA, which produce hazelnuts economically, the mechanical harvest has been widespread by the amount of planting technique and land topography allowed. For this purpose, machines with pneumatic (vacuum), pneumatic + mechanical and mechanical effective sweeping units are used. As a basic principle in the first harvesting machines developed for this purpose, aspiration of the fruits dropped to the garden floor was taken into account *(Parks and Fairbank, 1948)*, followed by mechanical and aspiration + mechanical collector combination methods *(Fridley and Adrian, 1959; Whitney et al, 1966).*

MATERIAL AND METHOD

In working with these machines, a good preparation of the ground (levelling and compacting) and a spreading product with lateral sweepers are required. The fact that the hazelnuts cultivated in the countries are short-husked as a kind of characteristic, causes the hazelnuts to be poured as grains during the harvesting period.

For this reason, no husk separation machines are used. Due to the definable geometric shape of the hazelnuts, it is possible to effectively clean them with known separation methods. Uncleaned stone and other elements are separated in water pools and cleaned nuts are dried in desiccants.

In the production of nuts in our country, the harvesting process is the way of pouring the fruits by shaking and then collecting them by hand from the floor or the branches. Harvesting with this method constitutes approximately 74% of the total labor requirement. This situation increases the production cost of hazelnut significantly and causes labor force based on heavy labor during the harvesting period.

The fact that the Turkish hazelnut varieties have a long husk and that the fruit is tightly wrapped and does not have an identifiable geometric shape makes the separation systems of such machines ineffective. In addition, the effectiveness of the sweeping units is also diminishing due to the differences in the planting technique and the characteristics of the garden grounds. Also, the large size of the machines creates problems due to the sowing technique. Despite the Italian machinery manufacturers have worked to enter the market for decades Turkey (demonstrative trials by farmers in bringing the machine to the garden Turkey) have not been successful due to the lack of appropriate equipment.

In this study, hazelnut harvesting machines having different collecting units designed and manufactured in order to reduce the harvest expenses and labor force requirement, which have an important place in hazelnut production cost, were examined.

RESULTS

Trailer type pneumatic nuts collection machines

Trailer type pneumatic nuts collection machine consists of five main units: aspirator, separator, unloader, suction mouth and transmission hose. This type of machine takes the movement of a diesel engine mounted on the tail shaft by a shaft or on a belt-pulley system. The general view of the pneumatic nuts harvesting machines is given in Figure 1.

Fig. 1 - General view of trailer type pneumatic nuts collection machines

As can be seen from Figure 1, the nuts, leaves, small branches, stones and powders collected by the suction pipe from the ground come to passive separators. As the mixture discharged from the separator passes through the air stream created by the fan, leaves and other light materials are removed. The remaining hazelnut is separated from the foreign material by the large-hole rotary sieve and the small-hole sieve. The cleaned nuts pass through the air conveyor fed by the radial ventilator and are bagged in here.

It is reported that in the previous studies, the product work performance changed according to the yield of the garden, and as the garden productivity increased, the work performance of the machine increased. In addition, it has been determined that the production of fruit gatherers improves the product performance significantly and reduces the labor requirement *(Biondi et al, 1992)*. According to the productivity of the garden, the product work performance was between 14.95-38.21 kg/Ewh (Ewh=Employee working hour), the harvesting efficiency was between 92.43 % and 95.13 % and the field work success was between 0.428-0.352 ha/MLh (MLh=Machines labor hour) non-collecting the hazelnuts by hand and moving the delivery hose by hand has been reported *(Beyhan M., 1992).*

Again, *Sauk (2016)* reported that under naturel spillage and in five different garden yield conditions, the product work success, collecting efficiency and the area of work success were between 18.90-67.18 kg/h, 97.68% and 99.36% and (in the case of harvesting the hand- from floor) 0.014 to 0.009 ha/MLh respectively.

Movable type pneumatic nuts collection machines

The movable type pneumatic picking machines are pulled by the tractor according to the movement transmission system (Figure 2) and are divided into two groups as a self-propelled and trailer type (Figure 3).

Fig. 2 - General view of trailer type pneumatic nuts collection machines

As seen in Figure 2, this type of machine takes its movement from the pto shaft of the tractor. Unlike non movable trailer type pneumatic hazelnut collection machines, sweeping units are added to the suction mouths of these machines. This unit is sweeping into the pre-barrel nipple suction tube.

Fig. 3 - General view of self-propelled type pneumatic nuts collection machines

As can be seen in Figure 3, the nuts that are naturally poured into the garden floor are turned into barrels by the sweeping unit and delivered to the machine by suction hose. *Monarca et al. (2009)* obtained product work performance, work force requirement and field work performance values of different types of hazelnut harvesters in different gardening conditions as in Table 1.

Table 1

Some work parameters of hazelnut harvesters in different gardening conditions ***(Monarca et al, 2009)***

Garden yield (t/ha)		Unit	Trailer type	Self-propelled
3.7	Product work performance	(kg/h)	880	985
	Labor requirement	(h/ha)	4.21	3.76
	Field work performance	(ha/h)	0.24	0.27
1.8	Product work performance	(kg/h)	627	980
	Labor requirement	(h/ha)	3.03	2.04
	Field work performance	(ha/h)	0.33	0.49

This type of machine is absorbed into the leaf, small stone, soil and coarse dust machine with the grain + ground nut from the ground of the garden, spreading a lot of dust which can be harmful to workers' health and environment. For this purpose, dust emission is reduced by using filters made of cyclone and napkin in type machines.

Mechanical Hazelnut Picking Machine

These types of machines with mechanical collection system consist of four main units: collection unit, separation system, and storage and power supply-hiking system. The general appearance of mechanically effective nuts harvesting machines is given in Figure 4.

Fig. 4 - The general appearance of mechanically effective hazelnuts machines

As can be seen from Figure 4, these machines are generally large in size and are widely used in modern gardens in the USA and France. Collecting machines which can be used in small gardens and can be mounted on garden tractors at 10-16 HP have also been developed

First, the machine's collection unit, developed by *Peterson and Monroe (1977),* consists of a drum with spirally placed rubber fingers. With this machine, 91% collection efficiency was achieved at 1.21 km/h speed and 70.2 min-1 rotation speed of collection drum, and field work performance was between 0.1-0.14 ha/h.

Later on, *Ghiotti (1989)* has developed a prototype system based on the principle that the chains of chains attached to a drum rotating in the opposite direction of motion hit the fruit. In previous studies, Yıldız (2000) has designed a prototype nuts collection machine with a tractor-driven mechanical pick-up, and said that this machine consists of four main units: picking, spiral conveyor, launcher and conveying channel. The prototype nuts harvesters were taken in the experiment under different garden yields, feed speeds and number of different picking cycles. It determined that the collection efficiency was 91.66% and the product work performance was 100.29 kg/h when garden yield at 225 kg/da, 3.2 km/h feed speed and 430 min^{-1} rotation speed.

Fanigliulo and Tomasone (2009) have worked on different garden floors with a mechanically effective nuts collection machine that is mounted on trailers. In the study, the product work performance of the machine and the field work performance in the grassy field were determined as 2.5 t/h and 0.35 ha/h respectively. In the case of non-grass conditions same variables were measured as a 2.6 t/h and 0.38 ha/h respectively

Pagano *et al. (2010)* have determined that the machine has a field work performance of 0.64 ha/h, a product work performance of 1.25 t/h and a collection efficiency of 71% in order to determine the performance values of a mechanically effective hazelnut harvester developed for flat terrain

Sauk (2016) has examined the possibilities of mechanical harvesting nuts grown in Turkey close to flat and flat land. Sauk tried a mechanically effective prototype nut harvesting machine under different gardening conditions. As a result of the work, the field work performance was found to be 0.158-0.102 ha/h and the product work performance was 124.83-1322.08 kg/h.

CONCLUSIONS

In countries that produce hazelnuts economically in international markets, mechanical harvesting methods have been developed according to the land topography, planting technique and the nature of the hazelnut variety. However, to meet a large part of world hazelnut production to be manually gather the nuts in Turkey is thought-provoking. In our country, the development of suitable mechanical harvesting methods for the planting technique and hazelnut planting where land topography is appropriate will be important in terms of cost reduction. Thus, the reduction in the cost of harvest due to the degree of mechanization of the hazelnut harvest will increase our competitive power in international markets.

A hazelnut harvester should be designed with high efficiency and sweeping efficiency in an ergonomic principles direction that takes into consideration the user comfort and safety of work, with a mechanically effective sweeping system that can make hazelnut harvesting in plain and sloping terrains taking into account the conditions of our country.

Depending on factors such as distance between branches, branch height, branch angle etc. in existing hazelnut gardens, the basic dimensions of the machine should be determined and these systems should be placed within this dimension. When such a hazelnut harvester is manufactured, the cost of harvesting and demand for hazelnut labor cost will be reduced, and on the other hand it will be economically and ergonomically beneficial, as the harvesting of hazelnuts will not damage the branches.

Thus, with the realization of gardening and manufacturing of a machine suitable for our hazelnut varieties, an important step will be taken to mechanize the hazelnut which is one of the most important problems in our country.

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GRAIN SIZE ANALYSIS TECHNIQUES IN AGRICULTURAL PRODUCTS / *TARIM ÜRÜNLERİNDE TANE BÜYÜKLÜĞÜ ANALİZ TEKNİKLERİ*

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ABSTRACT

Reduction of grain size in processing of grain products for food and feed purposes is the most important and energy consuming process. The performance of animals consuming mixed feeds of different grain sizes may vary. Therefore, grinding efficiency is an important parameter and the use of grain size analysis in terms of machine technique; is one of the main parameters in the comparison of the performances of grinding purposes and grinding activities. In this study, the most commonly used grain size analysis techniques (sieve analysis, microscopic (image processing) analysis, laser diffraction analysis, electrical resistance analysis and sedimentation analysis) were tried to be given comparatively.

ÖZET

Tahıl ürünlerinin gıda ve yem amacıyla işlenmesinde tane büyüklüğünün azaltılması en önemli ve enerji tüketen süreçlerden biridir. Farklı tane boyutlarında karışık yem tüketen hayvanların performansı değişebilir. Bu nedenle öğütme verimliliği önemli bir parametredir ve tane boyutu analizinin makine tekniği açısından kullanılması; öğütme ve taşlama etkinliklerinin performanslarının karşılaştırılmasında ana parametrelerden biridir. Bu çalışmada, en yaygın olarak kullanılan tane boyutu analiz teknikleri (elek analizi, mikroskobik (görüntü işleme) analizi, lazer kırınım analizi, elektriksel direnç analizi ve sedimantasyon analizi) karşılaştırmalı olarak verilmeye çalışılmıştır.

INTRODUCTION

Investigations in food science and technology, whether by the food industry, governmental agencies, or universities, often require determination of food composition and characteristics. Making an appropriate choice of analytical technique for a specific application requires a good knowledge of the various techniques (*Nielsen S S., 2017*).

Grain processing, including cereal and pulse processing, is one of the oldest and most important of all food technologies and forms a large and important part of the food production chain. Grain pulses are grown widely throughout the world and their dietary and economic importance is globally appreciated and recognized *(Tiwari et al, 2011).*

Reducing the grain size in the processing of grain products for food and feed purposes is the most important and most energy-consuming process. The following two points need to be taken into account in terms of energy consumption;

1. Grain size should be chosen appropriately for the purpose and avoid unnecessary excessively fine grinding.
2. The mills to be used during milling should be sensitive to the selection of the construction and operating parameters.

Therefore, use of grain size analysis in terms of machine technique is one of the main parameters in the comparison of the performances of grinding purposes and grinding activities (having different constitutive properties and different operating parameters) in terms of grinding efficiency.

Over recent decades, various new methods for grain-size analysis have been developed *(Stefano et al, 2010).* The most commonly used grain size analysis techniques are; sieve analysis, microscopic (image processing) analysis, laser diffraction analysis, electrical resistance analysis and sedimentation analysis techniques.

MATERIAL AND METHOD

Sieve Analysis

Sieve analysis is the oldest technique for measuring particle size distributions but is still a standard laboratory operation and extremely useful in practice *(Bhandari et al., 2013)*. Sieve analysis test has been used as the main method to determine particle size distribution of granular materials including coarse materials for many decades *(Kumara et al, 2012).*

Elimination; is the process of separating a solid grain mixture into components of different sizes using sieves. Size openings are based on a progressively decreasing standard series of elbow passes. The concept of "mesh number" is used when sieves used in screening are classified according to size. The mesh number indicates the number of holes per unit length (inch and mm) on one sieve. Tyler Ro Tap and USA standard sieve series are widely used. The sieve opening and mesh numbers of both sieve series are given in Table 1 *(Baker and Herman, 1995)*. Also, Figure 1 shows the sieve set and shake unit.

Table 1

The sieve opening and mesh numbers of Tyler Ro Tap and USA

Elek açıklığı (µ)	Tyler Ro Tap (mesh/inch)	USA (mesh/inch)
3360	6	6
2380	8	8
1680	10	12
1191	14	16
841	20	20
594	28	30
420	35	40
297	48	50
212	65	70
150	100	100
103	150	140
73	200	200
53	270	270

Fig. 1 - Tyler Ro Tap sifter and shaker

Microscopic Analysis

It is generally accepted as the reference method since the granules are the only method of direct observation and measurement. The method is based on grain counting at the microscope by dimensioning the granules with reference circles or scales *(Saklara et al, 2000).*

The microscope image is two-dimensional and the grain shape naturally deviates from spherical. In order to solve the problems that may arise due to these reasons and to ensure standard conditions, different diameters of the geometric meanings are defined. For example; Feret's diameter of a shape is a commonly used measure in shape analysis. Traditional methods for estimation of Feret's diameter are performed on binary images; one of these diameters is selected and counted. The number of areas to be scanned in the microscope and the number of grains to be counted in these areas are not given a definite number. However, it is recommended that at least 100 different fields and a minimum of 6 grain counts at a glance be recommended for a good analysis *(Allen T., 1992).*

Images are obtained with an optical microscope in the system. These images are animated by the CCD camera and transferred to the image monitor. It is then divided into 512x480 pixels, taken into memory and converted back into analogue. The dimensioning of the grains is done after distinguishing the grains touching each other, eliminating the grains cut at the edge of the image and filling the gaps in the grains. The image processing, analysis and measurement system is shown in Figure 2.

Fig. 2 - Image processing, analysis and measurement system

In calculating the grain size distribution, grain volume is assumed to be proportional to the weight. In other words, the intensities of all the particles in the sample are considered equal. Census results are converted to cumulative values in percentage by weight.

Microscopic grain size analysis can lead to long-term distraction. Therefore it is time consuming and tiring. Operator's ability is more important in this method than others. It is also a difficulty in the method of placing the grains on the microscope slides homogeneously to prevent overtaking. The most advanced form of the microscope method is image analyzers. They work by scanning a photograph or a direct microscope image with a camera and electronically evaluating all information related to the particles.

Laser Diffraction Analysis

Laser diffraction is one of the most popular methods of characterizing particles by measuring the light they scatter *(Pan et al, 2017).v*The determination of grain size by laser diffraction analysis is based on the fact that the grains reflect the laser beam by breaking and the angle of refraction is inversely proportional to grain size. Also, many researches have used laser diffraction particle-size analysis to rapidly determine size distributions of samples in various stages of disaggregation *(Mason et al, 2011)*. In other words, large grains break the laser beam in small angle and small grains in big angle *(Allen T., 1992).* This is schematically illustrated in Figure 3.

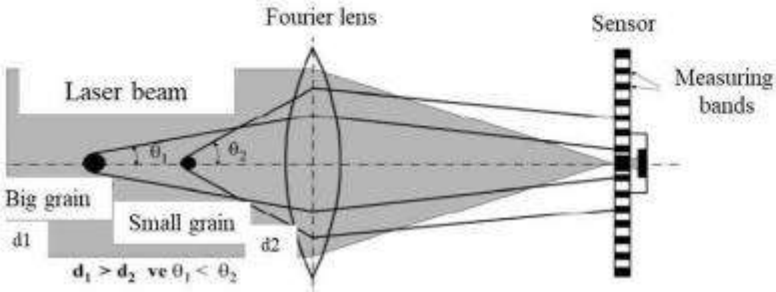

Fig. 3 - Inversely proportional relationship between the size of the grains and the angle of refraction of the rays

This method, which is becoming increasingly preferred and prevalent in determining the dimensions of the particles ranging from 0.05 to 2000 μ, is based on the principle of pumping the particles in water and disintegrant mixed into a particular cell by means of a suitable device and forcing the laser beams to pass. As can be seen in Fig. 4, laser diffraction devices usually come from three main parts: a laser unit, a sample preparation unit, and a computer *(Özer and Orhan, 2007).*

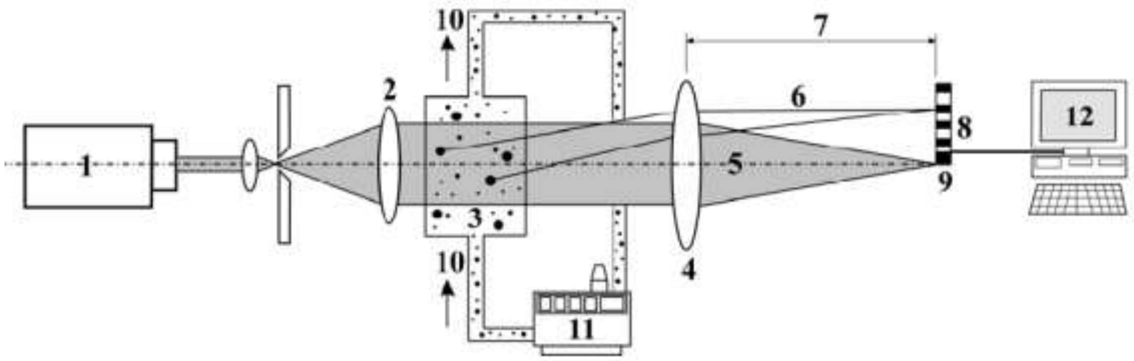

Fig. 4 - General view of the laser diffraction device

1. Laser beam, 2. Beam expander, 3. Measuring cell, 4. Fourier lens 5. Beam bunch 6. Beam of the same size, 7. Focal length of the lens, 8. Multi-element detector, 9. Center detector, 10. Flow direction of the suspension, 11. Sample preparation unit, 12. Computer

By means of the unit-connected pump, it sends the particles in the form of a mixture of water and disintegrant into a special cell. The particles, which are pumped continuously into this cell, pass through the front of the laser beam several times. This cell was placed in front of the laser beam and exactly in the center. At this time, due to the lens (Fourier transform lens) located in front of the sample cell and the measurement band (data collecting detector) located behind it, the reflected beams are collected by being broken from the granules and continuously evaluated. When the rays reflected by the particles are reflected on the measurement band by the computer running simultaneously, the average volumes are calculated and the particle size is determined

One of the most important features of the laser diffraction method is to calculate the particle size distribution based on the volume of the particles. With this feature, it differs from sieve analysis, hydrometer and pipette methods based on the weight of the grains. Another feature is the use of equivalent sphere theory. In other words, it calculates the diameter of the grain in equal volume with the grain *(Konert and Vandenberghe, 1997)*.

No matter how complicated and irregularly shaped the measured grains are, the volumes of the grains are calculated by means of the detector and the data collector, and this volume is presented in the form of the grain diameter by evaluating the equivalent round diameter. The most important advantages of this technique are; the weight of the granules used in the measurement and the specific mass are not needed. Because of the fact that the weight of the sample used in the experiment is avoided during the determination of the weight *(Rawle A., 1995)*.

Laser diffraction technique has become very popular in recent years. The main reasons for this are; short analysis time, operator independence, repeatability, ease of use, applicable to almost all kinds of samples.

Electrical Resistance Analysis

Electrical resistance analysis is an analysis of the relationship between the resistance of the granules to electrical current and their volume. The sample in an electrolyte is vacuumed into a glass tube with a circular opening at the bottom. The diameter of this opening may vary depending on the sample to be analyzed. Electric current is generated by the potential difference applied between the electrodes. As the grains pass openly, they show resistance to this electric current in proportion to their volume. This resistance difference determines the grain size. The electrical resistance diagram is given in Figure 5.

The main discussed aspects of the method are incorrect transition and end point determination. In theory, it is assumed that the granules passed one by one through the tube opening. In practice, however, granules can be passed over and over again in the form of a binary, a triple, or a cluster, and erroneous readings can be made. To prevent this, the raw data obtained at the end of the analysis are corrected by the probability equations. In the equations developed for this purpose, the equality which is proposed by Coulter firm and which is 10% of the possible faulty transition ratio is accepted as general.

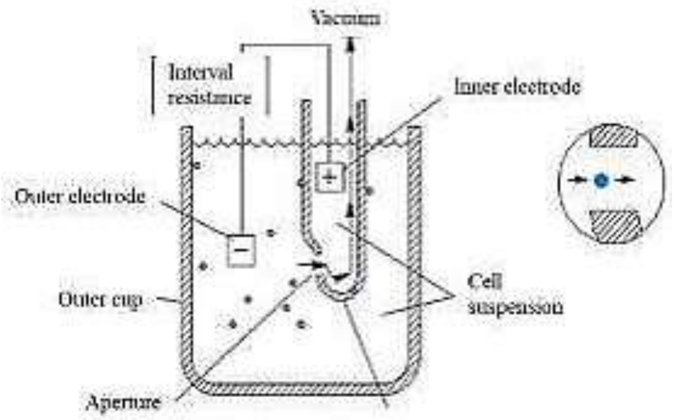

Fig. 5 - Electrical resistance working diagram

Another controversial endpoint concept is that the method is limited to temperature changes and electronic noise at the bottom of the measurement. Not all particles forming total volume can be counted by this method. The practical bottom dimension is 1 µm. The number or amount of grains under the lowest neck can be found using various interpolation techniques. The main idea in these techniques is based on the fact that the uncountable amount is subtracted from 100 *(Allen T., 1992).*

The most important advantage of the method is that the diameter found is the equivalent volume diameter. The effect of the particle shape on the measurement has been removed. Because the dimension statement is based on a geometric and physically strong point of view. In addition, providing a high resolution that is not available in other techniques is another important advantage *(Hildebrve and Row, 1995).*

Sedimentation Method

There are numerous models of sedimentation in fine particle suspensions, derived from or validated with physical measurements *(Benn at all, 2018).* The sedimentation process is generally based on the principle that solid particles are precipitated in a liquid or gaseous under the influence of gravity. It is applied to determine the size of small grains (<0.075 mm) that are too small to be identified by the screen and the percentages within the total mass. For this, a sample with an approximate weight of 50 g is sieved with a 0.075 mm sieve. This sample is poured into a sedimentation cylinder made of glass with a diameter of usually 6.5 cm and a height of 45-50 cm and water is added to complete the volume to 1000 cm^3. The precipitation cylinder is then agitated to bring the grain-water mixture to the same density throughout the cylinder at each point. The cylinder is then placed on a flat surface, allowing the particles to settle *(Liu and Evett, 1997)*. The precipitation cylinder is shown in Figure 6.

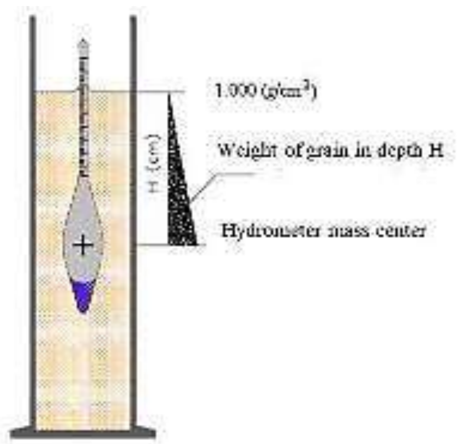

Fig. 6 - Hydrometer measurement technique

This idea, which is the basis of the sedimentation analysis, was investigated by *Stokes (1891)* and mathematically stated that there is a relationship between grain diameters and sedimentation rates. This expression, which emerges with some acceptance, is called the "Stokes Law" in the literature *(Rhodes M., 1998)* and it only examines the collapse of a single sphere in water.

A sphere with a diameter D is exposed to three different forces in a liquid with a viscosity η falling downward with a U limit speed *(Bardet J.P., 1997).* These are:

The weight of sphere $= \frac{1}{6}\pi D^3 \gamma_s$ (+) (1)

Drift resistance $= 3\pi \eta U D$ (-) (2)

Water buoyancy $= \frac{1}{6}\pi D^3 \gamma_w$ (-) (3)

The sphere falling downwards with the force of weight, drift resistance and buoyancy forces of water are counterproductive. For this reason, we can assume that the first (+) and the second (-) are marked as shown above. After a certain period of time, the sphere reaches a constant speed due to these two opposing forces which counteract the falling sphere by accelerating downwards, which means that the forces are in balance. We can show this with the following equation:

$$\frac{1}{6}\pi D^3 \gamma_s - \frac{1}{6}\pi D^3 \gamma_w - 3\pi \eta U D = 0 \tag{4}$$

By organizing this equation, we can express the speed of attraction as a function of the height of the diameter:

$$U = \frac{1}{18}\frac{\gamma_s - \gamma_w}{\eta} D^2 \tag{5}$$

equality emerges.

However, it should be known that this is only true for laminar flow conditions where the Reynolds number is less than 1 (Re <1). Since it is not possible to measure the velocity of the falling particles in the precipitation cylinder, if we want to arrange the above equation:

$$H = \frac{1}{18}\frac{\gamma_s - \gamma_w}{\eta} D^2 t \tag{6}$$

equality occurs.

However, since the parameter we want to measure in the laboratory environment is not the path or precipitation distance of the grains, but the diameter of the grains, we have equally obtained the fundamental equality we use to measure the diameters of the grains by repeating D by pulling it back (*Mason et. al., 2011*).

$$D = \sqrt{\frac{18\,\eta\, H}{(\gamma_s - \gamma_w)\, t}} \tag{7}$$

in Equality;

D = diameter of measured grains (mm),

H = water viscosity,

γs = unit volume weight of grains (g / cm3),

γw = water unit volume weight (g / cm3),

H = deposition distance of the granules (cm),

t = time from the beginning of the collapse process (min).

The most common methods used in the sedimentation method can be listed as follows *(Allen T., 1992).*

1) Hydrometer Method
2) Photostimulation method
3) Sedimentation Balance Method
4) Centrifugation Method
5) X-ray Absorption Method
6) Light Diffraction Method
7) Current Sensitive Region Method
8) Methods Based on Flow Dynamics
9) Drag Method

CONCLUSIONS

Our analysis technique differs according to the measurement range of the material. Furthermore, the definition of grain size in each analytical technique is determined by different methods.

- ✓ In sieve analysis, the measurement range is> 10 μm and the grain size is determined by the weight of the material passing through the sieve opening.
- ✓ In the microscope analysis; optic and electron microscopes respectively; the measurement range is 0.5-100 μm, 0.002-15 μm, and the grain size for both microscope types is determined according to Martin's, Feret's and equivalent circular diameter.
- ✓ Measurement range in laser diffraction analysis 0.05-2000 μm, specification of grain size according to equivalent spherical diameter,
- ✓ In electrical resistance analysis; the measurement range is 1-100 μm and the particle size is defined according to the equivalent spherical diameter,
- ✓ For sedimentation analysis is 1-75 μm and the grain size is defined according to the equivalent spherical diameter.

If the particle size analysis methods are compared; laser diffraction analysis is fast and easy to use, electrical resistance analysis has a high resolution, and sedimentation analysis is better than others in terms of grain size. Thus, the most reliable results are obtained in the electrical resistance method and the fastest analysis is obtained in the laser diffraction. Cost can vary greatly according to the manufacturer for the same technique. However, the most expensive method is again laser diffraction.

Since each method described above is based on a different physical property, it cannot be said that one has done a more accurate analysis than the others. It is also not possible to achieve such a result when the manufacturers are working on the development of these devices and the scientific researches carried out in these fields are taken into consideration.

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IMPROVING THE SEPARATION AND RECOVERING DEGREE OF FLOUR ADHERING TO BRAN, IN ORDER TO OBTAIN HIGH QUALITY FOOD PRODUCTS
/
ÎMBUNĂTĂŢIREA GRADULUI DE SEPARARE ȘI RECUPERARE A FĂINII ADERATĂ LA TĂRÂŢE ÎN VEDEREA OBŢINERII UNOR PRODUSE ALIMENTARE DE ÎNALTĂ CALITATE

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Keywords: finisher, self-cleaning, vibrator, extraction, flour, cereals, milling, bran.

ABSTRACT

The technical equipment frames within the strategy aiming to ensure the technical and material base, being designed to medium and large-capacity mills; it aims at recovering the flour adherent to bran, non-separated during the sieving process, in order to increase the extraction grade. This equipment can be also used in final stages of grist obtaining, for detaching the endosperm particles. In order to achieve this operation, high performance equipment, easy to maintain and operate, is necessary. One of the main equipment is the vibrator finisher with self-cleaning.

This equipment was achieved according to European integration strategy, being environmentally-friendly in compliance with current European and Romanian standards. Based on the above strategy, an equipment substantiated on modern technologies for increasing the economic efficiency, able to compete the abroad milling equipment, is necessary.

REZUMAT

Echipamentul tehnic se înscrie în strategia de asigurare a unei baze tehnico-materiale, este destinat morilor de medie şi mare capacitate şi are rolul de a recupera făina aderată la tărâţe, neseparată în procesul de cernere, în scopul măririi indicelui de extractive. Se poate utiliza cu rezultate bune şi în fazele finale de şrotuire, pentru desprinderea particulelor de endosperm legate de înveliş. Pentru acestea, sunt necesare utilaje cu un înalt grad tehnologic şi cu o importantă reducere a cheltuielilor de întreţinere şi exploatare. Unul din utilajele de bază este finisorul vibrator cu autocurăţire.

Realizarea acestui utilaj se înscrie în strategia de integrare europeană, având o mare importanţă prin faptul că asigură protecţia mediului şi a vieţii, în conformitate cu standardele actuale româneşti şi europene. Având la bază această strategie, este necesară realizarea de utilaje bazate pe tehnologii moderne de creştere a eficienţei economice, care să contrabalanseze ofertele de utilaje din import, destinate industriei morăritului.

INTRODUCTION

The main trend when designing and manufacturing equipment generally designed to food industry and milling and panification in particular, is to find the methods to improve the degree of separation of flour from wheat grains and to ensure appropriate transport, storing and extraction of flour from cells (*Banu C., 2002; Banu I., 2004; Istrate M. et al., 2001*).

By this equipment, the most modern milling technologies and technical equipment based on improving the degree of separation of flour by performing bran shaking and separation from endosperm waste, are boosted (*Găgeanu et al, 2006, 2007*). Within the finisher working process, the bran breaking is avoided and energy consumption is smaller than that of rollers (*Leonte M., 2001*).

The equipment designed to separate flour from bran for increasing the extraction degree with smaller energy consumption and reduced exploitation and maintenance expenses is of great help to relevant economic agents in the country. This equipment was designed according to national strategy, namely that of endowing with high performance equipment, eliminating the import, reducing the material and energy consumption, and finally competing to similar equipment manufactured by renowned companies (*Test report INMA, 2006*).

The vibrator finisher is a complex implement, designed to operate within the technological flow of milling enterprises of small, medium and big capacity.

MATERIAL AND METHOD

The vibratory finisher with self-cleaning is a high-performance equipment that separates the flour from bran, based on a modern technology of separating the powdery products. When designing the vibratory finisher with self-cleaning, a series of modern constructive solutions designed to obtaining superior technical and functional feats, have been adopted. Vibratory finisher with self-cleaning comprises the following component parts: frame, beater roller, sifting sieve, casing, feeding funnel, evacuating funnel, driving system.

Frame is a welded laminated-profile construction, on which are elastically mounted the other sub-assemblies, excepting the electric engine, that is jointly mounted.
Connection between the frame and vibratory movement parts is made by a support plate on which four helical compression springs are mounted.

Beater roller consists in an axle on which four beaters of special construction, that ensure the product beating separately from its coating, are fixed; they are demountable with possibility of adjusting the external diameter.

Sifting sieve consists in a cloth of nylon, perlon, or silk which meshes diameter frames within 180 µm and 236 µm, or metallic cloth with mesh diameter of 315 and 630 µm. An important characteristic is that the sieve changing is very rapidly and easily performed.

Casing is an insulated sheet welded construction with two special visiting windows and product feeding and evacuating bushings.

Feeding funnel is a sheet welded assembly endowed with a flange for coupling to upward equipment and with two arms for fixing on the equipment.

E**vacuating funnels** are welded constructions of special shape that ensure the evacuation of the two fractions: fine product and coarse product. The evacuation funnel designed to fine product is endowed with a coupling device for connecting to absorption system of installation where the equipment is integrated.

Driving system consists in an electric engine with flange on which axle is mounted a belt wheel ensuring the movement transmission to active part (beater roller).

The equipment is endowed with protection system that operates normally in terms of noise level.

Fig. 1 – Vibratory finisher with self-cleaning

Fig. 2 – Easy and rapid method of changing the sifting sieves

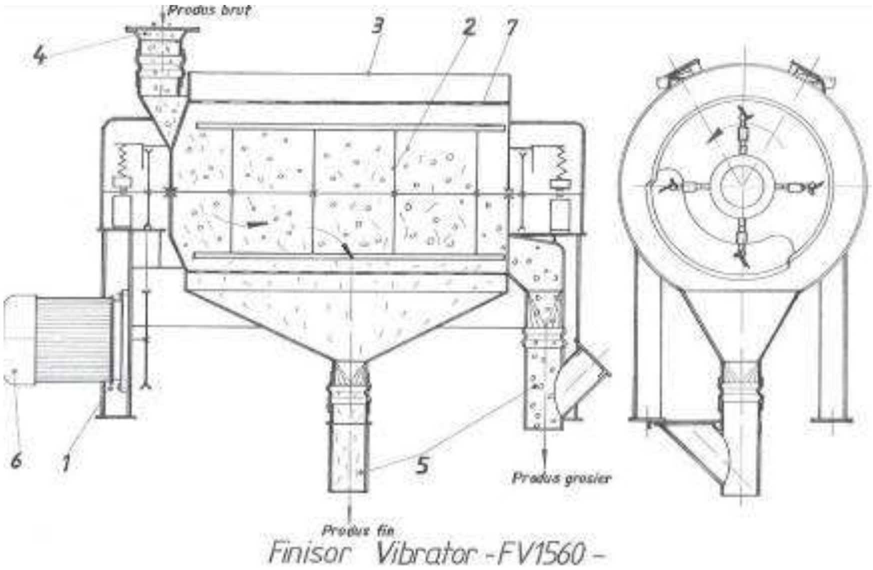

Fig. 3 – Installation scheme – Self-cleaning vibratory finisher – Components and working flow
1. Frame; 2. Beater roller; 3. Casing; 4 . Feeding funnel; 5. Evacuation funnel ; 6. Driving engine; 7. Sifting sieve

RESULTS

When establishing the technical and constructive solutions it was aimed to achieve a high-performance equipment characterised by: processing capacity in accordance with current requirements, specific energy consumption and reduced materials, easy access to active parts, easy maintenance and operation.

The equipment designing has based on the following premises:

- Possibility of recovering the flour adherent to bran, non-separated within the sifting process;
- Possibility of achieving a technical equipment endowed with self-cleaning system;
- Possibility of rapidly and easily changing the separation sieve;
- Possibility of using different types of beaters under different angles according to mixture to be separated;
- interchangeability .

Vibratory finisher working process runs as it follows: raw product enters the installation through a feeding funnel and reaches the fixed cylinder within the area where beater roller acts. Here, following the impact with beaters, it divides, namely the fine product passes through the sifting sieve and is evacuated through the evacuation funnel at the casing base, and the coarse product is transported in winding path from feeding to evacuation, being removed by a special funnel.

Number of revolutions of beater roller and amplitude of oscillating movement are synchronized, thus ensuring an efficient self-cleaning and a big capacity of equipment.

Fine product passing through the sieve is pushed by airflow into the pipe mounted on evacuation funnel of fine product. The pipe will be also coupled to the absorption system of installation.
Endowment with appropriate sifting sieve will be done on request of beneficiary.

Vibratory finisher with self-cleaning was designed as an insulated carcass construction, having the possibility to connect to absorption installation of technological flow for eliminating the dust pollution risk of working spaces.

Command system is placed in an ergonomic position so that the operator is in an orthostatic position.

Aesthetics of equipment is modern, the plane surfaces being endowed with average couplings and large dihedral angles between adjacent surfaces.

All the materials used in equipment manufacturing are environmentally-friendly.
Equipment is perfectly insulated for eliminating the environment pollution.

Technical and functional characteristics

- Working capacity:	- for flour	- kg/h	700
	- for bran	- kg/h	2000
- Maximum amplitude of oscillation		- mm	6
- Frequency of rotation		- rot/min	1500
- Installed power	- for flour	- kW	5.5

	- for bran	- kW	7.5
- Overall dimensions:			
- length	- for flour	- mm	1800
	- for bran	- mm	1850
- width		- mm	766
- height		- mm	1225
- Mass	- for flour	- kg	510
	- for bran	- kg	530

Table 1

Real parameters obtained in exploitation

No.	Requirement	M.U.	Manufacturing project expected	Testing achievements
1	Overall dimensions - length For flour For bran - width - height	 mm mm mm mm	 1800 1850 766 1225	 1800 1850 766 1225
2	Maximum amplitude of oscillation	mm	6	6
3	Frequency of rotation: - for flour - for bran	rot/min	 1500 1500	 1540 1535
4	Installed power -- for flour - for bran	 kW kW	 5.5 7.5	 5.5 7.5
5	Working capacity - For flour For bran	 kg/h kg/h	 700 2000	 708 2002
6	Specific energy consumption - for flour - for bran	 kWh/t kWh/t	 7.857 3.750	 4.594 2.636
7	Mass -- For flour For bran	 kg kg	 510 530	 509 529

Equipment technological endowment

Vibratory finisher for ground products was equipped with the following types of sieve cloth:
- sieve with hole diameter of ϕ=236 μm;
- sieve with hole diameter of ϕ=315 μm ;
- sieve with hole diameter of ϕ=630 μm.

Estimations on the equipment's technological effect

During the tests, samples were taken and determinations were made in terms of self-cleaning vibratory finisher technological effect for different working capacities and for the same technological endowment.

Fig. 4 – Product sifted on sieve with mesh of 236 μm

Fig. 5 - Product sifted on sieve with mesh of 315 μm

Fig. 6 – Product sifted on sieve with mesh of 630 μm

Fig. 7 – Refuse product on sieve with mesh of 630 μm

If we take into consideration that from the flour and bran mixture of test of 12.674 kg passing through the sieve of Φ=250 μm of mesh, processed for one minute, were obtained 0.356 kg flour and 12.318 kg bran, it results that a quantity of 2.81 % flour adherent to bran has obtained.

Performing the same operation, but making the sifting on sieve with mesh of 315 μm, out of the mixture of 26.873 kg, during one minute, 0.825 kg represented the product sifted and 26.048 kg the waste; therefore, a quantity of 3.07% has been recovered from flour adherent to bran.

By replacing the sieve cloth with another fabric of mesh of 630 μm and passing the mixture through it, for one minute, has obtained 2.411 kg flour (sifted) and 30.822 kg bran (refuse product), so an amount of 33.233 kg, namely 7.25% flour recovered.

Passing the refuse product from each sieve through laboratory similar sieves, is obtained a technological effect of 96.99 for sieve with Φ=250 μm. , 95.75 for sieve with Φ=315 μm and 90.502 for sieve with Φ=630 μm.

Table 2

Expected functional performances

Requirement	Solving method
Should separate the flour adherent to bran.	A cloth appropriate to separation was chosen.
Should protect the environment.	Finisher is endowed with joint coupling to absorpton installation.
Access to active parts	Finisher is endowed on both sides with visiting windows and easy access.
Possibility to adjust the amplitude (optimum amplitude).	Possbility of adding or taking out the weights necessary to obtain the inbalance.
Should prevent material cloggings	Equipment is endowed with wheel with eccentric and compression springs that ensure the vibration, and this way the sieve cleaning, thus, avoiding the clogging.

CONCLUSIONS

In Table 1 are presented the results of tests performed with vibratory finisher with self-cleaning.

During the tests of the equipment, it has found that adjustments and lubricating locations can be easily accessed, handling being very simple.

The electric engine appropriately operates and roller with beaters is dynamically balanced.

During the tests and at general checking of equipment state, it was concluded it has kept the specific settings and working parameters.

The tests results have confirmed the opportunity of constructive solutions chosen and technological endowment degree, thus achieving an efficient equipment with performances similar to the most recent relevant equipment at world level. This equipment ensures the diminishing of energy specific consumption, reduced maintenance and exploitation costs per ton of processed product.

So, the tests with VIBRATORY FINISHER WITH SELF-CLEANING have proved the following:

- modern constructive design of shaking system;
- technological endowment suitable to dimensions of meshes appropriate to equipment goal;
- technological joints for integrating the technological flow;.
- technological joints appropriate to feeding and evacuation system of processed product;
- appropriate electric couplings necessary to driving;
- technological and qualitative indexes according to manufacturing documents;
- simple technological adjustments, established in time;
- reduced energy specific consumption, diminished maintenance cost and easy exploitation;

- increased supply exportation ;
- improved working conditions by:
- easy adjustments, rapid service in case of daily or periodical maintenance;
- protection of environment, dust emanations at the working place and in atmosphere being prevented;
- reduced cost price comparing to prices of foreign companies producing milling equipment.

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ASPECTS REGARDING THE ANALYSIS OF THE STRESS IN FRONT LOADER COMPONENTS
/
ASPECTE PRIVIND ANALIZA SOLICITARILOR DIN COMPONENTELE ÎNCĂRCĂTORULUI FRONTAL

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Keywords: *equipment**,** front loader**,** SolidWorks, optimisation*

ABSTRACT
With the improvement of agricultural production, the volume of transport works has increased considerably. Inside livestock households and farms, the handling and transport of various materials (animal products, feed, manure, etc.) are important links of technological processes mechanization. Front loaders are the loading and unloading means used both in the field and on farms. The paper presents a CAE - Computer aided engineering analysis of the stress in the front loader components for two constructive variants. After the analysis of the results, the final shape of the component, the dimensions (length, thickness) and mass were determined. The applied mathematical model helps avoiding the over-dimensioning of the components by precisely determining the dimensions and minimizing the mass.

REZUMAT
Odată cu perfecţionarea producţiei agricole, volumul lucrărilor de transport a crescut considerabil. În interiorul gospodăriilor şi fermelor zootehnice, manipularea şi transportul diferitelor materiale (produse animaliere, nutreţuri, gunoi de grajd etc.) reprezintă verigi importante ale mecanizării proceselor tehnologice. Încărcătoarele frontale reprezintă mijloacele de încărcare-descărcare utilizate atât în câmp cât şi în ferme. În lucrare se prezintă o analiza CAE – Computer aided engineering a solicitărilor din componentele încărcătorului frontal pentru două variante constructive. În urma analizei rezultatelor s-a stabilit forma finală a componentei,dimensiunile (lungime, grosime) şi masa. Modelul matematic aplicat determină evitarea supradimensionării componentelor prin stabilirea cu precizie a dimensiunilor şi minimizarea masei.

INTRODUCTION
The development of agricultural production has influenced the volume of transport works that has grown considerably and in many agricultural processes transport is an integral part of works execution technology, (*Nedelcu et al., 2006*). Agricultural tractors are the main energy sources for agricultural works, while front loaders are one of the accessories for transportation and handling (*Ha and Kim, 2015, Mukhopadhyayet al., 2008*). They are used for pallet lifting, hay handling, manure gathering and soil levelling, etc.

Also, in agriculture are transported both agricultural products (seeds, fruits, vegetables, fodder, etc.) and various technological materials (*Nedelcu and Ciupercă, 2008*). The development of landscaping and land improvement works in agriculture also requires the transport and handling of a large volume of materials (earth, gravel, sand, etc.).

The large diversity of materials, with very diverse physical and mechanical properties, raises special problems regarding the construction of the loading and unloading means (*Popa et al., 2005*). The construction of the loading and unloading means is diversified, the materials and products handling equipment can be classified according to some of the criteria, the most frequently used being: the way the process takes place, the principle of operation, the type of working part, etc. (*Juan et al. 2018*).

Considering the conditions of the work process, the material loading and unloading equipment can be fixed and mobile (displaceable). Among the mobile machinery we can see the self-propelled machinery, which can be equipped with heat or electric motors, which ensure both the movement of the machines and the operation of the working parts. Lately, more and more loading and unloading machines are being used directly mounted on motor vehicles (trucks, tractors, self-propelled chassis).

Self-propelled loaders are made in two basic constructive forms: front loaders (with fixed boom and telescopic boom) and forklift loaders. Depending on the loader type, these systems may include additional links, forming a mechanical parallelogram (*Caoand Cleghorn, 2011*). In some solutions, an additional pair of compensation cylinders forms a hydraulic parallelogram.

Since tractors are the main mobile energy-efficient means of agriculture, a wide use has recently been gained by tractor-mounted loaders in the form of front loaders and forklifts. A particular feature of all these loaders is that the takeover of the material by the active parts of the loader is made directly by them, and no further intervention is required to ensure that the loader is powered. The highest universality of self-propelled loaders is represented by front loaders, the forklift loaders having a narrower range of use. Front loaders are characterized by being designed to be used both in the field and on farms, while forklift loaders are used more extensively in farm works and inside rooms (storehouses, animal shelters, etc.) (*Mihailescu et al., 1984, Voicu Gh., 2007*).

The development of a proper design process for a front loader can allow the system have an efficient behaviour regarding the operation and reliability of the machine (*Qian W., 2012*) and fuel consumption (*Bhola et al., 2018*).

MATERIAL AND METHODS

For the CAE - Computer aided engineering analysis of the lifting mechanism - lowering the bucket, the stresses acting on the components of the mechanism were determined when the soil response to excavation is maximum (R = 2700 daN). For this purpose, the Motion (SolidWorks 2017) module was used in the following working hypotheses:

- The mechanism is lowered to the maximum;
- The support frame of the mechanism is considered fixed;
- Hydraulic cylinders are locked (the machine is considered to move without lifting or lowering the bucket);
- Maximum force acts on the lower lip of the bucket (simplified hypothesis, most unfavourable case);

To eliminate redundancies, links were used between "Hinge" pieces and four rigid groups corresponding to the four hydraulic cylinders (Figures 1 a, b) were created.

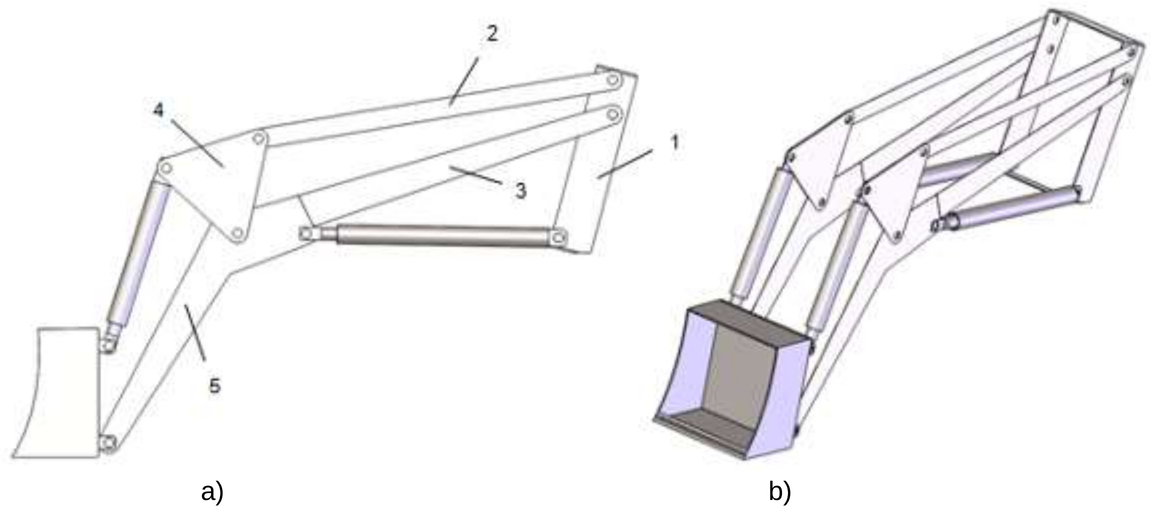

Fig. 1 - CAD model of the bucket drive mechanism:
a) lateral view; b) isometric view; 1- Support ; 2- Plate 1; 3- Plate 2; 4- Plate 3; 5- Back boom

The paper aims to optimize one of the components of the mechanism. For this purpose are exported to SolidWorks Simulation module the stresses resulting from the dynamic analysis for the "Back boom" component (Figure 2).

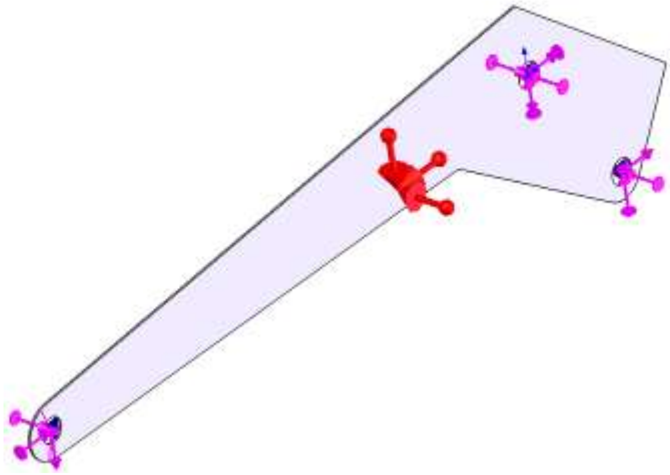

Fig. 2 - Stresses acting on back boom, determined by SolidWorks Motion module

Since the export procedure only considers stresses, the movement restraints have been redefined in the finite element analysis module so as to represent as accurately as possible the connections of the piece with the components of the mechanism as set out in the 3D model.

"BearingSupport"- type restrictions have been used to simulate the bearings.

The steel chosen for this component has the following main features:

- Elastic modulus: E=200000 MPa;
- Poisson's ratio: 0,29;
- Density: 7900 kg/m^3;
- Elastic limit: 352 MPa;
- Breaking limit: 420 MPa;
- Shear modulus: 77000 MPa.

12,833 advanced high-quality tetrahedron elements were used for the meshing with finite elements, resulting in a total of 26,789 knots (Figure 3). To improve accuracy, critical areas have been discretized with finer elements.

The mathematical model selected for solving is "Direct Sparse Solver", which offers the advantage of higher stability and superior accuracy, although slower. In the present case, as it is a piece with a low complexity, the calculation speed is not an impediment.

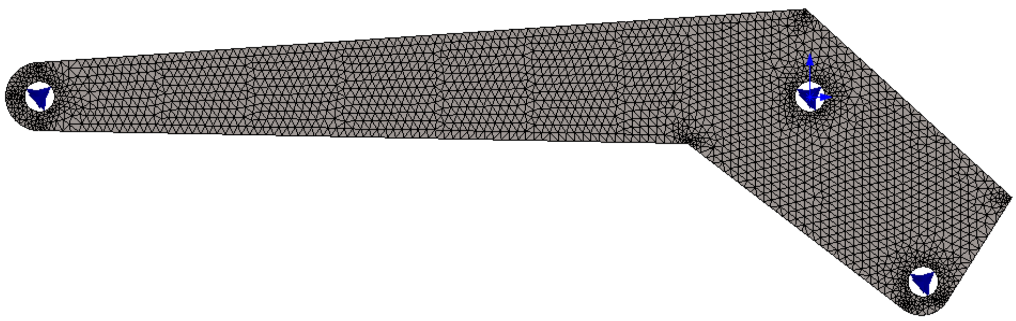

Fig. 3 - Finite element mesh of back boom

RESULTS

After the model was solved, the following results were obtained:

- The ultimate strength is: $\sigma = 151.1\ MPa$;
- Maximum deformation: 4.97 mm;
- Specific deformation: 5.64 x 10^{-4};

It can be seen that although the ultimate strength is about 43% of the elastic limit, the maximum deformation must be reduced by correspondingly varying the dimensional characteristics of the component. For this purpose, an optimization study will be carried out.

The following two conditions are required:

-The ultimate strength: 175 MPa;

- The component maximum deformation: 1mm, in the perpendicular direction, on its lateral side.

In order not to change the positions of the three bearings and the assembly area with the “Plate 2” component, the only sizes to be changed are the piece thickness and the lower side of 450 mm (Figure 4).

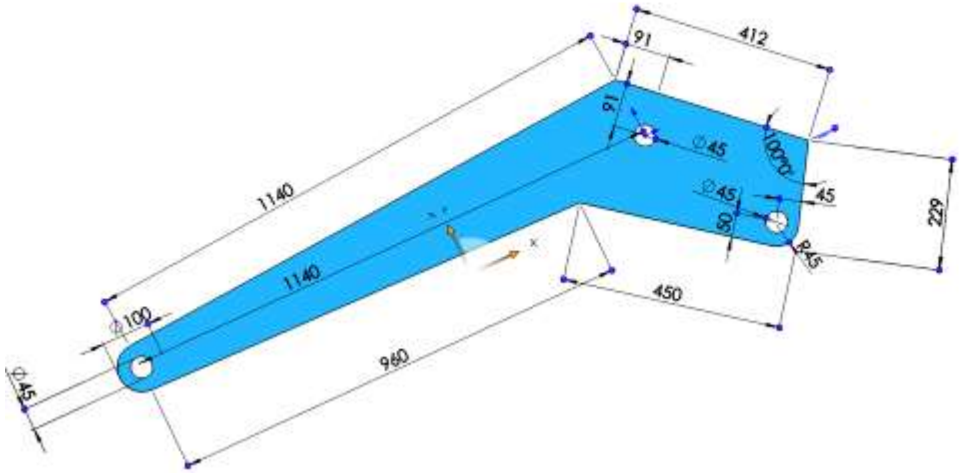

Fig. 4 - Location of dimensional parameters subject to optimisation

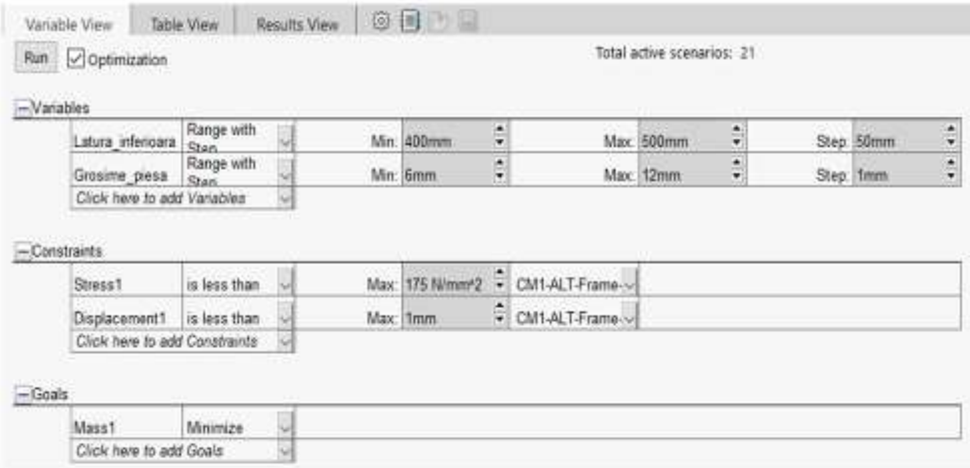

Fig. 5 - The variables, constraints and the objective of the optimisation process

In this context, in the first phase, an upper limit of 12 mm for the thickness of the material and a variation of the current dimension of 450 mm in the range of 400- 500 mm will be imposed.

The objective function will aim to minimize the mass of the piece (Figure 5).

For the optimum solution obtained after the first phase, the maximum displacement is 0.78 mm and the ultimate strength is 66 MPa. The thickness of the material increased to 8 mm and the lower side length to 500 mm. The mass of the optimum solution is 12.7 kg.

Variable View | Table View | Results View

23 of 23 scenarios ran successfully. Design Study Quality: High

		Current	Initial	Optimal (9)	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7	Scenario 8	Scenario 9	Scenario 10
Latura_inferioara		500mm	500mm	500mm	400mm	450mm	500mm	400mm	450mm	500mm	400mm	450mm	500mm	400mm
Grosime_piesa		12mm	12mm	8mm	6mm	6mm	6mm	7mm	7mm	7mm	8mm	8mm	8mm	9mm
Stress1	< 175 N/mm^2	44.2 N/mm^2	44.2 N/mm^2	66.1 N/mm^2	96 N/mm^2	93.4 N/mm^2	89.4 N/mm^2	83.3 N/mm^2	77.7 N/mm^2	75.9 N/mm^2	70.3 N/mm^2	65.6 N/mm^2	66.1 N/mm^2	63.2 N/mm^2
Displacement1	< 1mm	0.246mm	0.246mm	0.779mm	1.287mm	1.487mm	1.848mm	0.756mm	0.922mm	1.16mm	0.507mm	0.615mm	0.779mm	0.356mm
Mass1	Minimize	19.0599 kg	19.0599 kg	12.7066 kg	15.3436 kg	12.0454 kg	9.52994 kg	17.9009 kg	14.0529 kg	11.1183 kg	20.4581 kg	16.0605 kg	12.7066 kg	23.0154 kg

Fig. 6 - Partial view of case studies automatically determined by the optimization module, showing the optimal solution and non-compliant solutions - optimization phase I

In the second phase of optimization, the variation ranges of the piece thickness and the lower side dimension were reduced, around the optimal values, while the variation step was reduced as follows (Figure 7):

- Piece thickness: 7-9 mm, step 0.5 mm;
- Lower side dimension: 450-500 mm, step 10 mm.

Variable View | Table View | Results View

32 of 32 scenarios ran successfully. Design Study Quality: High

		Current	Initial	Optimal [12]	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7	Scenario 8	Scenario 9	Scenario 10
Latura_inferioara		500mm	500mm	500mm	450mm	460mm	470mm	480mm	490mm	500mm	450mm	460mm	470mm	480mm
Grosime_piesa		9mm	9mm	7.5mm	7mm	7mm	7mm	7mm	7mm	7mm	7.5mm	7.5mm	7.5mm	7.5mm
Stress1	< 175 N/mm^2	57.2 N/mm^2	57.2 N/mm^2	70.8 N/mm^2	77.7 N/mm^2	74.4 N/mm^2	77.1 N/mm^2	76.5 N/mm^2	73.7 N/mm^2	75.9 N/mm^2	72.5 N/mm^2	72 N/mm^2	69.1 N/mm^2	68.9 N/mm^2
Displacement1	< 1mm	0.552mm	0.552mm	0.944mm	0.922mm	0.962mm	1.094mm	1.053mm	1.105mm	1.16mm	0.747mm	0.781mm	0.817mm	0.857mm
Mass1	Minimize	14.2949 kg	14.2949 kg	11.9124 kg	14.0529 kg	13.4222 kg	12.817 kg	12.2333 kg	11.6679 kg	11.1183 kg	15.0667 kg	14.3809 kg	13.7325 kg	13.1071 kg

Fig. 7 - Partial view of case studies automatically determined by the optimization module, showing the optimal solution and non-compliant solutions - optimization phase II

Following the optimization phase II (Figure 7), the final values of the two dimensions having variable role are 500 mm (lower side) and 7.5 mm (piece thickness) respectively.

Maximum displacement of the optimal configuration, after the second phase, is 0.94 mm, the ultimate strength is 71 MPa and the mass is about 11.9 kg.

The final shape is shown in Figure 8.

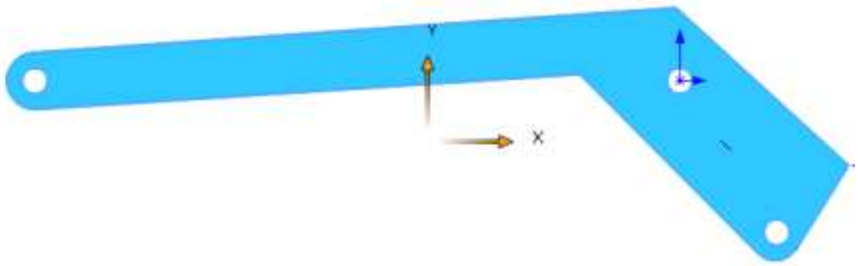

Fig. 8 - The final shape of the optimized component

CONCLUSIONS

To avoid over-dimensioning of the front loader components, the “Direct Sparse Solver” mathematical model of the SolidWorks software has been applied, which offers the advantage of precisely calculating the dimensions concerned under the conditions imposed by the designer:

-Stresses resulting from the dynamic analysis of the mechanism components were exported to the SolidWorks Simulation module;

-Displacement restrictions have been redefined in the finite element analysis module, while “BearingSupport”-type restrictions have been used to simulate bearings;

-The mathematical model selected for solving was “Direct Sparse Solver”, which offers the advantage of higher stability and higher precision;

-For optimizing the dimensions and establishing the final shape of the “Back boom”, two phases were carried out, the aim being to minimize the mass while maintaining the positions of the three bearings and the assembly area with the “Plate 2” component;

-In the first phase we obtained: the lower side length 500 mm, material thickness 8 mm, maximum displacement 0.78 mm, ultimate strength 66 MPa, optimum solution mass 12.7 kg.

-In the second phase for the final values of the two dimensions with variable role of 500 mm (lower side) and 7.5 mm (piece thickness) respectively, the maximum displacement obtained was 0.94 mm, the ultimate strength 71 MPa and the mass 11.9 kg;

- The final shape was considered the one obtained in the second optimization phase.

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CAPITALIZATION OF FATTY OIL OF LINUM USITATISSIMUM L. SEEDS (FLAX) OBTAINED BY COLD PRESSING FROM INDIGENOUS ECOLOGICAL CROP
/
VALORIFICAREA ULEIULUI GRAS DE LINUM USITATISSIMUM L. (IN) OBTINUT PRIN PRESARE LA RECE DIN CULTURA INDIGENA ECOLOGICA

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Keywords: *linseed oil, cosmetic, cold- pressed, indigenous, ecological crop*

ABSTRACT

Oil of Linum usitatissimum L. seeds, one of the gifts of nature, has great health benefits. They are an excellent source of alpha-linolenic acid, replenishing the beauty of the skin and being a hopeful ally for skin care.The paper presents the results of some experimental researches on the physicochemical and microbiological properties of linseed oil, six samples produced by Aroma Plant, Teleorman county, from six different batches of cold pressed oil obtained in the same conditions at the pilot scale. The oil is intended to be used as raw material in the production of cosmetics and body care products.

REZUMAT

Uleiul din seminţe de Linum usitatissimum L., unul dintre darurile naturii, prezintă mari beneficii pentru sănătate. Acesta este o sursă excelentă de acid alfa-linolenic, redând frumuseţea pielii şi fiind un aliat de nădejde pentru îngrijirea tenului. În lucrare sunt prezentate rezultatele unor cercetări experimentale privind proprietăţile fizico-chimice și microbiologice ale uleiului din seminţe de in, fiind luate în lucru șase probe produse de Aroma Plant, judeţul Teleorman, provenite din șase serii diferite de ulei presat la rece, obţinute în aceleaşi condiţii, la scară pilot. Uleiul se intenţionează să fie valorificat ca materie primă în obţinerea de produse cosmetice şi produse de îngrijire corporală.

INTRODUCTION

Cultivated around the world for over 7000 years, the *Linum usitatissimum L.* has been used for all sorts of affections. Cultivated first in Europe, being original from Egypt, the *Linum usitatissimum L.* oil and seed were used for thousands of years for medical purposes, especially for the treatment of various skin affections, cuts, burns and inflamed skin, but also with many other health benefits (*Abbas et. al., 2017; Akin DE, 2012; Gabr, 2017*).

The fatty oil of *Linum usitatissimum L.* seeds is mainly used for external use but also has internal utilities. The fatty oil of *Linum usitatissimum L.* seeds is an ally of beautiful skin, but successfully treats constipation, lowers cholesterol and relieves liver damage (*Gavazzi et, al., 2017; Gupta and Dash, 2017*). The fatty oil of *Linum usitatissimum L.* seeds are an exceptional source of omega 3 and omega 6 fatty acids, which protect the skin from ultraviolet radiation regardless of the season. These acids regulate the secretion of sebum so that, protected with linseed oil, the skin does not dehydrate and irritate, being shielded from the negative effect of ultraviolet rays.

The fatty oil of *Linum usitatissimum L.* seeds is a source of antioxidants that support hormonal balance, has an antimicrobial effect that makes it useful in treating acne-type diseases, but also against fungi and viruses. Because of these oil` s properties of *Linum usitatissimum L.* seeds, it is included in natural remedies for skin The fatty oil of *Linum usitatissimum L.* seeds is a very good source of vitamin A, which can be brought into the outer skin by lotions and creams containing linseed oil (*Paul-Victor et. al., 2017*). The fatty oil of *Linum usitatissimum L.* seeds are rich in: • vitamins and minerals, including group B vitamins, magnesium and manganese

• fiber-soluble and insoluble;
• phytonutrients, including several powerful antioxidants such as lignans;
• Omega 3 fatty acids, essential to fight inflammation.

• Insects are an excellent source of alpha-linolenic acid. Flaxseed oil is made up of 50% alpha-linolenic acid - five times more than walnut oil or canola, other important sources of alpha-linolenic acid;

• mucilage of galacturonic acid, rhamnose, galactose, xylose and arabinose;

• lipids formed from triglycerides of oleic, stearic, myristic and especially linoleic acids; protides;

• a cyanogenetic heteroside- linamaroside deducted in hydrogen cyanide, glucose and acetone;

• potassium and magnesium salts.

The fatty oil of *Linum usitatissimum L.* seeds plays the beauty of the skin and is a hopeful ally in the skin care routine. It contains vitamins, minerals, fatty acids Omega 3 and Omega 6 that have beneficial health effects. Acids regulate sebum secretion, protect the skin from dehydration and irritation. Facial fatty oil of *Linum usitatissimum L.* seeds treatments have antimicrobial effect on acne affected skin. They successfully reduce inflammation, irritation and redness of the skin. This oil can also be used as an adjuvant in treatments for eczema, cuperosis, psoriasis and burns (*Abbas et. al., 2017; Harsha et. al., 2015; Hobson and Deyholos, 2013; Rafieian-Kopaei et. al., 2017*).

The fatty oil of *Linum usitatissimum L.* seeds are composed of lignans (phytoestrogens with antioxidant action), they have antibacterial, antiparasitic and anti-cancer properties. This oil is rich in vitamin E, which brings many benefits to the skin. It reduces wrinkles and imperfections of the skin, it has a regenerative effect on the cells of the epidermis, reduces the spots that appear with aging and gives the maturity of the mature complexion (*Monica and Joseph, 2016*). Natural face treatments made with fatty oil of *Linum usitatissimum L.* seeds give good results for dry, dehydrated and wrinkled skin. The fatty oil of *Linum usitatissimum L.* seeds nourishes the skin and keeps the skin moist (*Monica and Joseph, 2016)*.

The fatty oil of *Linum usitatissimum L.* seeds also helps the skin produce more collagen, which is why its firmness is protected. This process is very important, because with the passage of time cells in the skin are more difficult to regenerate and thus the collagen degrades.

MATERIAL AND METHOD

1. Physical and chemical characterization of *Linum usitatissimum L.* oil, it is determined in accordance with the provisions of the European Pharmacopoeia, Edition 9.0 (*European Pharmacopoeia*).

*1.1. Description of Linum usitatissimum L. oil.*Clear oily liquid yellow or brownish - yellow, which by exposure to the air becomes blackish and gradually thickens with characteristic taste and smell.

1.2. Solubility determination. Very slightly soluble in ethanol, miscible with light petroleum.

It is determined in accordance with the provisions of the European Pharmacopoeia, Edition 9.0, Chapter IX.C. "Physical, chemical, physical and chemical determinations", Subchapter IX.C.1. "Solubility".

Equipment: -

Reagents: ethanol; light petroleum.

The working technique : Verification of the solubility of the pharmaceutical substances need not be performed in all the solvents provided in the monograph but it is necessary to control the solubility in at least two different solvents. If insoluble impurities are found, verify the solubility in the other solvents provided. When solubility is expected in solutions of acids or base solutions, the volume of the solution is not appreciated, because dissolution occurs as a result of a chemical reaction. Solubility can be expressed by specifying the volume of solvent (in milliliters) required to dissolve 1.0 gram of solid or 1.0 mL of liquid at 20 ± 20C. Different solubilities can also be expressed by means of expressions; in this case the solubility provisions refer to the temperature of 20 ± 50 °C. The meaning of these expressions is given below:

Table 1

Seminification of expressions used to express different solubilities

Expresions used	The volume of solvent (in milliliters) required to dissolve 1.0 gram of solid or 1.0 mL of liquid
Very slightly soluble	At most 1 mL
Slightly soluble	From 1 mL to 10 mL
Soluble	From 10 mL to 30 mL
Little soluble	From 30 mL to 100 mL
Very little soluble	From 100 mL to 500 mL
Hardly soluble	From 500 mL to 1000 mL
Very hardly soluble	From 1000 mL to 10.000 mL
Practically insoluble	More than 10.000 mL

The term "miscible" is attributed to liquid substances that can be mixed in any proportion with the intended solvent. When heat is released, the solubility of these substances is checked after two hours of dissolution, during which time the mixture is kept at 20 ± 20 ° C. The substance is considered to be dissolved when the solution examined with the naked eye still shows particles in suspension.

1.3. Identification of fatty oil by thin layer chromatography (CSS). It is determined in accordance with the provisions of the European Pharmacopoeia, Edition 9.0, Chapter 2.3 "Identification", subchapter 2.3.2. "Identification of fatty oils by thin-layer chromatography".

Equipment: -

Reagents: adsorbent: silica gel plates - octodecylsilyl R; sample to be analyzed: product as such; methylene chloride R; Test solution: dissolve approximately 20.0 mg (one drop) of the sample to be analyzed in 3.0 mL of methylene chloride R; glacial acetic acid R; acetone R; ethanol R; phosphomolybdic acid R;

- Reference solution: Dissolve 20.0 mg of in oil R in 3.0 mL of methylene chloride R;
- mobile phase I: ether R;
- mobile phase II: a mixture of methylene chloride R; glacial acetic acid R; acetone R, 20:40:50 (v / v / v);
- Spray solution: Phosphomolybdic acid R, 100,0 g / L, in ethanol R.

The working technique : On the starting line the following solutions are applied in the band, in points a and b:

a) 1.0 μL test solution;
b) 1.0 μL of reference solution.

Insert the chromatographic plate into the mobile phase I vessel and allow it to migrate 2 times over a distance of approximately 0.5 cm from the starting line. It is then developed twice using the mobile phase II at a distance of 8.0 cm from the starting line, remove the plate from the dish and let it dry in the air for a few minutes.

Detection: Spray the spray solution plate. Warm up for 3 minutes at 120^{0}C. Allow to cool in the air and examine in the light of day.

Results: The chromatogram obtained with the test solution shows the same spots as the chromatogram obtained with the reference solution.

1.4. Determination of iodine index

Note: The iodine index is the number in grams expressing the amount of halogen calculated as iodine fixed to 100 g of the sample to be analyzed.

Equipment: -

Reagents: glacial acetic acid R; chloroform R; cyclohexane R; iodine bromide solution R: dissolve 20 g of iodine bromide R in glacial acetic acid R and dilute to 1000 ml with the same solvent; potassium iodide R solution 100 g / L; water R; *iodide chloride solution R: dissolve 1,4 g of iodine chloride R in glacial acetic acid R and dilute to 100 ml with the same solvent; 0.1 M sodium thiosulphate solution;*

Starch solution R: 1 g of soluble R-starch is triturated with 5 ml of water R and, with stirring, 100 ml of hot water R containing 10 mg mercuric iodide R.

The working technique: If the product specification is not specified in the Product Technical Specification for which sample quantity to be used, Table 2 should be used:

Table 2

The amount of sample required to determine the iodine index

***Ii* supposed value**	**Amount of sample, g**
<20	1,0
20-60	0,5-0,25
60-100	0,25-0,15
>100	0,15-0,10

A sample of the analyte provided in the Technical Specification of the product is placed in a 250 mL flask fitted with a stopper and dried by rinsing with glacial acetic acid R in 15 mL of chloroform R. Very slowly, 25 mL of iodine solution R, close the vial and keep it in the dark for 30 minutes by shaking frequently. Add 10 ml of the 100 g / L solution of potassium iodide R and 100 ml of water R. Titrate with 0,1 M sodium thiosulphate solution R, vigorously stirring until the yellow color disappears. Add 5 ml starch solution R and continue titration with 0,1 M sodium thiosulphate solution R used for titration, (n1 = ml of 0,1 M sodium thiosulphate solution used to titrate the sample to be analyzed). Parallel and under the same conditions, a blank sample (n2 = ml of 0.1 M sodium thiosulphate solution used to titrate the control sample) is performed

Calculate the iodine index with the following formula:

$$Ii = 1{,}269\ (n_2 - n_1) / m$$

where:

n_1 = volume of sodium thiosulphate 0.1 M solution used to titrate the sample to be analyzed in ml;

n_2 = volume of sodium thiosulphate 0.1 M solution used to titrate the control sample, in mL;

1.269 = number of milligrams of iodine corresponding to 1 millilitre of sodium thiosulphate R 0,1 M solution;

m = sample mass to be analyzed, g.

1.5. Identification of components by chromatographic profile. It is determined according to the European Pharmacopoeia, Edition 9.0, Chapter 2.2. "Physical and Physicochemical Methods", subchapter 2.2.28 "Gas chromatography".

Equipment: - Gas chromatograph equipped with MS detector (mass spectrometer), splitting injector, automatic peak area integration system from the chromatograms obtained, 20000 R macrogol column (film thickness 0, 25 µm); l = 30 m; Ø = 0.25 mm; computer and printer.

Working conditions: carrier helium for chromatography R; flow: 1.5 mL/minute; division split of 1/60; Column temperature: 160^{0}C from 0-5 minutes, from 160^{0}C to 200^{0}C for 6-10 minutes, respectively 200^{0}C to 225^{0}C for 10 minutes; Injection port temperature: 220^{0}C, temperature of detector: 270^{0}C, injection volume: 1µL (for each solution).

Reagents: petroleum ether R; hydrochloric acid R in methanol, 0.5 M solution; water R; isooctane R; heptane R; anhydrous sodium sulfate R; sample to be analyzed: oil as such;

- *test solution:* weigh 0.1 g of the sample to be analyzed in a round-bottomed flask and dissolve in 5 mL of light petroleum R and 50 mL of hydrochloric acid R in methanol, 0.5 M solution. at reflux and stirring in the nest at about 65^{0}C for 1 hour (until no more drops of unleaded oil are observed). Project and pass into a separating funnel. The round bottomed flask with 30-40 mL of water R, then with 40 mL of isooctane R and add to the separating funnel. Wash the isooctane layer with water until the pH is neutral. Separate the isooctane layer, pass anhydrous sodium sulphate R to remove the water and filtrează.

- *reference solution A:* prepare a calibration mixture with the composition described in the European Pharmacopoeia, in force, Chapter 2.4.22. table 2.4.22.-1., the substances being dissolved in heptane R, as follows:

Mixed substances	**Amount, (%, m/m)**
Methyl laureate R	5
Methyl myristate R	5
Methyl palmitate R	10
Methyl stearate R	20
Methyl arachidate R	40
Methyl oleate R	20

The working technique: Inject 1 µL reference solution A and 1 µL test solution. Record retention times.

Resolution: minimum 1,8 of the peaks determined by methyl oleate and methyl stearate from the chromatogram obtained with the reference solution A.

Identification: localize the oil components in the sample to be analyzed by using the MS spectra library in the M / Z range: 40-450. Determine the percentage content of these components by the normalization procedure.

1.6. Determination of relative density (d_{20}^{20}). It is performed in accordance with the European Pharmacopoeia, Edition 9.0, Chapter 2.2., Physical and Physicochemical Methods, Subchapter 2.2.5, "Relative Density".

Equipment: analytical balance; pycnometer.

Reagents: water R. The working technique : Weigh the empty pycnometer, fill with water R at 200 ° C and weigh again. The difference between the mass of the water pycnometer R and the empty pycnometer is the mass of the water volume R at 200 °C (m 1). The pycnometer is emptied, dried, filled with the sample to be analyzed at 200 °C and weighed.

The difference between the mass of the liquid pycnometer and the empty pycnometer is the mass of the sample to be analyzed at 200 ° C (m). The accuracy of the determination is at the fourth decimal place.

$$d_{20}^{20} = \frac{m}{m_1}$$

where:

d_{20}^{20}=relative density;

m= mass of the sample volume, in grams;

m_1= mass of the water volume, in grams.

1.7. Determination of refractive index. It is performed in accordance with the European Pharmacopoeia, Edition 9.0, Chapter 2.2, "Physical and Physicochemical Methods", subchapter 2.2.6, "Refractive Index".

Equipment: refractometer.

The working technique : Examine the refractometer at a temperature of 20 ± 0.5 ºC at the wavelength of the sodium D radiation (λ = 589.3 nm). A few drops of the analyte liquid are brought between the two prisms of the refractometer that are tightly sealed and viewed through the eyepiece. There are two areas, one bright and the other dark, bounded by a separation line that must be clear. The boundary between the light and dark areas is exactly the point where the crosshairs are crossed. Read on the split scale the refractive index value, relative to the wavelength D of the sodium. The reading shall be carried out with an accuracy of three decimal places and, if appropriate, the fourth decimal place.

1.8. Determination of acidity index. It is performed in accordance with European Pharmacopoeia, Edition 9.0, Chapter 2.5, "Assays", subchapter 2.5.1, "Acid value", taking into account 5.0 g of the sample to be analyzed.

Reagents: alcohol (96%, v / v) R; ether R; petroleum ether (light petroleum R3); 0.1M potassium hydroxide saline; phenolphthalein R solution: 10 g / L in ethyl alcohol R (96% v / v);

The working technique: Dissolve 5.0 g of the sample to be analyzed in 50 ml of a mixture of equal volumes of ethyl dealcohol R and light petroleum ether previously neutralized with 0.1 M potassium hydroxide solution using 0.5mL phenolphthalein solution as indicator. If necessary, heat to about 90 °C to dissolve the sample to be analyzed. When the sample to be analyzed is titrated with 0,1 M potassium hydroxide until the pink color persists for at least 15 seconds.

Acidity index, $I_a = \frac{5{,}61 \; x \; V \; x \; F}{m}$

where:

I_a=acidity index;

V = the volume of 0.1 M potassium hydroxide used for titration in mL;

F = factor of 0.1 M potassium hydroxide solution;

M = mass of the sample to be analyzed, in grams;

5.61 = number of milligrams of potassium hydroxide corresponding to 1.0 mL of potassium hydroxide 0.1 mol / L in water.

1.9. Determination of index of peroxide. It is performed in accordance with European Pharmacopoeia, Edition 9.0, Chapter 2.5, "Assays", subchapter 2.5.5, "Peroxide value", considering 5.0g of the sample to be analyzed.

Reagents: chloroform R; glacial acetic acid R; saturated solution of potassium iodide R; water R; mercury iodine R; sodium thiosulfate, R, 0.01 M solution; Starch solution R: Stir 1.0g of soluble starch R with 5.0mL of water and stir gently to add this mixture to 100mL of boiling water R containing 10.0mg of mercuric iodide R.

The working technique: 5.0 g of the sample to be analyzed is placed in a 250 mL flask equipped with a stopper. Add 30 mL of a mixture of 2 volumes of chloroform R and 3 glacial acetic acid volumes R. Stir and add 0.5 mL of saturated potassium iodide solution R. Add 30 mL of water R and shake exactly one minute this moment.

Titrate with sodium thiosulphate R, 0.01 M solution, add the titrant a little and stir continuously until the yellow colour disappears. Add 5.0 mL of deamidone R solution and continue titration, stirring until the yellow colour of the solution is removed.

Prepare under the same conditions like a blank sample. The volume of sodium thiosulphate R, 0.01M used for titration of the blank sample shall not exceed 0.1 mL.

Index of peroxide, $I_p = \frac{10(n_1 - n_2)}{m}$

where:

I_p=index of peroxide;

n_1= volume of sodium thiosulphate, 0,01M solution used to titrate the sample to be analyzed in mL;

n_2= volume of sodium thiosulphate, 0,01M solution used to titrate the control sample in mL;

m= mass of the sample to be analyzed, in grams.

1.10. Determination of saponification index

It is performed in accordance with European Pharmacopoeia, Edition 9.0, Chapter 2.5 "Assays", subchapter 2.5.6. "Saponification value".

Equipment: it's not necessary.

Reagents: 0.5 M hydrochloric acid; ethanol (96%) R; potassium hydroxide R; phenolphthalein, solution R1: phenolphthalein R, 10 g / L in ethanol R; free aldehyde ethanol R: mix 1200 mL ethanol (96%) R with 5 mL of a 400 g silver silver nitrate solution R and 10 mL of 500 g / L cooled potassium hydroxide solution. Shake, leave for a few days rest and then filter. Distil the filtrate before use.

- 0.5 M alcoholic potassium hydroxide: dissolve 3 g of potassium hydroxide R in 5 ml of water R and dilute to 100 ml with ethanol free of ethanol R.

The working technique: To determine the amount of test sample to be considered, Table 3 is used.

Table 3

The amount of sample required to determine the saponification index

The supposed index *Is*	The amount of sample, g
<3	20
3-10	12-15
10-40	8-12
40-60	5-8
60-100	3-5
100-200	2,5-3
200-300	1-2
300-400	0,5-1

According to the Technical Specification and the above table, a sample quantity to be analyzed (m, g) is introduced into a 250 mL conical borosilicate flask equipped with a refrigerant. Add 25 mL of 0.5M potassium hydroxide solution in 90% ethanol, V / V and a few pieces of glass. It is mounted on the condenser and refluxed on a water basis for 30 minutes (unless otherwise recommended). Add 1 mL of phenolphthalein R1 solution and titrate immediately (still hot) with 0.5 M hydrochloric acid (n1 mL 0.5 M hydrochloric acid) until discoloration of the solution.

In parallel, a control sample (in 2 mL of 0.5 M hydrochloric acid) is performed.

Calculation:

$$Saponification\ index,\ Is = 28{,}05 \times (n_2 - n_1) / m,$$

In which:

28,05 = the amount of potassium hydroxide in mg corresponding to 1 ml of 0,5 M hydrochloric acid solution;

n_1 = = volume of 0,5 M hydrochloric acid solution used to titrate the sample to be analyzed in mL;

n_2 = the volume of 0,5 M hydrochloric acid used to titrate the control sample in ml;

m = the mass of the sample to be analyzed, in g.

1.11. Determining Content in Unsaponifiable Matters

It is performed in accordance with European Pharmacopoeia, Edition 9.0, Chapter 2.5 "Assays", subchapter 2.5.7. "Unsaponifiable matter".

Equipment: a reflux system; distillation plant; separation funnel.

Reagents: Potassium hydroxide R, 2.0 M alcoholic solution; R-ether, free of peroxides: anesthetic R; potassium hydroxide R, 30 g / L solution; Potassium hydroxide R, 0,1 M alcoholic solution; phenolphthalein solution; acetone R; water R.

The working technique: Inject a quantity of the sample to be analyzed according to the Technical Specification of the product into a 250 mL borosilicate pot and add 50,0 ml of potassium hydroxide R, 2,0 M alcoholic solution. Heats up 1 hour, rotating frequently. Cool to a temperature below 250 ° C and transfer the contents to a separating funnel with 100 ml of water R. Carefully shake the liquid and wash three times with 100.0 ml of free peroxide R . Combine the ether layers in another separating funnel containing 40.0 mL of water R, shake for a few minutes, allow to separate and remove the aqueous phase. Wash the ether layer R with 40.0 ml of water R each and then wash successively with 40.0 ml of potassium hydroxide R, 30 g / L solution and 40.0 ml of water R; repeat the procedure three times. Then wash the ether phase several times with 40.0 mL water R until it has no alkaline reaction in the presence of phenolphthalein. Transfer the ether phase into a vessel washing the separation funnel with R-free ether, peroxides. Pour the ether cautiously, add to the residue 6.0 mL of acetone R. Remove the solvent to air stream and dry at 100-105 ° C to constant weight. Cool in the desiccator and weigh it.

Calculation:

$$Unsaponifiable\ substances,\ \% = 100\ a / m_p$$

Where: a = mass of residue in g; mp = mass of sample to be analyzed in g;100 = correlation factor.

Residue the residue with phenolphthalein, dissolve in 20 ml of alcohol R and titrate with sodium hydroxide R, alcohol solution, 0,1 M.

Note: If the volume of sodium hydroxide, the 0,1 M alcoholic solution used is greater than 0,2 mL, then the separation layers are incomplete so that the weighed residue cannot be considered as "non-saponifiable matter". If in doubt, the test should be repeated.

1.12. Determination of the limit for heavy metals (Lead). It is carried out in accordance with the European Pharmacopoeia, Edition 9.0, chapter "Limit tests", subchapter "Heavy metals".

Equipment: Atomic absorption spectrophotometer in the flame.

Reagents: Test solution: The way to obtain the test solution is described in the Technical Specification of the Product; reference solution: a mixture of 10 mL standard plum solution (1 ppm or 2 ppm) and 2 mL aqueous solution of the analyte; blank solution: a mixture of 10 mL of water R and 2 mL of the aqueous solution of the analyte in accordance with the Technical Specification of the product; water R; sodium hydroxide R, 1.0 M solution; thioacetamide solution R: dissolve 40 g of thioacetamide R in 1000 ml of water R; glycerol R (85%);

- hydrochloric acid R, 70% (v / v) solution; sodium hydroxide R, dilute solution: dissolve 8.5 g of sodium hydroxide R in water R and dilute to 100 ml with the same solvent.
- pH buffer 3,5: dissolve 25,0 g of ammonium acetate R in 25 ml of water R and add 0,8 ml of hydrochloric acid R, 70% (v / v) solution. Adjust the pH if necessary with hydrochloric acid R or dilute ammonia R. Dilute with water R to 100 mL;
- thioacetamide reagent: To a 0.2 mL solution of thioacetamide R is added 1 mL of a mixture of 5 mL of water R, 15 mL, 1.0 M sodium hydroxide, 1.0 M solution and 20 mL glycerol R (85%), . It's running on the water bath for 20 seconds. Prepare before use.

The working technique: To each of the solutions (test solution, reference solution and blank solution) add 2.0 mL of buffer solution pH 3.5. Mix and add 1.2 mL of thioacetamide reagent R. Solutions are examined after 2 minutes.

System suitability: The reference solution has a slight brown color compared to the blank solution.

Results:

Any color of the test solution is not more intense than the reference solution. If the result is difficult to assess, filter the solutions through a 0.45 μm membrane.

Filtration is performed smoothly and uniformly by constantly pressing the piston. Compare the spot obtained with those solutions.

2. Microbiological Characterization of *Linum usitatissimum L.* oil

It is carried out in accordance with European Edition 9.0, Chapter 2.6.12."Microbiological Examination of Non-Sterile Products: Microbial Enumeration Tests" and Chapter 2.6.13.,"Microbiological Examination of Non-Sterile Products: Tests for Specified Micro-Organisms ".

2.1. Determination of microbial contamination of Linum usitatissimum L. Oil. Verification of microbial contamination consists in determining the total number of aerobic microorganisms (TAMC) and the total combined number of filamentous yeasts and fungi (TYMC), respectively the isolation and identification of specific micro-organisms *(Escherichia coli* and *Salmonella sp.).*

2.1.1. Determination of the total number of aerobic microorganisms (TAMC). It is carried out in accordance with European Edition 9.0, Chapter 2.6.12. "Microbiological Examination of Non-Sterile Products: Microbial Enumeration Tests ".

Equipment: Analytical Balance KERN EG 420 3 NM, Venticell 111Oven, Incucell 404 Incubator, Friocell 404 Incubator, Caloris TCR 140 Incubator, Hot air microbiological flow with Telstar AV 100 laminar airflow, Bacterial airflow microwave flow BSC-EN I-IV

Laboratory glassware: Petri dishes (Ø = 9 cm), 160/16 mm tubes, graduated pipettes of 1, 2, 5 and 10 ml with graduations of 0.5 and 0.1 ml, respectively, 100 mL graduated cylinders; 250 mL Erlenmeyer flasks, Stand. *Culture medium and solutions: Casein soybean hydrolyzate and soy (Casein soya bean digest agar), buffered sodium chloride and peptone buffer* pH = 7.00 (*buffered sodium chloride broth* pH = 7.0) *The working technique :* In a sterile Erlenmeyer flask, 10mL of product was added 1mL Polysorbate 80 (Tween 80) and suspended in 90mL *buffered sodium chloride and peptone buffer* pH 7.0 (pH 7.0). Homogenize well. The dilution is 1:10. In a sterile Erlenmeyer flask, 10mL of product was added 1mL Polysorbate 80 (Tween 80) and suspended in 90mL *buffered sodium chloride and peptone buffer* pH 7.0 (pH 7.0). Homogenize well. The dilution is 1:10.

Concurrently, negative control samples are carried out as follows: in 2 Petri dishes 10 to 15 ml *Casein and soybean hydrolyzate agar* are distributed and in 2 Petri dishes are dispensed 1 ml *Sodium chloride and peptone buffered saline* + 10-15 ml *Casein hydrolyzate and soybean hydrolyzate;*

The casein and soybean hydrolyzate plates are incubated for 3-5 days at 30-35^{0}C. Check the samples throughout the incubation period. For a proper evaluation, select the plots with no more than 250 colonies.

Count the developed colonies and make the arithmetic mean for each dilution. Calculate the total number of colony forming units / gram (UFC / mL divided by the number of dilutions performed.)

Interpretation of results:

The total number of aerobic microorganisms (TAMC) will be considered equal to the UFC average determined by the casein and soybean hydrolyzate medium. If UFC of yew and filamentous fungi are detected on this culture medium, they are considered in the total number of CFUs for this medium.

2.1.2. Determination of total combined yeast and filamentous fungi (TYMC). It is carried out in accordance with European Edition 9.0, Chapter 2.6.12 "Microbiological Examination of Non-Sterile Products: Microbial Enumeration Tests ".

Equipment: Analytical Balance KERN EG 420 3 NM, Venticell 111Oven, Incucell 404 Incubator, Friocell 404 Incubator, Caloris TCR 140 Incubator, Hot air microbiological flow with Telstar AV 100 laminar airflow, - Bacterial airflow microwave flow BSC-EN I-IV

Laboratory glassware: Petri dishes (Ø = 9 cm), 160/16 mm tubes, graduated pipettes of 1, 2, 5 and 10 ml with graduations of 0.5 and 0.1 ml, respectively 100 mL graduated cylinders; 250 mL Erlenmeyer flasks, Stand.

Culture medium and solutions:

- Sabouraud Agar Dextrose Agar (Sabouraud Agar with Dextrose) ;
- buffered sodium chloride and peptone buffer pH = 7.00 (buffered sodium chloride broth pH = 7.0)

The working technique: In a sterile Erlenmeyer flask, add 1mL of Polysorbate 80 (Tween 80) to 10mL of product and suspend in 90mL buffered sodium chloride and peptone buffer pH 7.0 (Buffered sodium chloride peptone broth pH = 7.0). Homogenize well. The dilution is 1:10. From this, serial dilutions (1: 100; 1: 1000, etc.) are prepared using sodium chloride and peptone buffer buffered as a diluent, pH = 7.0.

In each pair of 9 cm diameter Petri dishes, transfer 1 mL of each prepared dilution. For bacteria, add 10-15 mL Sabouraud Dextrose Agar (Sabouraud Agar) broth to each plate. The culture medium is liquefied and used when it reaches 45^{0}C.

Concurrently, negative control samples are carried out as follows: in 2 Petri dishes spread 10 -15 mL

Medium Sabouraud Agar with dextrose are distributed; 2 Petri dishes are dispensed 1 ml *Sodium Chloride Buffer and Peptone* + 10 -15 ml *Sabouraud Agar with dextrose;*

Sabouraud dextrose agar plates are incubated for 5-7 days at 20-25°C. Check the samples throughout the incubation period. For a proper evaluation, select the plots with no more than 250 colonies. Count the developed colonies and make the arithmetic mean for each dilution. Calculate the total number of colony forming units / gram (UFC / mL divided by the number of dilutions performed.)

Interpretation of results:

The total number of combined yeasts and filamentous fungi (TYMC) will be considered equal to the average UFC determined on the dewormed Sabouraud Agar medium. If UFC bacteria are detected on this culture medium, they are considered in the total number of UFCs developed on this medium.

2.1.3. Isolation and identification of gram-negative bacteria tolerant to biliary salts. It is carried out in accordance with European Edition 9.0, Chapter 2.6.13. "Microbiological Examination of Non-Sterile Products: Tests for Specified Micro-Organisms ".

Equipment: Analytical Balance KERN EG 420 3 NM, Venticell 111Oven, Incucell 404 Incubator, Friocell 404 Incubator, Caloris TCR 140 Incubator, Hot air microbiological flow with Telstar AV 100 laminar airflow, Bacterial airflow microwave flow BSC-EN I-IV.

Laboratory glassware: Petri dishes (Ø = 9 cm), 160/16 mm tubes, graduated pipettes of 1, 2, 5 and 10 ml with graduations of 0.5 and 0.1 ml, respectively 100 mL graduated cylinders; 250 mL Erlenmeyer flasks, Stand*. Culture medium and solutions:* Enterobacteria enrichment broth *(Enterobacteria enrichment broth – Mossel)*; Agar with red phenol, purple crystal, bile sieve and glucose *(Violet red bile glucose agar);* Casein soya bean digest broth *(Casein soya bean digest broth). The working technique:* In a sterile Erlenmeyer flask, add 10mL of Polisorbate 80 (Tween 80) to 10mL of product and suspend in 90ml *Casein soya bean digest broth*. Homogenize well. A 1: 10 dilution is obtained. It is homogenized and incubated at 20-25 ° C for 2-3 hours for the bacteria to pass through the exponential multiplication phase. From the obtained sample transfer 1mL to a sterile tube with Mossel enameling broth for *Enterobacteria enrichment broth (Mossel).* Incubate at 30-35^{0}C for 24-48 hours. Perform subcultures on Petri dishes with *Medium Agar with red phenol, purple crystal, bile salts and glucose* (*Violet red bile glucose agar).* Incubate at 30 - 35^{0}C for 24-48 hours. The product corresponds to the absence of colonies of gram-negative bacteria red or reddish.

2.1.4. Control of specific micro-organisms

2.1.4.1. Isolation and identification of Escherichia coli. It is carried out in accordance with European Edition 9.0, Chapter 2.6.13. "Microbiological Examination of Non-Sterile Products: Tests for Specified Micro-Organisms".

Equipments: Analytical Balance KERN EG 420 3 NM, Venticell 111 Oven, Incucell 404 Incubator, Friocell 404 Incubator, Caloris TCR 140 Incubator, Hot air microbiological flow with Telstar AV 100 laminar airflow, Bacterial airflow microwave flow BSC-EN I-IV

Laboratory glassware: Petri dishes (Ø = 9 cm), 160/16 mm tubes, graduated pipettes of 1, 2, 5 and 10 ml with graduations of 0.5 and 0.1 ml, respectively 100 mL graduated cylinders; 250 mL Erlenmeyer flasks, Stand

Culture medium: MacConkey Batch *(MacConkey broth);* MacConkey Agar *(MacConkey agar);* Casein soya bean digest broth *(Casein soya bean digest broth);* Triple sugar iron agar medium (TSI) (Triple sugar iron agar).

The working technique:

In a sterile Erlenmeyer flask, suspend 10mL of product in 90mL *Casein soya bean digest broth*. Homogenize well. A 1: 10 dilution is obtained. Homogenize and incubate at 30-35 °C for 18-24 hours.

Transfer 1 mL of the culture obtained in a sterile Erlenmeyer containing 100 mL of *MacConkey Broth*. Incubate at 42-44 ° C 24 - 48 hours.

If the culture medium becomes opalescent and the purple-yellow color turns yellow, subcultures are made on *MacConkey agar* plates. Incubate at 30-35ºC for 18-72 hours.

Interpretation: If colonies of Gram-negative bacteria of lactose and non-lactose red bacteria are suspected, the presence of *Escherichia coli* is suspected.

Confirmation of the presence of *Escherichia coli* is performed by biochemical tests by inoculation on Petri dishes with *Triple sugar iron agar (TSI). Escherichia coli* ferments glucose, lactose, saccharose and indole.

2.1.4.2 Isolation and identification of *Salmonella sp.*

It is carried out in accordance with European Edition 9.0, Chapter 2.6.13. "Microbiological Examination of Non-Sterile Products: Tests for Specified Micro-Organisms".

Equipments: Analytical Balance KERN EG 420 3 NM, Venticell 111Oven, Incucell 404 Incubator, Friocell 404 Incubator, Caloris TCR 140 Incubator, Hot air microbiological flow with Telstar AV 100 laminar airflow, Bacterial airflow microwave flow BSC-EN I-IV, Refrigerated RD33C refrigeration unit, Systec V95 autoclave, Raypa autoclave.

Laboratory glassware: Petri dishes (Ø = 9 cm), 160/16 mm tubes, graduated pipettes of 1, 2, 5 and 10 ml with graduations of 0.5 and 0.1 ml, respectively 100 mL graduated cylinders; 250 mL Erlenmeyer flasks, Stand.

Culture medium and solutions:

- *Rappaport Vassiliadis Salmonella enrichment broth;*
- *Xylose, lysine, deoxycholate agar;*
- *Casein soya bean digest broth.*

The working technique: In a sterile Erlenmeyer flask, suspend 10 mL of product in 90 mL *Casein soybean bean digest broth*. Homogenize well. A 1: 10 dilution is obtained. It is homogenized and incubated at 30-35 ° C for 18-24 hours. Transfer 0.1 mL of the culture obtained to a test tube containing 10 mL of *Rappaport Vassiliadis Salmonella enrichment broth*. Incubate at 30-350C for 18-24 hours. Perform subcultures on Petri dishes with *Xylose, lysine, deoxycholate agar* medium. Incubate at 30 - 35^{0}C for 18 - 48 hours.

Interpretation: Possible existence of the micro-organism *Salmonella sp.* is indicated by the presence of well-developed red colonies with the optional colored black center.

Confirmation is performed by biochemical tests. *Salmonella sp*. fermentase glucose, optional lactose, does not produce indole.

Aglutinase with polyvalent and group anti*Salmonella* sera.

RESULTS

To conduct the study, there have been taken into action six samples of flaxseed oil (*Linum usitatissimum L.*), produced by S.C. AROMA PLANT S.R.L. Furculeşti, Teleorman county, (in the south – east of Romania) which are derived from six different batches of fatty oils, obtained under the same conditions at the pilot scale, namely:

- I1= sample of vegetable oil obtained by cold pressing of flaxseed (*Linum usitatissimum L.*), Batch 007.05.17, Expires 05.2019;
- I2 = sample of vegetable oil obtained by cold pressing of flaxseed (*Linum usitatissimum L.*), Batch 008.05.17, Expires 05.2019;

- I3 = sample of vegetable oil obtained by cold pressing of flaxseed (*Linum usitatissimum L.*), Batch 009.05.17, Expires 05.2019;
- I4 = sample of vegetable oil obtained by cold pressing of flaxseed (*Linum usitatissimum L.*), Batch 010.05.17, Expires 05.2019;
- I5 = sample of vegetable oil obtained by cold pressing of flaxseed (*Linum usitatissimum L.*), Batch 011.05.17, Expires 05.2019;
- I2 = sample of vegetable oil obtained by cold pressing of flaxseed (*Linum usitatissimum L.*), Batch 012.05.17, Expires 05.2019.

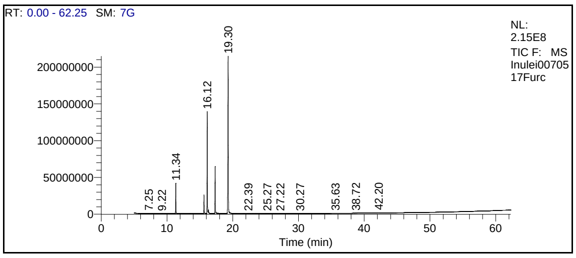
The results obtained in the physico-chemical analysis of samples of *Linum usitatissimum L.* obtained by cold pressing are shown in the table below:

Table 4

The results obtained in the physico-chemical analysis of flax oil (*Linum usitatissimum L.*), samples I1, I2 and I3

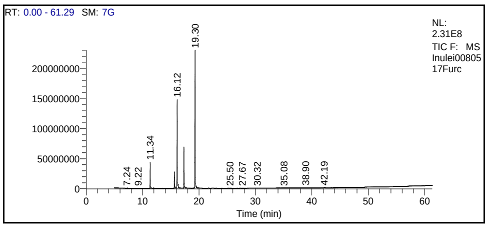
No.	Characteristics	Admissibility limits	*Sample I1*	*Sample I2*	*Sample I3*
1.	Description: - appearance - colour - smell - taste	*-oily, clear liquid, which at -20^{0}C becomes a viscous mass.* *- yellowish or brownish-yellowish color, which, by exposure to the air, becomes blackish and gradually becomes rough. Cooling to 20^{0} °C becomes a soft mass.* *-characteristic* *-characteristic*	fulfils fulfils fulfils fulfils	fulfils fulfils fulfils fulfils	fulfils fulfils fulfils fulfils
2.	Solubility	- very slightly soluble in ethanol, miscible with light petroleum	fulfils	fulfils	fulfils
3.	Identification, A: - fatty oils (CSS) B: - iodine index C: - chromatographic profile	positive 160-200 positive	fulfils 176 fulfils	fulfils 176 fulfils	fulfils 180 fulfils
4.	Relative density, d_{20}^{20}	0.900 – 0.940	0.916	0.925	0.915
5.	Refraction index	1.470-1.490	1.479	1.482	1.480
6.	Acidity index, max	4.5	1.5	1.44	0.74
7.	Iodine index	160-200	176	176	180
8.	Index of peroxide, max	15.0	0.92	1.9	2.8
9.	Saponification index	188-195	192	192	191
10.	Unsaponifiable substances, % max	1.5	0.3	0.3	0.2
11.	Fatty acids composition: - saturated fatty acids with the C chain less than 16 atoms, % max - palmitic acid, %. -palmitoleic acid, %, max. - stearic acid, %, - oleic acid, %. - linoleic acid, % - linolenic acid, % - arachidic acid, %, max.	1.0 3.0-8.0 1.0 2.0-8.0 11.0-35.0 11.0-24.0 35.0-65.0 1.0	<0.01 6.0 <0.01 4.27 24.16 11.64 51.47 0.1	<0.01 6.02 0.11 4.31 23.89 12.76 51.24 0.1	<0.01 5.75 <0.01 4.11 24.26 12.66 51.71 008
12.	Heavy metals -Lead (Pb), ppm, max.	5.0	< 5.0	< 5.0	< 5.0

The chromatographic profile of *Linum usitatissimum L.*– sample I1, sample I2, sample I3 is represented in Figures 1, 2 and 3.



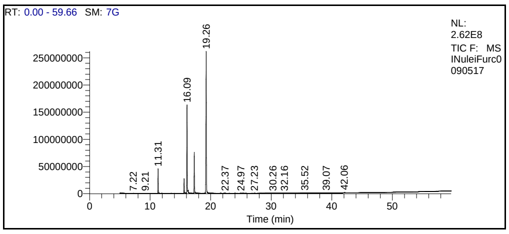
No.	Compound name	RT	Area %	Peak Area	Peak Height	S/N
1.	Palmitic C16:0	11.34	6.00	136310483	37242853	28043.68
2.	Stearic C18:0	15.64	4.27	97012407	23248525	17504.52
3.	Oleic C18:1	16.12	24.16	548878869	129433956	97463.12
4.	Cis Vaccenic	16.29	1.04	23651203	4536974	3416.32
5.	Linoleic γ C18:2	17.33	12.64	287190429	60415829	45492.82
6.	Linoleic α C18:2	17.69	0.13	2844214	505406	380.57
7.	Linolenic α C18:3	19.09	0.08	1872179	419752	316.07
8.	Linolenic γ C18:3	19.30	51.47	1169061161	205214594	154525.56
9.	Arahic C20:0	21.65	0.10	2199693	269380	202.84
10.	Ricinoleic	42.19	0.11	2508891	263720	198.58

Fig. 1 – Chromatogram of *Linum usitatissimum L.*– sample I1



No.	Compound name	RT	Area %	Peak Area	Peak Height	S/N
1.	Palmitic C16:0	11.34	6.02	150619375	39164633	28004.56
2.	Palmitoleic C16:1	11.91	0.11	2694795	521692	373.03
3.	Stearic C18:0	15.64	4.31	107818480	24968451	17853.62
4.	Oleic C18:1	16.12	23.89	597710526	136888098	97881.44
5.	Cis Vaccenic	16.28	1.34	33476134	5850779	4183.58
6.	Linoleic γ C18:2	17.32	12.76	319174300	64656529	46232.47
7.	Linoleic α C18:2	17.69	0.15	3750675	619588	443.03
8.	Linolenic γ C18:3	19.30	51.24	1281997471	219827726	157187.18
9.	Arahic C20:0	21.65	0.10	2391571	293534	209.89
10.	Ricinoleic	42.18	0.09	2328131	231882	165.81

Fig. 2 – Chromatogram of *Linum usitatissimum L.*– sample I2



No.	Compound name	RT	Area %	Peak Area	Peak Height	S/N
1.	Palmitic C16:0	11.31	5.75	157786819	41199716	31240.46
2.	Palmitoleic C16:1	15.61	4.11	112664052	25296856	19181.82
3.	Stearic C18:0	16.09	24.26	665191516	151362440	114773.43
4.	Oleic C18:1	16.25	1.06	28984913	5447448	4130.63
5.	Cis Vaccenic	17.28	12.66	347044282	71331490	54088.45
6.	Linoleic γ C18:2	17.66	0.11	3112227	600224	455.13
7.	Linoleic α C18:2	19.04	0.08	2114931	448265	339.91
8.	Linolenic γ C18:3	19.26	51.71	1417847942	249714589	189350.81
9.	Arahic C20:0	21.60	0.08	2168900	289280	219.35
10.	Ricinoleic	42.06	0.18	5067467	383070	290.47

Fig. 3 – Chromatogram of *Linum usitatissimum L.*– sample I3

The results obtained in the microbiological analyzes of the *Linum usitatissimum L.* oil are shown in Table 5.

Table 5

The results obtained in the microbiological analyzes of the *Linum usitatissimum L.* oil **– samples I1, I2, I3, I4, I5 and I6**

Crt. No.	Characteristics	Admissibility limits	Results for *sample I1*	Results for *sample I2*	Results for *sample I3*
1	Microbial contamination: -Total number of aerobic microorganisms (TAMC), UFC/mL, max -Total number of yeast and filamentous fungi combined (TYMC), UFC/mL, max. - Gram negative bacteria tolerant to biliary salts, UFC/mL, max. -*Escherichia coli*/mL -*Salmonella sp./25* mL	1×10^4 1×10^2 1×10^2 absent absent	<10 <10 <10 absent absent	<10 <10 <10 absent absent	<10 <10 <10 absent absent

CONCLUSIONS

As it can be seen from the Tables and graphic representations above: As can be seen from the above tables and graphs, all six samples of cold-pressed *Linum usitatissimum L.* oil are within the admissibility limits of the European Pharmacopoeia, edition 9.0. The parameters "acidity index", "peroxide index" and "unsaponifiable substances" record values below the admissible limits. Parameters "saponification index", "iodine index", "refractive index" and "relative density" have oscillatory values between the two admissible limits. With regard to the chromatographic profiles of the samples analyzed, *Linum usitatissimum L.* oil has a low linoleic acid content (for example, sample I1, for Series 007.05.17, shows 11.64% linoleic acid, which is close to the minimum limit accepted). Stearic acid also has a low percentage (for example, the sample of the 012.05.17 series has a stearic acid content of 3.69%). However, linolenic acid content is close to the maximum admissible limit (the highest percentage is registered for sample I6 - Series 012.05.17, of 52.19%, under the maximum admissible limit of 65%). Values obtained from the microbiological analysis of *Linum usitatissimum L.* oil show that it is of intentional quality and safety, subject to the admissibility limits laid down by the European Pharmacopoeia, the edition in force concerning the quality of the natural product of vegetable plant origin, view of microbial contamination. All the results obtained qualify this product as a very important natural source of raw material for the cosmetics and body care industry.

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PHYSICO-CHEMICAL AND MICROBIOLOGICAL CHARACTERIZATION OF ARGAN (*Argania spinosa L.*) OIL - RAW MATERIAL IN COSMETICS INDUSTRY / *CARACTERIZAREA FIZICO-CHIMICA SI MICROBIOLOGICA A ULEIULUI DE ARGAN* (*Argania spinosa L.*) *– MATERIE PRIMA IN INDUSTRIA COSMETICA*

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Keywords: *argan oil, cosmetics, cold- pressed, vitamin E, Ʊ3 and Ʊ6*

ABSTRACT

Natural product with precious virtues, Argan oil (Argania spinosa L.) is a great help for beauty, being the vegetable oil most rich in vitamin E, Ʊ$_3$ and Ʊ$_6$ helping to treat and prevent some of the most important problems of the skin. The paper presents the results of some experimental researches on the physico-chemical and microbiological properties of Argan oil, being taken into action three samples produced by a Moroccan company and coming from three different batches of cold pressed oil, obtained under the same conditions at the pilot scale. The oil will be used in the production of cosmetics and body care products with increased effectiveness and efficiency.

REZUMAT

Produs natural cu preţioase virtuţi, uleiul de argan (Argania spinosa L.) este un ajutor de nădejde pentru frumuseţe, fiind uleiul vegetal cel mai bogat în vitamina E, Ʊ3 si Ʊ6, contribuind în tratarea și prevenirea unora dintre cele mai importante probleme ale pielii. În lucrare sunt prezentate rezultatele unor cercetări experimentale privind proprietăţile fizico-chimice si microbiologice ale uleiului de argan, fiind luate in lucru trei probe produse de o companie din Maroc şi provenite din trei serii diferite de ulei presat la rece, obţinute în aceleaşi condiţii, la scară pilot. Uleiul va fi valorificat în obținerea de produse cosmetice și produse de îngrijire corporală cu eficacitate și eficiență crescută.

INTRODUCTION

Argan is best known for its oil used by berber females for skin, hair and nail care and is found in hundreds of different beauty recipes.

Normally, argan oil is obtained from the seeds of *Argana spinosa L.,* native to Morocco, growing in restricted areas (in the Southwest of Morocco, Essaouira-Agadir), in need of specific climatic conditions. Women who work in oil preparation are also responsible for harvesting the fruit. Once harvested, the fruits are dried and peeled like nuts. That peel is cleaned of each fruit and remains an acorn. That hole is broken by the cooperative workers, but so that the core does not grow. The shells are removed carefully before placing the seeds in the basket in which they are collected. [10-13, 19].

Fig. 1 – Obtaining argan oil by Moroccan women by squeezing saplings argan fruit

Cold pressing of the kernels produces a high quality biological and nutritional oil with remarkable properties that keeps intact all the active principles of the kernel rich in polyunsaturated essential fatty acids, tocopherols, phenolic antioxidant compounds and sterols.

Argan oil is a great help for health and beauty. [14, 15, 18].

Beyond the many miraculous effects on the beauty of women, argan oil makes a full contribution to treating and preventing some of the most important skin problems.

Benefits of Argan oil [5-7]:

- *On the hair* - Argan oil is often called golden liquid by beauty experts because of the positive effects it has on maintenance, beauty and hair health. Its properties are similar to jojoba oil that can turn dry, tangled and fragile hair into one with opposite properties.[16]

Some of the clear and recognized advantages that argan oil has on hair are:

- penetrates the pores of the hair and improves its elasticity;
- hydrating and nutrients provided by natural argan oil contribute to healthy hair growth;
- natural antioxidants present in argan oil strengthen the hair and repair damaged hair membrane;
- Argan oil is recommended for the type of hair that is difficult to comb, as it restores the smoothness of the hair, making it easy to comb and trim;
- contains vitamin E, which is a fabulous substance for hair treatment of any type; vitamin E has positive effects on natural regeneration and hair repair;
- is a direct source of nutrients essential to the health of hair and pore, thanks to the rich content of unsaturated fatty acids, omega-3 and omega-9, which are able to treat including brittle hair and hair spikes Strengthening hair structure of proteins;
- Argan oil is the right choice for treating and repairing damaged, dry hair, affected by aggressive environmental factors and excessive hair styling.
- *On the skin:* The advantages of using Argan oil are:
- It has moisturizing and microbial properties, with qualities much larger than a simple moisturizing lotion as it does not contain cholesterol; argan oil is more effective than other natural skin moisturizing substances, such as shea butter or olive oil, due to its high fatty acid content.
- Helps restore natural skin pH.
- helps to wrinkle the wrinkles and gives the skin elasticity.
- regulates the release of sebum in the case of oily skin.
- it is useful in treating dry skin.
- fades and participates in the healing of spots and pustules caused by acne or varicella.
- due to its ability to neutralize free radicals, it plays an important role in the treatment of eczema, acne and psoriasis.
- it has the property of regenerating the skin by revitalizing cell functions, preventing premature aging caused by pollution, smoking, excessive exposure to sun, etc.
- By applying argan oil to the nails, they are hardened, so it is recommended for treating brittle nails.
- Oil also helps to reduce skin inflammation and irritation. Pregnant women can apply argan oil to the body to prevent stretch marks.
- Make-up based on minerals tends to dry the skin; this problem can be avoided by masking the skin with 1-2 drops of argan oil before applying make-up.

In short, the benefits of skin argan oil are: prevents moisture loss in the skin; blurred wrinkles; prevents aging of the skin; stimulates the regeneration of skin cells; reduce scars; provides skin elasticity; prevents stretch marks; has tonic properties; helps cure eczema and psoriasis.

Argan oil not only moisturizes but also gives the skin a youthful glow and reduces the visibility of wrinkles. The antioxidant effect of argan oil makes it the most effective anti-aging product. Reface the elasticity of the skin and leave it softer. The best way to apply argan oil for an anti-aging effect is to massage a few drops directly onto the face and neck before bedtime. The oil acts as a moisturizing agent and anti-aging agent, two in one. Argan oil is used to soothe skin diseases such as acne, psoriasis, eczema, dry skin. It can also be used successfully to prevent stretch marks.

Argan oil is used with good results in treating acne. Where many oils and moisturizers can accentuate skin problems such as acne, argan oil soothes the affected skin portion and helps heal it. Acne is often the result of an oily skin. Argan oil helps to balance the skin by providing the necessary hydration.

Argan oil also contains antioxidants that help restore damaged cells and reduce inflammation. Applying only a few splashes of argan oil to the skin affected by acne after facial washing provides the necessary moisture, nutrients having direct access to clean, dry skin. Massaging gently and repeating the process twice a day can help treat a mild form of acne and balance an oily or dry skin.

Argan oil is considered one of the most valuable natural health remedies. Beyond the many miraculous effects on women's beauty, argan oil makes a full contribution to treating and preventing some of the most important skin diseases, arthritis or cancer. [2-4].

MATERIAL AND METHOD

2. Physical and chemical characterization of argan oil, it is performed in accordance with the European Pharmacopoeia, Edition 9.0, Chapter 2.2, "Physical and Physicochemical Methods". [1, 8, 9].

1.1. Description of argan oil

Oily, clear, yellowish - green liquid with pleasant, pleasant, characteristic smell.

1.2. Determination of refractive index

It is performed in accordance with the European Pharmacopoeia, Edition 9.0, Chapter 2.2, "Physical and Physicochemical Methods", subchapter 2.2.6, "Refractive Index".

Equipment: -refractometer.

The working technique:

Examine the refractometer at a temperature of 20 ± 0,5 ºC at the wavelength of the sodium D radiation (λ = 589,3 nm). A few drops of the analyte liquid are brought between the two prisms of the refractometer that are tightly sealed and viewed through the eyepiece. There are two areas, one bright and the other dark, bounded by a separation line that must be clear. The boundary between the light and dark areas is exactly the point where the crosshairs are crossed. Read on the split scale the refractive index value, relative to the wavelength D of the sodium. The reading shall be carried out with an accuracy of three decimal places and, if appropriate, the fourth decimal place.

1.3. Determination of relative density (d_{20}^{20})

It is performed in accordance with the European Pharmacopoeia, Edition 9.0, Chapter 2.2., Physical and Physicochemical Methods, Subchapter 2.2.5, "Relative Density".

Equipment: analytical balance; pycnometer.

Reagents: water R.

The working technique:

Weigh the empty pycnometer, fill with water R at 200 °C and weigh again. The difference between the mass of the water pycnometer R and the empty pycnometer is the mass of the water volume R at 200 °C (m 1). The pycnometer is emptied, dried, filled with the sample to be analyzed at 200 ° C and weighed.

The difference between the mass of the liquid pycnometer and the empty pycnometer is the mass of the sample to be analyzed at 200 °C (m). The accuracy of the determination is at the fourth decimal place.

$$d_{20}^{20} = \frac{m}{m_1}$$

in which: d_{20}^{20}=relative density; m= mass of the sample volume, in grams; m_1= mass of the water volume, in grams.

1.4. Determination of saponification index

It is performed in accordance with European Pharmacopoeia, Edition 9.0, Chapter 2.5 "Assays", subchapter 2.5.6. "Saponification value".

Equipment: it's not necessary.

Reagents:0.5 M hydrochloric acid; ethanol (96%) R; potassium hydroxide R; phenolphthalein, solution R1: phenolphthalein R, 10 g / L in ethanol R;

- *free aldehyde ethanol R:* mix 1200 mL ethanol (96%) R with 5 mL of a 400 g silver silver nitrate solution R

and 10 mL of 500 g / L cooled potassium hydroxide solution. Shake, leave for a few days rest and then filter.

Distil the filtrate before use.

- 0.5 M alcoholic potassium hydroxide: dissolve 3 g of potassium hydroxide R in 5 ml of water R and dilute to 100 ml with ethanol free of ethanol R.

The working technique: To determine the amount of test sample to be considered, Table 1 is used.

Table 1

The amount of sample required to determine the saponification index

The supposed index *Is*	The amount of sample, g
<3	20
3-10	12-15
10-40	8-12
40-60	5-8
60-100	3-5
100-200	2,5-3
200-300	1-2
300-400	0,5-1

According to the Technical Specification and the above table, a sample quantity to be analyzed (m, g) is introduced into a 250 mL conical borosilicate flask equipped with a refrigerant. Add 25 mL of 0.5M potassium hydroxide solution in 90% ethanol, V/ V and a few pieces of glass. It is mounted on the condenser and refluxed on a water basis for 30 minutes (unless otherwise recommended). Add 1 mL of phenolphthalein R1 solution and titrate immediately (still hot) with 0.5 M hydrochloric acid (n1 mL 0.5 M hydrochloric acid) until discoloration of the solution.

In paralel, a control sample (in 2 mL of 0.5 M hydrochloric acid) is performed.

Calculation: Saponification index, Is = 28,05 x $(n_2\text{-}n_1)$ */ m,*

In which: 28,05 = the amount of potassium hydroxide in mg corresponding to 1 ml of 0,5 M hydrochloric acid solution; n_1 = volume of 0,5 M hydrochloric acid solution used to titrate the sample to be analyzed in mL;

n_2 = the volume of 0,5 M hydrochloric acid used to titrate the control sample in ml; m = the mass of the sample to be analyzed, in g.

1.5. Determination of acidity index

It is performed in accordance with European Pharmacopoeia, Edition 9.0, Chapter 2.5, "Assays", subchapter 2.5.1, "Acid value", taking into account 5.0 g of the sample to be analyzed.

Reagents: alcohol (96%, v / v) R; ether R; petroleum ether (light petroleum R3); 0.1M potassium hydroxide saline; phenolphthalein R solution: 10 g / L in ethyl alcohol R (96% v / v).

The working technique: Dissolve 5.0 g of the sample to be analyzed in 50 ml of a mixture of equal volumes of ethyl dealcohol R and light petroleum ether previously neutralized with 0.1M potassium hydroxide solution using 0.5mL phenolphthalein solution as indicator. If necessary, heat to about 90° C to dissolve the sample to be analyzed. When the sample to be analyzed is titrated with 0,1 M potassium hydroxide until the pink color persists for at least 15 seconds

$$\text{Acidity index, } I_a = \frac{5{,}61\ x\ V\ x\ F}{m}$$

In which: I_a=acidity index; V = the volume of 0,1 M potassium hydroxide used for titration in mL; F = factor of 0,1 M potassium hydroxide solution; M = mass of the sample to be analyzed, in grams; 5.61 = number of milligrams of potassium hydroxide corresponding to 1.0 mL of potassium hydroxide 0.1 mol/ L in water.

1.6. Determination of index of peroxide

It is performed in accordance with European Pharmacopoeia, Edition 9.0, Chapter 2.5, "Assays", subchapter 2.5.5, "Peroxide value", considering 5.0g of the sample to be analyzed.

Reagents: chloroform R; glacial acetic acid R; saturated solution of potassium iodide R; water R; mercury iodine R; sodium thiosulfate, R, 0.01 M solution; Starch solution R: Stir 1.0 g of soluble starch R with 5.0mL of water and stir gently to add this mixture to 100mL of boiling water R containing 10.0mg of mercuric iodide R.

The working technique: 5.0 g of the sample to be analyzed is placed in a 250 mL flask equipped with a stopper. Add 30 mL of a mixture of 2 volumes of chloroform R and 3 glacial acetic acid volumes R. Stir and add 0.5 mL of saturated potassium iodide solution R. Add 30 mL of water R and shake exactly one minute this moment.

Titrate with sodium thiosulphate R, 0.01M solution, add the titrant a little and stir continuously until

the yellow color disappears. Add 5.0 mL of deamidone R solution and continue titration, stirring until the yellow color of the solution is removed.

Prepare under the same conditions like a blank sample. The volume of sodium thiosulphate R, 0,01M used for titration of the blank sample shall not exceed 0.1 mL.

Index of peroxide, $I_p = \frac{10(n_1 - n_2)}{m}$

In which: I_p=index of peroxide; n_1= volume of sodium thiosulphate, 0,01M solution used to titrate the sample to be analyzed in mL; n_2= volume of sodium thiosulphate, 0,01M solution used to titrate the control sample in mL; m= mass of the sample to be analyzed, in grams.

1.7. Determining Content in Unsaponifiable Matters

It is performed in accordance with European Pharmacopoeia, Edition 9.0, Chapter 2.5 "Assays", subchapter 2.5.7. "Unsaponifiable matter".

Equipment: a reflux system; distillation plant; separation funnel.

Reagents: Potassium hydroxide R, 2.0 M alcoholic solution; R-ether, free of peroxides: anesthetic R; potassium hydroxide R, 30 g / L solution; Potassium hydroxide R, 0,1 M alcoholic solution; phenolphthalein solution; acetone R; water R.

The working technique: Inject a quantity of the sample to be analyzed according to the Technical Specification of the product into a 250 mL borosilicate pot and add 50,0 ml of potassium hydroxide R, 2,0 M alcoholic solution. Heats up 1 hour, rotating frequently. Cool to a temperature below 250 ° C and transfer the contents to a separating funnel with 100 ml of water R. Carefully shake the liquid and wash three times with 100.0 ml of free peroxide R. Combine the ether layers in another separating funnel containing 40.0 mL of water R, shake for a few minutes, allow to separate and remove the aqueous phase. Wash the ether layer R with 40.0 ml of water R each and then wash successively with 40.0 ml of potassium hydroxide R, 30 g / L solution and 40.0 ml of water R; repeat the procedure three times. Then wash the ether phase several times with 40.0 mL water R until it has no alkaline reaction in the presence of phenolphthalein. Transfer the ether phase into a vessel washing the separation funnel with R-free ether, peroxides. Pour the ether cautiously, add to the residue 6.0 mL of acetone R. Remove the solvent to air stream and dry at 100-105 °C to constant weight. Cool in the desiccator and weigh it.

Calculation:

Unsaponifiable substances, % = 100 a / m_p

Where: a = mass of residue in g; mp = mass of sample to be analyzed in g; 100 = correlation factor.

Residue the residue with phenolphthalein, dissolve in 20 ml of alcohol R and titrate with sodium hydroxide R, alcohol solution, 0,1 M.

Note: If the volume of sodium hydroxide, the 0.1 M alcoholic solution used is greater than 0,2 mL, then the separation layers are incomplete so that the weighed residue cannot be considered as "non-saponifiable matter". If in doubt, the test should be repeated.

1.8. Determination of iodine index

Note: The iodine index is the number in grams expressing the amount of halogen calculated as iodine fixed to 100 g of the sample to be analyzed.

Equipment: -

Reagents: glacial acetic acid R; chloroform R; cyclohexane R; iodine bromide solution R: dissolve 20 g of iodine bromide R in glacial acetic acid R and dilute to 1000 ml with the same solvent; potassium iodide R solution 100 g / L; water R; iodide chloride solution R: dissolve 1,4 g of iodine chloride R in glacial acetic acid R and dilute to 100 ml with the same solvent; 0.1 M sodium thiosulphate solution; Starch solution R: 1 g of soluble R-starch is triturated with 5 ml of water R and, with stirring, 100 ml of hot water R containing 10 mg mercuric iodide R.

The working technique: If the product specification is not specified in the Product Technical Specification for which sample quantity to be used, the following table should be used:

Table 2

The amount of sample required to determine the iodine index

***Ii* supposed value**	**Amount of sample, g**
<20	1,0
20-60	0.5-0.25
60-100	0.25-0.15
>100	0.15-0.10

A sample of the analyte provided in the Technical Specification of the product is placed in a 250 mL flask fitted with a stopper and dried by rinsing with glacial acetic acid R in 15 mL of chloroform R. Very slowly, 25 mL of iodine solution R, close the vial and keep it in the dark for 30 minutes by shaking frequently. Add 10 ml of the 100 g / L solution of potassium iodide R and 100 ml of water R. Titrate with 0,1 M sodium thiosulphate solution R, vigorously stirring until the yellow color disappears. Add 5 ml starch solution R and continue titration with 0.1 M sodium thiosulphate solution R used for titration (n1 = ml of 0,1 M sodium thiosulphate solution used to titrate the sample to be analyzed). Parallel and under the same conditions, a blank sample (n2 = ml of 0.1 M sodium thiosulphate solution used to titrate the control sample) is performed

Calculate the iodine index with the following formula:

$$Ii = 1{,}269\ (n_2 - n_1)\ /\ m$$

where:

n_1 = volume of sodium thiosulphate 0.1 M solution used to titrate the sample to be analyzed in ml;

n_2 = volume of sodium thiosulphate 0.1 M solution used to titrate the control sample, in mL;

1,269 = number of milligrams of iodine corresponding to 1 milliliter of sodium thiosulphate R 0.1 M solution;

m = sample mass to be analyzed, g.

1.9. Identification of components by chromatographic profile

It is determined according to the European Pharmacopoeia, Edition 9.0, Chapter 2.2. "Physical and Physicochemical Methods", subchapter 2.2.28 "Gas chromatography".

Equipment: Gas chromatograph equipped with MS detector (mass spectrometer), splitting injector, automatic peak area integration system from the chromatograms obtained, 20 000 R macrogol column (film thickness 0, 25 µm); l = 30 m; Ø = 0.25mm; computer and printer.

Working conditions : carrier helium for chromatography R; debit :1,5 mL/ minute; division split of 1/ 60; Column temperature: 160^{0}C from 0-5 minutes, from 160^{0}C to 200^{0}C for 6-10 minutes, respectively 200^{0}C to 225^{0}C for 10 minutes; Injection port temperature: 220^{0}C; temperature of detector: 270^{0}C; injection volume: 1µL (for each solution).

Reagents: petroleum ether R; hydrochloric acid R in methanol, 0.5 M solution; water R; isooctane R; - heptane R; anhydrous sodium sulfate R; sample to be analyzed: oil as such; test solution: weigh 0,1 g of the sample to be analyzed in a round-bottomed flask and dissolve in 5,0 mL of light petroleum R and 50 mL of hydrochloric acid R in methanol, 0,5 M solution. at reflux and stirring in the nest at about 650C for 1 hour (until no more drops of unleaded oil are observed). Project and pass into a separating funnel. The round bottomed flask with 30 -40 mL of water R, then with 40 mL of isooctane R and add to the separating funnel. Wash the isooctane layer with water until the pH is neutral. Separate the isooctane layer, pass anhydrous sodium sulphate R to remove the water and filtrează.

- *reference solution A:* prepare a calibration mixture with the composition described in the European Pharmacopoeia, in force, Chapter 2.4.22. Table 2.4.22.-1., the substances being dissolved in heptane R, as follows:

Mixed substances	Amount, (%, m/m)
Methyl laureate R	5
Methyl myristate R	5
Methyl palmitate R	10
Methyl stearate R	20
Methyl arachidate R	40
Methyl oleate R	20

The working technique: Inject 1 µL reference solution A and 1 µL test solution. Record retention times.

Resolution: minimum 1,8 of the peaks determined by methyl oleate and methyl stearate from the chromatogram obtained with the reference solution A.

Identification: localize the oil components in the sample to be analyzed by using the MS spectra library in the M / Z range: 40-450. Determine the percentage content of these components by the normalization procedure.

2. Microbiological Characterization of Argan Oil

It is carried out in accordance with European Edition 9.0, Chapter 2.6.12. "Microbiological Examination of Non-Sterile Products: Microbial Enumeration Tests" and Chapter 2.6.13., "Microbiological Examination of Non-Sterile Products: Tests for Specified Micro-Organisms ".

2.1. Determination of microbial contamination of argan oil

Verification of microbial contamination consists in determining the total number of aerobic microorganisms (TAMC) and the total combined number of filamentous yeasts and fungi (TYMC),

respectively the isolation and identification of specific micro-organisms *(Escherichia coli and Salmonella sp.).*

2.1.1. Determination of the total number of aerobic microorganisms (TAMC)

It is carried out in accordance with European Edition 9.0, Chapter 2.6.12. "Microbiological Examination of Non-Sterile Products: Microbial Enumeration Tests ".

Equipment: Analytical Balance KERN EG 420 3 NM, Venticell 111Oven, Incucell 404 Incubator, Friocell 404 Incubator, Caloris TCR 140 Incubator, Hot air microbiological flow with Telstar AV 100 laminar airflow, Bacterial airflow microwave flow BSC-EN I-IV

Laboratory glassware: Petri dishes (Ø = 9 cm), 160/16 mm tubes, graduated pipettes of 1, 2, 5 and 10 ml with graduations of 0.5 and 0.1 ml, respectively 100 mL graduated cylinders; 250 mL Erlenmeyer flasks, Stand.

Culture medium and solutions: Casein soybean hydrolyzate and soy (Casein soya bean digest agar, buffered sodium chloride and peptone buffer pH = 7.00 (*buffered sodium chloride broth* pH = 7.0)

The working technique : In a sterile Erlenmeyer flask, 10mL of product was added 1mL Polysorbate 80 (Tween 80) and suspended in 90mL *buffered sodium chloride and peptone buffer* pH 7.0 (pH 7.0).
Homogenize well. The dilution is 1:10.

In a sterile Erlenmeyer flask, 10mL of product was added 1mL Polysorbate 80 (Tween 80) and suspended in 90mL *buffered sodium chloride and peptone buffer* pH 7.0 (pH 7.0). Homogenize well. The dilution is 1:10.

Concurrently, negative control samples are carried out as follows: in 2 Petri dishes 10 to 15 ml *Casein and soybean hydrolyzate agar* are distributed; in 2 Petri dishes are dispensed 1 ml *Sodium chloride and peptone buffered saline* + 10-15 ml *Casein hydrolyzate and soybean hydrolyzate.*

The casein and soybean hydrolyzate plates are incubated for 3-5 days at 30-35^{0}C. Check the samples throughout the incubation period. For a proper evaluation, select the plots with no more than 250 colonies. Count the developed colonies and make the arithmetic mean for each dilution. Calculate the total number of colony forming units / gram (UFC / mL divided by the number of dilutions performed.)

Interpretation of results:

The total number of aerobic microorganisms (TAMC) will be considered equal to the UFC average determined by the casein and soybean hydrolysate medium. If UFC of yew and filamentous fungi are detected on this culture medium, they are considered in the total number of CFUs for this medium.

2.1.2. Determination of total combined yeast and filamentous fungi (TYMC)

It is carried out in accordance with European Edition 9.0, Chapter 2.6.12 "Microbiological Examination of Non-Sterile Products: Microbial Enumeration Tests ".

Equipments: Analytical Balance KERN EG 420 3 NM; Venticell 111Oven; Incucell 404 Incubator; Friocell 404 Incubator; Caloris TCR 140 Incubator; Hot air microbiological flow with Telstar AV 100 laminar airflow; Bacterial airflow microwave flow BSC-EN I-IV

Laboratory glassware: Petri dishes (Ø = 9 cm), 160/16 mm tubes, graduated pipettes of 1, 2, 5 and 10 ml with graduations of 0.5 and 0.1 ml,respectively 100 mL graduated cylinders;250 mL Erlenmeyer flasks; Stand.

Culture medium and solutions: Sabouraud Agar Dextrose Agar (Sabouraud Agar with Dextrose); buffered sodium chloride and peptone buffer pH = 7.00 (buffered sodium chloride broth pH = 7.0).

The working technique : In a sterile Erlenmeyer flask, add 1mL of Polysorbate 80 (Tween 80) to 10mL of product and suspend in 90 mL buffered sodium chloride and peptone buffer pH 7.0 (Buffered sodium chloride peptone broth pH = 7.0). Homogenize well. The dilution is 1:10. From this, serial dilutions (1: 100; 1:1000, etc.) are prepared using sodium chloride and peptone buffer buffered as a diluent, pH = 7.0.

In each pair of 9 cm diameter Petri dishes, transfer 1 mL of each prepared dilution. For bacteria, add 10-15 mL Sabouraud Dextrose Agar (Sabouraud Agar) broth to each plate. The culture medium is liquefied and used when it reaches 45^0C.

Concurrently, negative control samples are carried out as follows: in 2 Petri dishes spread 10 -15 mL *Medium Sabouraud Agar with dextrose* are distributed; 2 Petri dishes are dispensed 1 ml *Sodium Chloride Buffer and Peptone* + 10 -15 ml *Sabouraud Agar with dextrose;*

Sabouraud dextrose agar plates are incubated for 5-7 days at 20-25°C. Check the samples throughout the incubation period. For a proper evaluation, select the plots with no more than 250 colonies. Count the developed colonies and make the arithmetic mean for each dilution. Calculate the total number of colony forming units / gram (UFC / mL divided by the number of dilutions performed.)

Interpretation of results:

The total number of combined yeasts and filamentous fungi (TYMC) will be considered equal to the average UFC determined on the dewormed Sabouraud Agar medium. If UFC bacteria are detected on this culture medium, they are considered in the total number of UFCs developed on this medium.

2.1.3. Isolation and identification of gram-negative bacteria tolerant to biliary salts

It is carried out in accordance with European Edition 9.0, Chapter 2.6.13. "Microbiological Examination of Non-Sterile Products: Tests for Specified Micro-Organisms ".

Equipments: Analytical Balance KERN EG 420 3 NM, Venticell 111Oven, Incucell 404 Incubator, Friocell 404 Incubator, Caloris TCR 140 Incubator, Hot air microbiological flow with Telstar AV 100 laminar airflow, Bacterial airflow microwave flow BSC-EN I-IV.

Laboratory glassware: Petri dishes (Ø = 9 cm),160/16 mm tubes, graduated pipettes of 1, 2, 5 and 10 ml with graduations of 0.5 and 0.1 ml, respectively 100 mL graduated cylinders; 250 mL Erlenmeyer flasks, Stand.

Culture medium and solutions: Enterobacteria enrichment broth *(Enterobacteria enrichment broth – Mossel)*; Agar with red phenol, purple crystal, bile sieve and glucose *(Violet red bile glucose agar);* Casein soya bean digest broth *(Casein soya bean digest broth).*

The working technique : In a sterile Erlenmeyer flask, add 10mL of Polisorbate 80 (Tween 80) to 10mL of product and suspend in 90ml *Casein soya bean digest broth*. Homogenize well. A 1: 10 dilution is obtained. It is homogenized and incubated at 20-25 ° C for 2-3 hours for the bacteria to pass through the exponential multiplication phase. From the obtained sample transfer 1mL to a sterile tube with Mossel enameling broth for *Enterobacteria enrichment broth (Mossel).* Incubate at 30-35^0C for 24-48 hours. Perform subcultures on Petri dishes with *Medium Agar with red phenol, purple crystal, bile salts and glucose* (*Violet red bile glucose agar).* Incubate at 30 - 35^0C for 24-48 hours. The product corresponds to the absence of colonies of gram-negative bacteria red or reddish.

2.1.4. Control of specific micro-organisms

2.1.4.1. Isolation and identification of Escherichia coli.

It is carried out in accordance with European Edition 9.0, Chapter 2.6.13. "Microbiological Examination of Non-Sterile Products: Tests for Specified Micro-Organisms".

Equipments: Analytical Balance KERN EG 420 3 NM, Venticell 111Oven, Incucell 404 Incubator, Friocell 404 Incubator, Caloris TCR 140 Incubator, Hot air microbiological flow with Telstar AV 100 laminar airflow, Bacterial airflow microwave flow BSC-EN I-IV.

Laboratory glassware: Petri dishes (Ø = 9 cm), 160/16 mm tubes, graduated pipettes of 1, 2, 5 and 10 ml with graduations of 0.5 and 0.1 ml, respectively, 100 mL graduated cylinders; 250 mL Erlenmeyer flasks, Stand.

Culture medium: MacConkey Batch *(MacConkey broth);* MacConkey Agar *(MacConkey agar);* Casein soya bean digest broth *(Casein soya bean digest broth);* Triple sugar iron agar medium (TSI) (Triple sugar iron agar).

The working technique: In a sterile Erlenmeyer flask, suspend 10mL of product in 90 mL *Casein soya bean digest broth*. Homogenize well. A 1:10 dilution is obtained. Homogenize and incubate at 30-35 ° C for 18-24 hours. Transfer 1 mL of the culture obtained in a sterile Erlenmeyer containing 100 mL of *MacConkey*

Broth. Incubate at 42-44 ° C 24 - 48 hours. If the culture medium becomes opalescent and the purple-yellow color turns yellow, subcultures are made on *MacConkey agar* plates. Incubate at 30-35ºC for 18-72 hours.

Interpretation:

If colonies of Gram-negative bacteria of lactose and non-lactose red bacteria are suspected, the presence of *Escherichia coli* is suspected. Confirmation of the presence of *Escherichia coli* is performed by biochemical tests by inoculation on Petri dishes with *Triple sugar iron agar (TSI). Escherichia coli* ferments glucose, lactose, saccharose and indole.

2.1.4.2 Isolation and identification of Salmonella sp.

It is carried out in accordance with European Edition 9.0, Chapter 2.6.13. "Microbiological Examination of Non-Sterile Products: Tests for Specified Micro-Organisms".

Equipments: Analytical Balance KERN EG 420 3 NM, Venticell 111Oven, Incucell 404 Incubator, Friocell 404 Incubator, Caloris TCR 140 Incubator, Hot air microbiological flow with Telstar AV 100 laminar airflow, Bacterial airflow microwave flow BSC-EN I-IV, Refrigerated RD33C refrigeration unit, Systec V95 autoclave, Raypa autoclave.

Laboratory glassware: Petri dishes (Ø = 9 cm), 160/16 mm tubes, graduated pipettes of 1, 2, 5 and 10 ml with graduations of 0.5 and 0.1 ml, respectively 100 mL graduated cylinders; 250 mL Erlenmeyer flasks, Stand.

Culture medium and solutions: Rappaport Vassiliadis Salmonella enrichment broth; Xylose, lysine, deoxycholate agar; Casein soya bean digest broth;

The working technique: In a sterile Erlenmeyer flask, suspend 10 mL of product in 90 mL *Casein soybean bean digest broth*. Homogenize well. A 1: 10 dilution is obtained. It is homogenized and incubated at 30-35 °C for 18-24 hours. Transfer 0.1 mL of the culture obtained to a test tube containing 10 mL of *Rappaport Vassiliadis Salmonella enrichment broth*. Incubate at 30-35^{0}C for 18-24 hours. Perform subcultures on Petri dishes with *Xylose, lysine, deoxycholate agar* medium. Incubate at 30-35^{0}C for 18-48 hours.

Interpretation: Possible existence of the micro-organism *Salmonella sp.* is indicated by the presence of well-developed red colonies with the optional colored black center. Confirmation is performed by biochemical tests. *Salmonella sp*. fermentase glucose, optional lactose, does not produce indole. Aglutinase with polyvalent and group anti-*Salmonella* sera.

RESULTS

To conduct the study, there have been taken into action three samples of argan oil *(Argania spinosa L.)* produced by a Moroccon company and derived from three different fatty oil batches, obtained under the same conditions at the pilot scale, namely: A1= sample of argan oil *(Argania spinosa L.)* obtained by cold pressing, cosmetic use/ A2 = sample of argan oil *(Argania spinosa L.)* obtained by cold pressing, series 64003/ HAC1, cosmetic use/ A3 = sample of vegetable argan oil *(Argania spinosa L.)* obtained by cold pressing, series 64003 - HAC2, cosmetic use.

The results obtained in the physico-chemical analysis of samples of *Argania spinosa L.* obtained by cold pressing are:

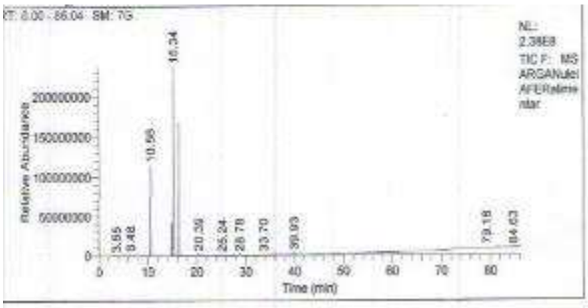
Table 3

The results obtained in the physico-chemical analysis of argan oil (*Argania spinosa L.*), *samples* A1, A2 si A3

No.	Characteristics	Admissibility limits	Results for *sample A1*	Results for *sample A2*	Results for *sample A3*	Observa-tions
13.	Appearance	clear oily liquid	fulfil	fulfil	fulfil	-
14.	Colour	yellow - green	fulfil	fulfil	fulfil	-
15.	Smell	pleasant, agreeable, characteristic	fulfil	fulfil	fulfil	-
16.	Refraction index	1,4600-1,4700	1,4695	1,4650	1,4692	-
17.	Relative density	0,9100-0,9200	0,9147	0,9123	0,9156	-
18.	Saponification index	189,0-195,0	192,8	193,6	193,6	-
19.	Acidity index	1,3-3,0	1,87	2,2	1,90	-
20.	Index of peroxide, max	3,0	2,64	2,9	2,72	-

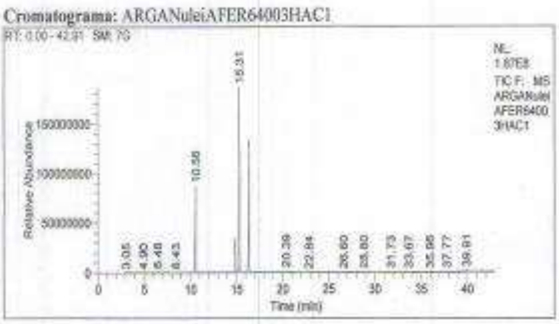
No.	Characteristics	Admissibility limits	Results for *sample A1*	Results for *sample A2*	Results for *sample A3*	Observa-tions
21.	Unsaponifiable matters	0,3 - 1,1	0,99	0,8	1,05	-
22.	Iodine index	92, 0 - 102 ,0	98,9	99,3	99,2	-
23.	Palmitic acid, %	13,5 – 16,4	15,61	15,95	15,73	Sample was analyzed by gas chromatography coupled with mass spectro-metry
24.	Stearic acid, %	4,2 -5,6	4,24	4,31	4,11	
25.	Oleic acid, %	43,1- 46,9	44,20	43,81	44,16	
26.	Linoleic acid, %	31,6 – 36,4	32,74	33,21	32,99	
27.	Linolenic acid, %, max.	0,1	0	0	0	
28.	Arachidic acid, %, max.	0,4	0,36	0,32	0,35	
29.	Gadoleic acid, %, max.	0,5	0,39	0,35	0,38	

The cromatographic profile of argan oil (*Argania spinosa L.*), sample A1 (Figures 2-4):



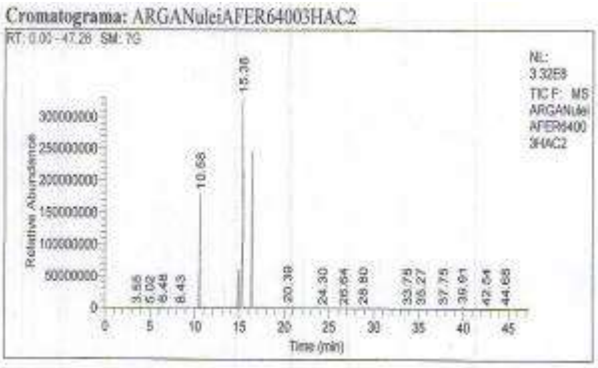
Nr.	Nume Compus	RT	Area %	Peak Area	Peak Height	S/N
1.	Myristic C14:0	6.48	0.17	4969738	1536276	784.45
2.	Palmitic C16:0	10.56	15.61	458899290	105053923	61671.23
3.	Stearic C18:0	14.88	7.24	209087921	41033238	24088.30
4.	Oleic C18:1	15.33	44.20	1276825196	223070255	130951.95
5.	Cis Vacc	15.42	0.33	9450515	2621707	1539.06
6.	Linoleic C18:2	16.38	30.74	888002709	158893604	93277.46
7.	Arachic C20:0	20.39	0.46	13340000	1891626	1110.47
8.	Gondoic C20:1	21.04	0.39	11139737	1517066	890.58
9.	Behenic C22:0	28.78	0.17	4777924	471192	276.61
10.	Squalene	39.92	0.70	20147050	1597417	937.75

Fig. 2 – Chromatogram of argan oil (*Argania spinosa L.*) – sample A1



Nr.	Nume Compus	RT	Area %	Peak Area	Peak Height	S/N
1.	Myristic C14:0	6.48	0.18	3698019	941813	998.39
2.	Palmitic C16:0	10.56	15.95	332011138	79496512	84272.12
3.	Stearic C18:0	14.87	7.31	152074727	32187416	34121.01
4.	Oleic C18:1	15.31	43.31	901438717	174482587	184964.30
5.	Cis Vacc	15.42	0.40	8382422	2004937	2125.38
6.	Linoleic C18:2	16.36	31.21	649623003	125572464	133116.00
7.	Arachic C20:0	20.39	0.42	8778576	1239302	1313.75
8.	Gondoic C20:1	21.04	0.35	7203902	979932	1038.80
9.	Behenic C22:0	28.80	0.15	3061940	298614	316.55
10.	Squalene	39.91	0.72	15014355	1231895	1305.90

Fig. 3 – Chromatogram of argan oil (*Argania spinosa L.*) – sample A2



Nr.	Nume Compus	RT	Area %	Peak Area	Peak Height	S/N
1.	Myristic C14:0	6.48	0.18	3698019	941813	998.39
2.	Palmitic C16:0	10.56	15.95	332011138	79496512	84272.12
3.	Stearic C18:0	14.87	7.31	152074727	32187416	34121.01
4.	Oleic C18:1	15.31	43.31	901438717	174482587	184964.30
5.	Cis Vacc	15.42	0.40	8382422	2004937	2125.38
6.	Linoleic C18:2	16.36	31.21	649623003	125572464	133116.00
7.	Arachic C20:0	20.39	0.42	8778576	1239302	1313.75
8.	Gondoic C20:1	21.04	0.35	7203902	979932	1038.80
9.	Behenic C22:0	28.80	0.15	3061940	298614	316.55
10.	Squalene	39.91	0.72	15014355	1231895	1305.90

Fig. 4 – Chromatogram of argan oil (*Argania spinosa L.*) – sample A3

The results obtained in the microbiological analyzes of the argan oil (Aragania spinosa L.) are shown in Table 7.

Table 7

The results obtained in the microbiological analyzes of the argan oil – samples A1, A2 şi A3

No.	Characteristics	Admissibility limits	Results for *sample A1*	Results for *sample A2*	Results for *sample A3*
1	Microbial contamination: -Total number of aerobic microorganisms (TAMC), UFC/mL, max -Total number of yeast and filamentous fungi combined (TYMC), UFC/mL, max. - Gram negative bacteria tolerant to biliary salts, UFC/mL, max. -*Escherichia coli*/ mL -*Salmonella sp./ 25* mL	1×10^4 1×10^2 1×10^2 absent absent	2×10^1 <10 <10 absent absent	1×10^1 <10 <10 absent absent	7×10^3 <10 <10 absent absent

CONCLUSIONS

As can be seen from the tables and graphic representations above:

- the acidity index has values between the two admissibility limits, being higher for sample A2 (2,2);
- the peroxide index records values close to the admissibility limit, being also higher for sample A2 (2,9);
- the unsaponifiable has values between the two admissibility limits, being higher for sample A3 (1,05);
- relative density has values between the two admissibility limits, being higher for sample A3 (0,9156);
- the saponification index and the iodine index show oscillating values between the two admissibility limits.

Relating the chromatographic profiles of the analyzed samples:

- Argan oil has stearic acid close to the minimum admissible limit (4,24% for sample A1, 4,31% for sample A2 and 4,11% for sample A3 under conditions where the maximum admissible limit is 5.6%).
- The palmitic acid content is high, the highest percentage being identified in sample A2 (15.95%).
- The content in gadoleic acid is between the two admissibility limits, being higher for sample A1 (0,39%).
- Linoleic acid has values between the two admissibility limits, being higher for sample A3 (32,99%).
- Oleic acid has oscillating values between the two limits of admissibility, being higher gor sample A1 (44,2%).

The three samples analyzed meet the specifications of the manufacturer's specification, falling within the general limits of ARGAN oil literature.

Values obtained from the microbiological analysis of argan oil show that it is of intentional quality and safety, subject to the admissibility limits laid down by the European Pharmacopoeia, the edition in force concerning the quality of the natural product of vegetable plant origin, view of microbial contamination.

All the results obtained qualify this product as a very important natural source of raw material for the cosmetics and body care industry.

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A BIBLIOMETRIC ANALYSIS ON SUBSOILING TECHNOLOGY
/
ANALIZĂ BIBLIOMETRICĂ ASUPRA TEHNOLOGIILOR DE PRELUCRARE ADÂNCĂ A SOLULUI

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Keywords: *soil loosening, subsoil, tillage, tillage tool, bibliometry, database*

ABSTRACT

Based on several selected databases, this paper applies bibliometric method to analyze the scientific publication on subsoiling related technology. Using the proposed method, basic information of the publications and most cited articles is provided. Also, the references selection procedure is presented in detail. The methodology of references selection consists in automatic and manual scientific database interrogation using characteristic keywords base on title and abstracts and study of references list from selected paper. The evolution of literature during the accounted period of selected databases, identification of most influential knowledge generators in the field and suggested trends for further research is explored.

REZUMAT

Lucrarea de faţă îşi propune aplicarea unei metode bibliometrice, în vederea analizei publicaţiilor ştiinţifice îndomeniul tehnologiei de prelucrare adâncă a solului, în câteva baze de date considerate cele mai importante în prezent. Prin analiza propusă se identifică principalele publicaţii precum şi cele mai citate articole în domeniu. De asemenea este prezentată detaliat şi metoda de analiză utilizată. Metodologia de selecţie constă în interogarea automată şi manuală a celor mai importante baze de date ştiinţifice utilizând cuvinte cheie caracteristice. Interogarea s-a realizat luând în considerare titlurile lucrărilor şi rezumatul, precum şi bibliografia articolelor selectate. Astfel, este explorată evoluţia literaturii de specialitate în perioada de timp selectată, identificarea celor mai importante surse generatoare de informaţie ştiinţifică în domeniu şi de asemenea trendul cercetărilor în domeniul ales.

INTRODUCTION

This paper presents preliminary information concerning the state of the art in the field of subsoiling technology. Soil compaction represents one of the most important problem in today's agriculture. In the vegetal production the compaction and the destruction of the soil structure, as a direct effect of the compaction process, are due in particular to the intensive crop production. According to conducted studies presented in (*http://agrointel.ro*) more than 65% of agricultural land in Eastern Europe is compacted, which is reflected in agricultural production, involving losses between 15% and 35%. Other frequent negative effects of soil compaction are: decrease in soil drainage capacity, increased risk of disease, deficiencies in accessing nutrients in the root zone, etc.

Under these circumstances, finding and implementing strategies to prevent soil compaction becomes a priority under the conditions of intensive agriculture.One of the main methods currently used, mostly as a corrective action, is soil processing with subsoiling tools, a process also known as scarification. So, scarification is therefore an agro-ameliorative work of deep loosening of the soil without turning the furrow. The direct result of the scarification operation is: to achieve a deeper soil penetration by the plant roots, increase the water and air infiltration capacity in the soil, and to improve the conditions necessary for carrying out biological activities in the upper soil profile.

Because the soil processing with subsoil tools is a complex and costly operation, in order to be efficiently realized it is necessary to understand the optimal conditions for the execution of the work and the proper working process. Considering that, depending on the compaction degree of the soil, its humidity and the depth of work, the underground works can destroy the soil by compressing in the working tool area and then lifting it without loosening it. So, it is necessary to understand the conditions that lead to the aeration of the soil rather than its compaction.

In this context, the aim of this study is to make a rigorous references selection for literature review [20] concerning the state of the art in field of subsoiling technology, using a bibliometric method, through interrogation of representative scientific databases using specific keywords. The paper will be completed with author's perspective over present and further development in the field of soil loosening and tillage toolstechnology.

MATERIAL AND METHOD

The field of research, the object of references selection, here, is represented by the soil tillage related technology. The methodology used for the selection of representative references of the above mentioned field of research is further presented during the following steps: selection of references by interrogation of representative scientific databases; refining results applying including or excluding criteria as article type, source type, thematic, language, and year of publication; selection of references by interrogation of representative scientific databases using combined syntax and additional keywords and the final analysis.

In the first stage of the research, *references selection by representative scientific databases,* seven databases were interrogated as presented in Table 1.

Table 1

Databases used for references selection

Name	Short name	Web adress
Cambridge Journals	Cambridge	http://www.cambridge.org/
IEEE Explore	IEEE	http://ieeexplore.ieee.org/
ProQuest	ProQuest	http://www.proquest.com/
Science Direct	Science Direct	http://www.sciencedirect.com/
Scopus	Scopus	https://www.scopus.com/
Springer Link	Springer	http://link.springer.com/
Web of Knowledge – Thomson Reuters	ISI	https://apps.webofknowledge.com
Wiley – Online Library	Wiley	http://onlinelibrary.wiley.com/

The database query procedure used specific syntax, keywords and logical operators (and, etc.) as well as the fields of the search area indication, respectively the title of the paper, summary, content, bibliographic references. The search fields specific to each database are shown in Table 2.

Table 2

Databases field of search used

Database	Field of search
Cambridge	All fields
IEEE	Article title, abstract, keyword
ProQuest	Full text
Science Direct	Article title, abstract, keyword
Scopus	Article title, abstract
Springer	Article title, abstract
ISI	Article title
Wiley	All fields

In order to refine the results obtained, a number of exclusion and inclusion criteria have been used, such as: type of article (books and encyclopedias were excluded, only review articles or original content being considered), the source of the article (i.e. journal), the publication language (only articles published in English were considered) and the year of publication (the 10-year period was considered to be representative for the present research). The synthesis of the selection criteria used is presented in Table 3.

The main keywords used for selection of references were: subsoil, tillage, tillage tool, soil loosening. The results of the interrogation procedure, used in selected databases, are presented in Table 4. Taking into account the high number of articles returned following the queries, the second stage of the research went to their manual review and elimination of duplicate items and the selection of those in the field of agriculture and engineering as well as the limitation of the 10-year timeframe (2007-2017). Due to the high number of returned items, manual selection could not be performed for some keywords and databases, as presented in Table 4.

Table 3

The synthesis of including or excluding criteria

Field	Including criteria	Excluding criteria
Document type	Article, Review	Book Review, Books, Business Article, Conference paper, Conference review, Databases, Discussion, Editorial, Erratum, Letter, Note, Report, Short communication, Short Survey, Undefined etc.
Source type	Journal	Book Series, Conference Proceedings, Images, Laboratory Protocols, Reference Works, Trade Publications etc.
Language	English	Chinese, German, France, Italian, Japanese etc.

Table 4

Keywords and databases excepted to manual selection of databases interrogation

Name	Keywords
Science Direct	tillage soil loosening subsoil
Scopus	tillage
Springer Link	subsoil tillage soil loosening
Web of Knowledge – Thomson Reuters	subsoil tillage
Wiley – Online Library	subsoil tillage tillage tool soil loosening

RESULTS

After the selection, the returned items on bibliography were analyzed, identifying other bibliographic sources not automatically indexed by the databases with the specific search fields used. The number of articles remaining after the selection is presented in Table 5.

A first analysis of the results obtained by querying the databases refers to the importance of the keywords used, representative for the approached field. Their importance was quantified by the number of items originally returned (Figure 1). From the analysis of the results obtained, it is clear that the most representative keyword, based on the number of returns in 7 databases of 8 was tillage.

This reflects the increased interest in optimizing tillage technology in order to maximize agricultural output and minimize the number of necessary operations with a direct impact on reducing the amount of the energy consumed in this respect.

Also, the analysis of the topics covered by the returned articles shows a particular interest in the improvement of tillage tools. Assertion demonstrated by the number of articles returned from using the keyword tool, respectively querying databases using the tillage tool or tillage and tool.

The comparative analysis of the results obtained from the query using the keyword "tillage" and "tillage tool" or "tillage and tool" syntax reflects the importance of additional keywords in the bibliometric analysis and the identification of representative works in the analyzed field.

This affirmation is supportedby the significant reduction in the number of items returned after querying the databases, using the “tillage” keyword and the “tillage tool” syntax (Figure 1).

Another topic of interest, representative of the field, is deep soil processing, as evidenced by the high number of articles returned after querying the databases using the underlying keyword.

The low number of results returned from the use of the word soil loosening compared to the other keywords used is explained by the fact that it refers to a specific subdomain in a specific agricultural operation but has been chosen for its use in the present research, in order to analyze the interest of the researchers for this operation, respectively of the current state of research in this field, considered by the authors to be of high importance in the field.

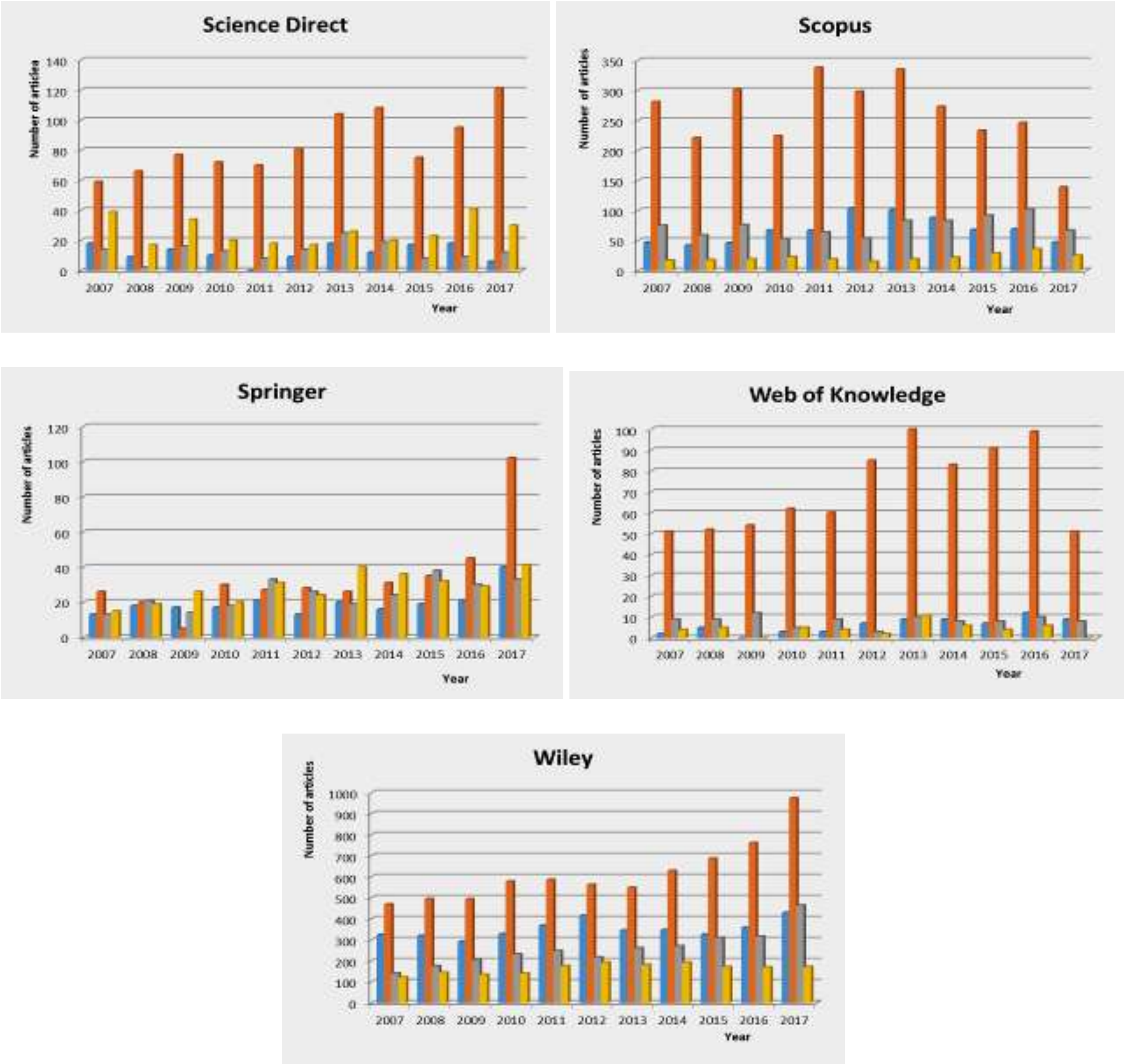
Table 5

Results of databases interrogation

Name	Keywords	Initial number of articles	Refined number of articles
Cambridge Journals	subsoil	173	4
	tillage	1064	338
	tillage tool	347	4
	soil loosening	2705	4
IEEE Explore	subsoil	84	51
	tillage	103	66
	tillage tool	10	8
	soil loosening	6	6
ProQuest	subsoil	9037	160
	tillage	16739	238
	tillage tool	6604	97
	soil loosening	1657	57
Science Direct	subsoil	9889	107
	tillage	15460	379
	tillage tool	4700	43
	soil loosening	2450	210
Scopus	subsoil	9304	113
	tillage	12370	133
	tillage tool	1257	42
	soil loosening	592	34
Springer Link	subsoil	16844	194
	tillage	17938	330
	tillage tool	6719	269
	soil loosening	10197	313
Web of Knowledge – Thomson Reuters	subsoil	8128	173
	tillage	25918	719
	tillage tool	1283	95
	soil loosening	993	49
Wiley – Online Library	subsoil	10500	3760
	tillage	13613	6723
	tillage tool	4811	2808
	soil loosening	5540	1797

Another aspect analyzed by the research was the yearly distribution of the articles returned after the interrogation of the databases with the main objective to identify the research trend in the analyzed field. Five databases (Science Direct, Scopus, Springer Link, Web of Knowledge and Wiley) were chosen based on the fact that they have an analysis tool that allow the selected option and the high number of returned articles. The results obtained are highlighted in Figure 1. The analysis shows an increased interest, especially on "tillage". The rising trend in three of the five analyzed databases shows an increasing interest in the area of interest analyzed in this paper, starting with 2010, and continuing in the present. The affirmations being proved by the number of works indexed in the databases mentioned during 2010-2017.

Using a specific tool available in Scopus database, we also analyzed the geographic location of the authors with interest in the analyzed field. This analysis can be considered a useful tool in identifying authors based on their location with increased interest in the field considered. This analysis is important in conducting research on the current state of research in a given field, by identifying representative authors for it but also, specific institutions or geographic regions who have a specific interest in thetopic. The results obtained are shown in Figure 2.



Legend:

- subsoil
- tillage
- tillage tool
- soil loosening

Fig. 1 - Yearly distribution of selected articles from queried databases

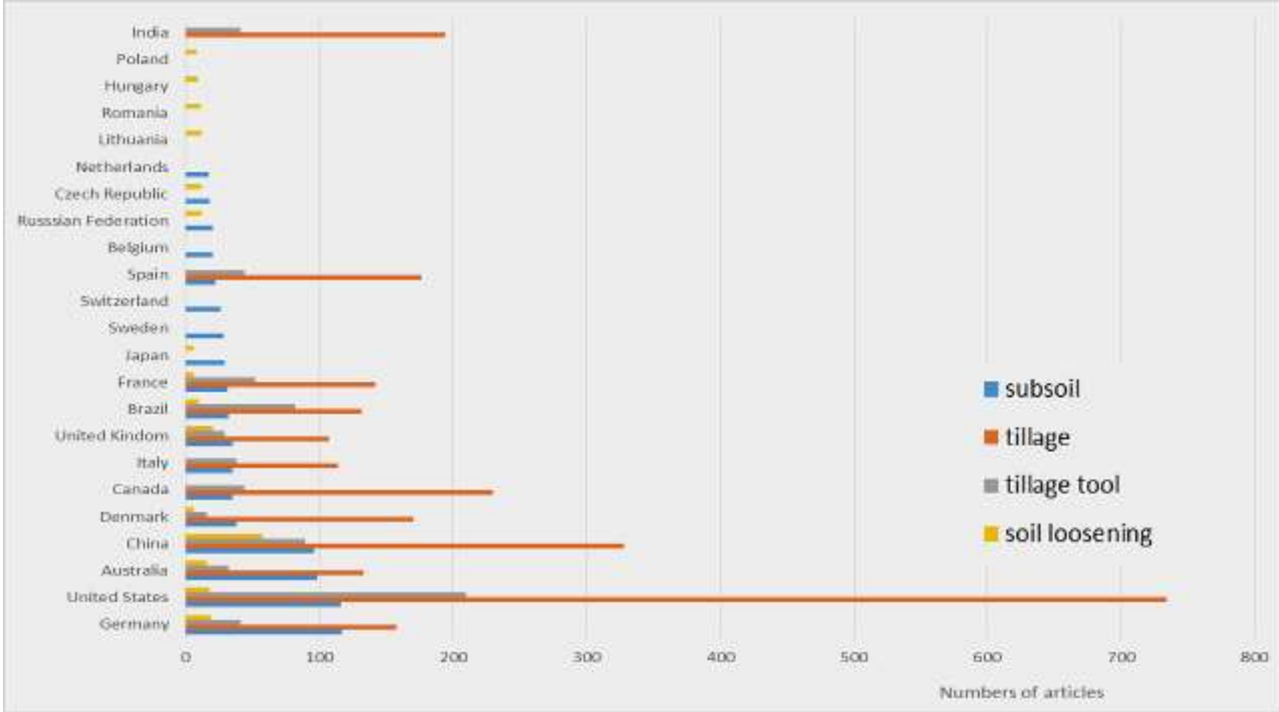


Fig. 2 - Geographic distribution of selected articles from Scopus database

Analyzing the returned data, can be seen the high number of articles on all used keywords for the most developed countries with large agricultural potential as United States, Germany, China, Italy, France and Brazil. It is also worth mentioning the interest of the Eastern European countries, like Czech Republic, Lithuania, Hungary, Poland and Romania in the field of soil processing, taking into account keyword "soil loosening". This can be justified by the problems associated with intensive farming, massive machinery and generated hardpan etc.

Using the number of articles returned in correlation with the affiliation of major authors, a number of universities / research institutes with a high interest in deep soil technology technologies have been identified. Some of the results are shown in Table 5.

Table 5

Interrogation results from Scopus databases regarding to representative authors and their affiliation

Keywords	Authors	Affiliation	No. of articles	Publication years	Ref. no.
Subsoil	Araya, A., Xiong, X. Zhang, H. Araya, K. Teramoto, C. Kataoka, T. Ohmiya, K. Liu, F. Jia, H. Zhang, C. Zhu, B. Wang, N. Meng, Q. Harano, Y. Ozima, M.	Senshu University, Environmental Science Laboratory, Tokyo, Japan; Heilongjiang Academy of Agricultural Sciences, Jiamusi Branch, Harbin, China. Hokkaido University, Graduate School of Engineering, Sapporo, Japan.	4	2007-2012	[1], [2], [3], [9]
	Guo, G., Zhang, H., Araya K, Jia, H., Ohomiya, K., Matsuda, J.				
Soil loosening	Novak, P., Masek, J. Benes, L. Kumhalova, J.	Czech University of Life Sciences Prague, Faculty of Engineering, Prague	4	2012-2016	[4], [10], [11], [14], [16]
	Chyba, J., Kroulik, M. Brant, V. Masek, J.				
	Masek, J. Kroulik, M. Kviz, Z. Novak, P.				
	Kroulik, M. Brant, V. Chyba, J. Zabransky, P.,				
	Matache, M.G. Voicu, G. Cârdei, P. Persu, C.	National Institute of Research - Development for Machines,	5		[5], [6],

	David, A.-D. Voicu, G. Duţu, M. Constantin, N. Irimia, D. Persu, C. Cociu, A. David, A. Voicu, G. Marin, E. Dutu, M. Gheorghe, G.	Installations Designed to Agriculture and Food Industry, Romania Politehnica University of Bucharest, Romania			[7], [8], [15]
Tillage	Sarauskis, E., Buragiene, S. Romaneckas, K. Masilionyte, L. Kriauciuniene, Z. Sakalauskas, A. Jasinskas, A. Karayel, D.	AleksandrasStulginskis University, Institute of Agroecosystems and Soil Science, Kaunas, Lithuania	9	2011-2017	[17], [18], [19]
	Hula, J. Novak, P. Kumhalova, J.	Czech University of Life Sciences Prague, Faculty of Engineering, Prague	1	2017	[10]
Tillage and tool	Liu, J. Lobb, D.A. Chen, Y. Kushwaha, R.L.	University of Manitoba, Department of Biosystems Engineering, Winnipeg, Canada	2	2007-2008	[12], [13]

Based on this analysis the most relevant articles and articles generators have been identified for the specific field of interest. Following the identified resourced will assure a high level of coverage regarding the state of the art and future trends. The proposed method can be applied to other specific fields as well in order to identify the the most notable generators of knowledge in the field of interest.

CONCLUSIONS

A bibliometric method was used to study the scientific production regarding a specific engineering field namely tillage subsoiling technology. The study was performed by interrogating eight scientific databases, considered by the authors the most relevant in the field, over a ten years period up to 2017. The results were obtained by using both automatic selections with the help of logic syntax and in some cases in order to better refine the results obtained, manual selection method was used.

The results showed the interest evolution over years and future trends in the field. Also, the most relevant articles and the origin of it as authors or institution was identified in order to reduce the future effort in finding relevant sources of knowledge for the specific field.

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ASPECTS REGARDING THE FLATTENED INSTALLATION FOR THE DRYING CEREALS IN A WET CONDITION
/
ASPECTE PRIVIND INSTALAŢIA DE APLATIZAT ÎN VEDEREA ÎNSILOZĂRII CEREALELOR ÎN STARE UMEDĂ

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Keywords: *flattening grains, conservation, superior quality.*

ABSTRACT

Grains flattening processing is one of the current work is an integral part of the silage feed technologies with high humidity.

INMA Bucharest has developed and tested an experimental model for the flattening plant for the sowing of cereals in the humid state under the high humidity harvesting and ensiling technology for the processing of grains by flattening.

The paper presents some experimental research carried out with such an installation. The obtained results generate new valid solutions for producing a high quality feed product, which will increase the production of feed, improve the nutritional qualities and increase the animal production.

REZUMAT

Prelucrarea boabelor prin aplatizare este una din lucrările actuale care este parte integrantă din tehnologiile de însilozare a furajelor cu umiditate ridicată.

INMA Bucureşti a realizat şi testat un model experimental al unei instalaţii de aplatizat în vederea însilozării cerealelor în stare umedă în cadrul tehnologiei de recoltare şi însilozare la umiditate ridicată care să realizeze prelucrarea boabelor prin aplatizare.

Lucrarea prezintă unele cercetări experimentale realizate cu o astfel de instalaţie. Rezultatele obţinute generează noi soluţii valide pentru realizarea unui produs furajer de calitate superioara, care să conducă la creşterea producţiei de furaje, îmbunătăţirea calităţilor nutritive şi creşterea producţiei animaliere.

INTRODCTION

In regions with a temperate climate, as in our country, green table is not available all year round forage production must be maintained conveniently. It is necessary to harvest the plant physiological condition optimal to reduce the loss of nutrients by conservation and to ensure high palatability of the feed. Silage is certainly the method that best meets these conditions, if carried out well-defined criteria.

Fodder is any product or by-product of vegetable, animal, mineral, and synthetic origin, which, used in animal feed, ensures vital functions and exploits their productive potential *(Samuil C., 2009)*.

Grains have a wide use in animal feed, providing more than 80% of the total forage in the diet concentrates used. The cereal grains used in the feed, the corn had the highest energy value. They are used to balance feed ratios, accounting for 30% to even 100% of monogastric concentrates (*http://www.creeaza.com*).

Nutrition and nourishment have a direct and obvious effect not only on the level of animal production but also on reproduction, growth and development processes, animal health and, last but not least, economic efficiency - a decisive factor in the development of livestock farming *(Pop M., 2014)*.

The transformation of vegetable mass production into livestock products depends mainly on the quantity and quality of the feed obtained, factors that are largely influenced by the mechanized execution of the works, especially those of harvesting, transport and processing.

Ensiling process may be likened to a three-component system: plant enzymes, bacteria, wherein each element plays a specific role.

Epiphytic bacteria (existing microflora on the plant) the developed mass in the process of ensiling fodder, metabolizând and producing soluble sugars in lactic acid bacteria, lactic acid, a natural preservative of the silo. On the plant, however, lactic bacteria are not always the majority, but may be other types of microorganisms that can degrade feed. It is known that the microflora (microorganisms) on the plant in green is totally different from that of the future silo, *(Vintu V., 2004)*.

At present, different technologies are used for ensilage,they are different and by the space used and by the method, which is different by the space used by the method, the state of the silage feed and the type of substances used for the preservation therefor.

Using technology ensilage grain with high humidity in condition flattened is one of the most successful methods but this must be done in optimal conditions knowledge and follow the defining parameters consrvare.

The use of grain silage technology in the flattened stage with high humidity, lead to the achievement of advantages, such as:

- Reduce storage space and the possibility of using simple construction, less costly;
- Releasing land for successive crops earlier and in better preparing the ground for future crops;
- Obtaining a quality silage with high digestibility;
- Obtaining various feed rich in nutrients;
- Possibility administration ration feed animals at any time of year.

In the present paper we have proposed to present some important results with a flattening installation for cereal ensilage in the harvesting technology and high-humidity ensiling of cereals.

MATERIAL AND METHOD

Methods for the preparation of cereal grain for ruminants and monogastric are different, but in general they can be divided into methods used in cold or hot. Among the methods for cold preparing included: flattening, grinding, soaking, silage grain cereals with high moisture and preserving the addition of chemicals. Methods for preparing hot cereal grains is applied to both the feed and the other foodder (oilseed), and this group of methods include: steam flattening, expansion, micronizing, roasting, extrusion and granulation (*http://www.creeaza.com*).

For the superior exploitation by natural preservation, by silage of cereal grains of the type of barley, sorghum and apple quantities of grain obtained from late varieties of varieties or from double cultures, which do not reach the autumn harvest maturity, the utilization of the stocks of wet corn in agricultural units, a technology is needed for the processing of the grains by flattening, flushing, and also for the production of high-digestibility quality silos *(Ciobanu V. G. et al., 2016; Mănişor P., 1981).*

Harvesting is done at a humidity of between 30-40%, when the physiological maturity reached; the grains accumulated the maximum of the dry substance and the black point at the base of the cariops.

The maturing stages of corn, especially milk-wax, should be followed, so as not to miss the optimal time of harvesting. If harvesting is delayed and humidity fell below 30%, the keeping quality may deteriorate because compaction is no longer done correctly and in space (air) of flattened grains can develop a bad microflora (*http://www.creeaza.com*).

High moisture corn grain of 20-30% and can be preserved using preserving agent or mixture of substances which inhibit the growth of molds and have favorable influence on the performance of animals.

The technological process of mechanization to obtain flattened concentrated concentrate for silage is represented by the following works: harvesting, loading, transport, if necessary hydro-thermal treatment of grain cereals, crushing / flattening without grinding and placing the material in the silo, Figure1.

The working process of the flattening machines / installations follows: grain cereals are loaded into the feed basket by means of a front loader or a hopper / belt conveyor are taken over by the feed roller and inserted between the rollers where the flattening process takes place. Cereal flakes obtained are collected and transported to the silo.

Cereal grains preserved in the wet state in silos or "bags" retains all the properties of nutritional energy, protein, minerals, vitamins, pigments. Acidification induced by preservation and favored by the flattening of the grains is beneficial to the digestion of the animals, so it is noticed that the nutritional value of maize and sorghum used for fattening cattle is higher by ca.10% in the case of silting of grains with a moisture content of 28-33% of the nutritional value is due to the increased digestibility of protein and starch from crushed wet grains (*Mănişor P., 1994*).

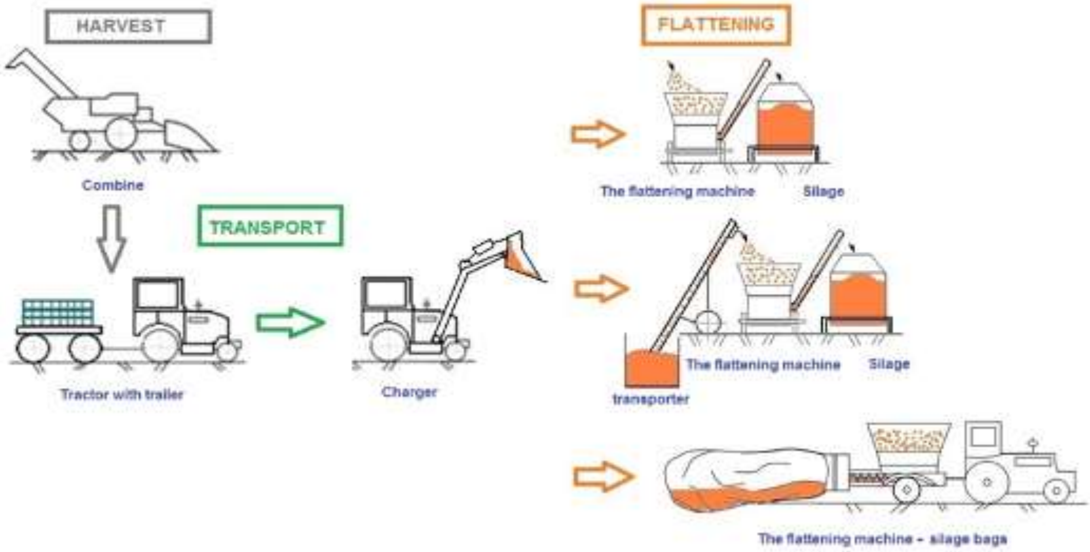

Fig. 1 - The flow of mechanization of the harvest of grain silage and grain in silos or "bags"

On the basis of the internal and international situation analysis, INMA Bucharest aims to address the issue of the superior utilization of grain cereals by wet preservation by the establishment of a specialized plant to flatten (wet) wet grains, collection by a screw conveyor, spraying a preservative crushed material, homogenizing the flat material in the interior of the conveyor with a preservative, discharging into the silage, called The flattened installation for the drying cereals in a wet condition – IAICU, Figure 2.

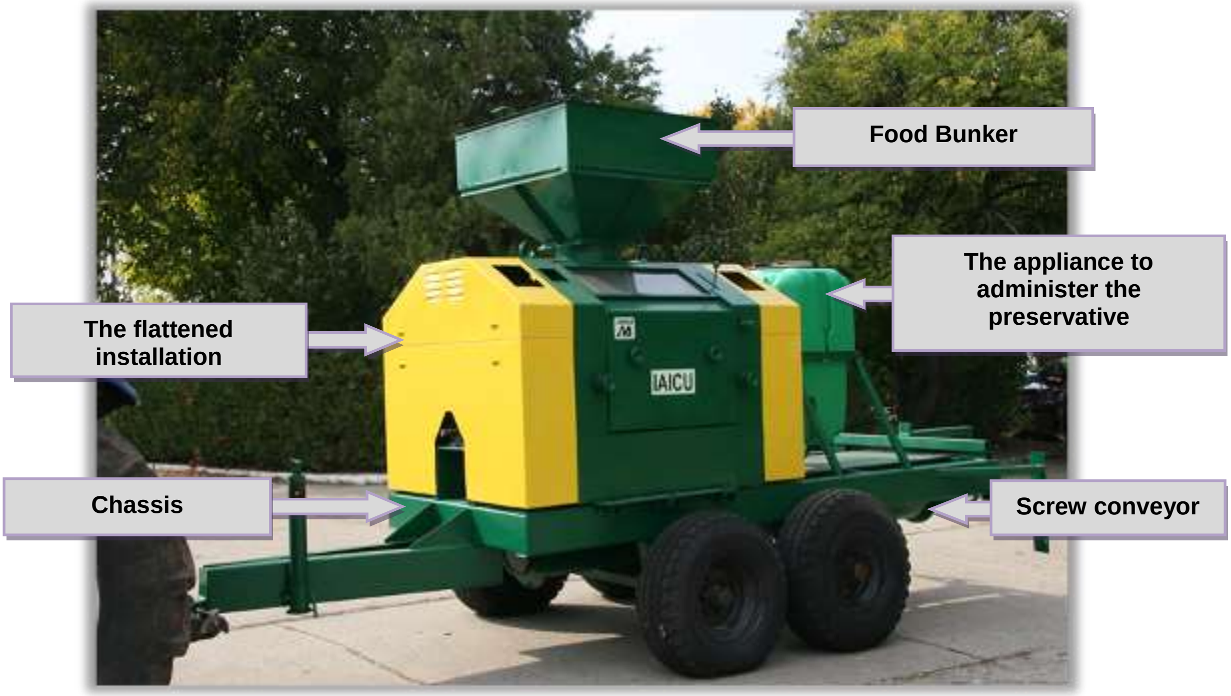

Fig. 2 - The flattened installation for the drying cereals in a wet condition, IAICU-0

The flattened installation for the drying cereals in a wet condition (IAICU) It consists of the following main parts: installation of flat IAICU-1.0; food bunker, IAICU-2.0; screw conveyor, TEV-3.0; chassis, IAICU-6.0; liquid preservative, IACL-7.0. The machine is used in aggregate with tractors with a power of more than 55 HP, and the machine is driven from the power take-off of the tractor by means of a cardan shaft.

The technological process working flat installation is as follows: processed product enters by gravity feed zone where, after accumulating up to 2/3 of its volume, the product is directed to the feed rollers whose charge can be adjusted by means of a dispenser mechanism. By providing a constant and uniform distribution over the entire active length of their work, the feed rollers, the product is fueled directly into the gap created between the ironing cylinder (fixed and mobile). Due to the differential speed between the two rollers, the product is processed by crushing or flattening. The working surface of the roller is kept free of a set of brushes specially made.

The work process takes place simultaneously in each half of roll. The drive rollers is achieved by means of a mechanical transmission chain wheels coupled to the PTO of the tractor through drive shafts.

Processed product is then sent to the steps of the gravity flow of processing that is performed by the conveyor helical transport / mixing with preservatives. IAICU used for experimentation facility type tractor New Holland 80 HP with PTO speed to 540 min^{-1}.

For the measurement, verification and recording of the experiment parameters determined according to the procedure IAICU system, apparatus and devices used for measuring only checked metrologically adjusted or calibrated properly, such as: moisture meter, tachometer, electronic balance. After idling evidence was passed to running load tests (by product). Before loading the product was checked the connection for product supply and delivery module for both passages for tansport and mixed with preservative.

Grains of corn were used to perform the experiments.

The product feed of the roller was progressively made by testing the machine at 1/4, 2/4, 3/4 and 1/1 of the provided capacity the feed capacity being adjusted by means of adjusting devices. The two passes of the roller were equipped to perform crushing technological processes.

RESULTS

In the experiments conducted have the following results:

Laboratory measurements about the organoleptic and physico-chemical properties of the product subject to the experiments, Table 1, and the degree of impurities and cracks in the raw material mass, which may affect the flattening.

Table 1

Organoleptic and physico-chemical properties of corn grain

Parametru	***Parameter value***	***UM***
Appearance and taste	characteristic of healthy corn	-
Color	reddish yellow	-
Odour	no hot smell, mold or other foreign odors	-
Hectolitric mass	76	[kg/hl]
Specific weight limits	1.4	[gf/cm^2]
Foreign bodies	1.4	[%]
Humidity	20-25	[%]

Throughout the product operation of IAICU, a series of measurements were made:

- **Kinematics**, referring to the speeds of the flattening rollers, Table 2, of the feed cylinders, as well as of the helical mixing and transport conveyor.
- **Energy**, determining the power used in the flattening process, Table 3.

Table 2

Parameters for idle operation

Crt. No.	**Parametru**	**U.M.**	**The value of the test parameters**			
			P.I	**P.II**	**P.III**	**Media**
1.	PTO speed of the tractor	rev / min	525	535	533	530
2.	Speed up the active organel flattening system	rev / min	394	400	399	398
3.	Active-power system speed	rev / min	118	120	120	119
4.	Active-speed screw conveyor organ	rev / min	70	73	68	70.33

The required power, Table 3, for actuating roller flattening machines results from the sum of the power consumed for crushing the material, the friction between the rolls, the power required for the blending and transporting of the flattened grains, and the power losses in transmissions.

Table 3

Effective power

Crt. No.	Specific feature	Number of rollers	U.M.	The value of the test parameters			
				P.I	P.II	P.III	Media %
1.	Effective power	2	HP	22.8	23.5	24.3	23.53
		4	HP	46.5	46.8	47.2	46.83

Indices of exploitation

The degree of wetting was determined by reporting the wetted grains to the total number of grains in the sample. For the assays, 3 samples of 100 grains were taken as samples, Table 4.

Table 4

Degree of crushing - sample 100 grains

Crt. No.	Specific feature	U.M.	The value of the test parameters			
			P.I	P.II	P.III	Media %
1.	Number of crushed grains	pcs.	97	95	98	96.66

The degree of wetting was determined by reporting the wetted grains to the total number of grains in the sample. For the assays, 3 samples of 100 grains were taken as samples, Table 5.

Table 5

Degree of wetting – sample 100 grains

Crt. No.	Specific feature	U.M.	The value of the test parameters			
			P.I	P.II	P.III	Media %
1.	Number of grains wetted at the exit of the helical conveyor	pcs.	90	92	95	92.33

The working capacity of the machine was determined on the basis of the results obtained under operating conditions. The capacity of the flattened grain rolls is the amount of material passing through the space between rollers in the unit of time. This depends on a number of factors, the main ones being: the work slot width, the length of the rollers, the peripheral speed of the rollers, the properties of the workpiece and the filling volume of the working slit.

Effective working capacity, Table 6, was determined by weighting the mass of grains flattened in the unit of time, in this case within one minute.

Table 6

Effective work capacity of the equipmen t- measuring time, 1 min

Crt. No.	Specific feature	Number of rollers	U.M.	The value of the test parameters			
				P.I	P.II	P.III	Media %
1.	Effective work capacity	2	t/h	22	23.5	23.8	23.1
		4	t/h	43.5	45.3	45.8	44.86

Following the experiments with the experimental model of the IAICU plant, the following idea has emerged, namely that the IAICU plant fulfills the functional role for which it was made, namely the flattening of the cereal grains, the administration of the liquid preservative and the transport of the flattened product for packaging.

CONCLUSIONS

The silage technology comprises a succession of operations that lead to the production of a good quality pickled fodder: preparation of the storage facilities; establishing the harvesting age; harvesting and transport; silage itself.

Flattening is accomplished by special machines / installations fitted with smooth or chamfered valleys, among which grain beads, resulting in smaller particles, without producing fine powders. The flattened cereals are well consumed by all animal species.

In the course of the paper the experimental researches with the IAIC system were briefly presented on the basis of a specialized methodology and analysis of the process of flattening cereal grains in a wet state, resulting in a series of exploitation indexes: the crushing rate of 97-98% a sample and the degree of wetting 100 grains of 90-95%.

The degree of wetting can increase after the packing operation by transferring moisture from the wetted to the non-wetted grains.

The actual working capacity of the machine varies depending on the number of rollers, at 2 strokes it is 22 - 23,8% and at 4 valves it is approx. 45% and the effector power ranges from 22% to 46%.

The use of this plant to obtain values mixtures for feed prescriptions in livestock farms will help to improve the quality of feed thanks to mechanical processing and the modification of the form of feed by means of flattening.

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GENERAL CONSIDERATIONS ON REED HARVESTING MACHINE FROM WETLANDS SUITABLE FOR ITS GROWING
/
CONSIDERAȚII GENERALE PRIVIND MAȘINA DE RECOLTAT STUF IN ZONELE UMEDE PROPICE DEZVOLTĂRII ACESTUIA

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Keywords: *renewable energy, GHC emission, reed harvester machine.*

ABSTRACT
Discussions about the need for renewable energy, the need for nature conservation, the need to double the world's food production to eliminate hunger, the need to reduce carbon dioxide emission, and the wish to reduce dependency on dwindling oil resources, show that these issues are intimately related and sometimes mutually exclusive. In INMA Bucharest has been designed a reed harvesting machine to correspond to environmental requirements specifically of the Danube Delta Biosphere Reservation, regarding the harvesting of reed vegetation located near the margins of the canals and lakes, as well as the reed vegetation of the floating islands especially in deep water conditions and in all ground conditions. The reed vegetation is a great ecological danger for the Danube Delta Reservation ,annual GHG emissions due to fire, in case it is not harvested at intervals of one maybe two years. The reed harvesting machine has a new technology that provides the reed vegetation harvesting as sheaves, throughout the year, especially during the warm season, when the reed vegetation is still bearing leaves, the harvested material making it suitable to obtain alternative energy. To harvest this vegetation, the harvesting machine equipment was designed to realize cutting, forming and binding the sheaves of reed vegetation in deep water conditions. The paper presents the description of the reed harvester, its components and its technical characteristics.

REZUMAT
Discuțiile privind nevoia de energie regenerabilă, nevoia de conservare a naturii, necesitatea de a dubla producția alimentară mondială pentru a elimina foametea, necesitatea de a reduce emisiile de dioxid de carbon și dorința de a reduce dependența de diminuarea resurselor de petrol arată că aceste aspecte sunt intim legate și, uneori, se exclud reciproc. La INMA București a fost proiectată o mașină de recoltare a stufului care să corespundă cerințelor de mediu specifice Rezervației Biosferei Delta Dunării privind recoltarea vegetației de stuf, situată în apropierea marginilor canalelor și a lacurilor, precum și vegetația stufului insulelor plutitoare în condiții de adâncime și în toate condițiile de la sol. Vegetația stufului este un pericol ecologic deosebit pentru Rezervația Deltei Dunării, emisiile anuale de GHG din cauza incendiului, în cazul în care nu se recoltează la intervale de un an, poate doi ani. Mașina de recoltare a stufului are o nouă tehnologie care asigură recoltarea vegetației în timpul anului, mai ales în timpul sezonului cald, când vegetația de stuf este încă purtătoare de frunze, materialul recoltat fiind potrivit pentru a obține energie alternativă. Pentru recoltarea acestei vegetații, echipamentul mașinii de recoltare a fost conceput pentru a realiza tăierea, formarea și legarea snopilor de stuf în condiții de adâncime. Lucrarea prezintă descrierea mașinii de recoltat stuf, a componentelor sale și a caracteristicilor sale tehnice.

INTRODUCTION
In a study by Greenpeace and the European Alternative Energy Council, it is reported that over the past eight years, the means needed to eliminate the causes responsible for greenhouse gas emissions have been analyzed. These are radical measures that will allow the abandonment of technologies from all activities that have led to climate and environmental changes, the cost of this "green revolution" being estimated at $ 14.7 billion, only for the preparatory phase by 2020 (*Ivan et. al., 2017*).

Reeds thrive in waterlogged and inundated areas with little competition from other vegetation, so that the stands are practically homogeneous. Reed lands are often part of valuable wetland ecosystems; they serve as grazing areas, resting and breeding places for birds and protect fish and crustaceans (*Yamian et. al.*, *2012*).

Reed Harvester Machine is a Diesel engine driven self-propelled machine, which cuts the reed, gathers and binds it in bundles and stores the storage staff on the storage platform. The bundles shall be unloaded manually by another means of transport or the storage area if it is in the immediate vicinity of the harvest area.

Cutting and shearing equipment will be positional depending on soil or water depth and will be provided with a float placed under the cutting platform to ensure the harvesting position and buoyancy of the machine with / without load in water deep. Reed harvesting, which consists of cutting the dry culms in winter to produce roof thatch, is potentially one of the most specific and sustainable use of reedbeds (*Moss et al., 2003*). It is considered as beneficial in the long term by refraining the hydroseral process, but incompatible with bird nesting activities in the short term (*Mathevet R., 2004*; *Ward D., 1992*). As a result, reed cutting in Western Europe is mostly for conservation purposes and limited to small reedbeds often located on natural reserves. Management recommendations are currently to harvest every other year while maintaining a mosaic of patches harvested over a longer (7–15 years) rotation (*Hawke and Jose, 1996*; *White et. al., 2006*). Studies conducted at Maliuc have shown that in the Danube Delta easy reed harvesting machines are required with simple construction as much as possible, suitable for very low load of land, and a transport loads made of sheaves or packets of high volume and low weight reed (*Poulin et. al., 2009*).

Commercial cutting, on the other hand, is mostly limited to large reed areas in Eastern Europe (*Sandy, 2006*; *Szijj J.,1981*). The driving platform will have a driving seat with a driver's seat, with a double joystick and shortcut switches, a chair for the operator who picks and loads the sheaves, hydrostatic transmission, electromechanical system for command transmission, electrical installation required for lighting and signaling etc.

The rack storage and transport platform will be constructed to protect the load when the machine is moving and to contribute to the buoyancy of the machine under deep water conditions. The car will be serviced by 3 people and will ensure safe working conditions.

MATERIAL AND METHOD

For not to influence the MRS floatability, regardless of the load size, the equipment has been designed with a reduced weight, being equipped with its own float. The reed harvester (Figure 1) carries out the cutting of the reed, its assembly and its attachment in sheaves, on uninhabited lands and under deep water conditions. The reed cutter, harvested and bundled, is provided with floats that ensure total buoyancy of the whole assembly, and the machine's position is not affected by deep water harvesting of the weight of the equipment.

Reed harvesting machine is composed of an equipment for cutting and tying reed sheaves, a driving platform fitted with chairs, steering column and command console, platform for storing and transporting reed to storage places, a 45 kW internal combustion motor, mechanic-hydrostatic transmission for driving and actuating the equipment, two driving wheels and two steering wheels with wide low pressure tires, which do not affect the rhizomes of the harvested reed and ensure the machine’s buoyancy with/without load, hydraulic installation for positioning the equipment, electrical installation necessary for the machine to operate and to move on public roads, etc.

Fig. 1 a - Front view

Fig. 1.b - Rear view

The reed harvester is made up of several assemblies as follows:

The front wheel assembly (Figure 2) carries out the movement and handling of the machine and consists of two left-hand wheels fitted with rim retention tires and special rims on which the hydrostatic motors. The pressure in these tires is 0.3-0.5 bar, which gives them the properties to protect the rhizomes of the reed and the suspension of the seats on the driving platform. The front wheels are also fitted with three radially disposed wheels, which are mounted on padded rims (they help to increase the speed and handling of the car when driving in deep water).

Fig. 2 - Front wheel assembly

The rear wheel assembly (Figure 3) contributes to the movement of the machine and consists of two left-handed wheels with wide tires and special rims different from those of the front wheels. These wheels ensure the machine's loadability and buoyancy under field and deep water conditions, with or without load.

Fig. 3 - Rear-wheel assembly

The hydraulic system assembly (Figure 4) carries out the movement of the machine consisting of a three-pump tandem (two hydrostatic piston pumps and variable flow for driving the hydrostatic motors on the front wheels and a gear pump to drive the transmission and the position equipment mounted on the Kubota internal combustion engine, two hydrostatic motors with piston and variable flow mounted on the front wheels, gear motor mounted on the equipment, equipment cylinder, equipment, distributors, two joysticks, pipes, hoses and an oil hydraulic reservoir.

Fig. 4. a - Hydraulic motor connections

Fig. 4. b - Distributor drive cutting mechanism

The electrical installation assembly performs the transmission of the controls to the hydraulic system, for the movement and handling of the machine and ensures the illumination of the machine for its movement on the public roads. The electrical installation consists of energy sources, a series of tracking, transmitting and warning devices, electric conductors, etc.

The welded platform assembly (Figure 5) provides the support for the assembly of wheel assemblies, riding and storing platforms, internal combustion engine, hydraulic and electric installations, balustrades, engine hoods, etc. It consists of metal profiles (rectangular and round pipes) that are found in the specific market offer.

Fig. 5 - Welded platform

The engine assembly is the energy source of the machine and is composed of the Kubota engine, 36.5 kW at 2700 rpm, and is located behind the machine (to achieve the horizontal position of the platform when harvested under deep, with / without load), air filter, water heater, motor mounting brackets and fasteners.

Fig. 6 - Kubota motor - attachment assembly

The balustrade assembly includes the fixed rails of the driving platform and the rear engine compartment and the mobile rails that are located on the sides of the reed storage platform. The balustrades are Ø32 mm round pipes.

The leading platform assembly in front of the machine ensures optimal working conditions and visibility for the driver and charger that takes the sheaves and transmits it to the charger on the reed storage platform. The driver's platform includes a driver's seat with a double port joystick and seat belt, a seat for the platform loader with a seat belt, a box of commands located on the right of the driver and a battery and toolbox. Also, the platform also includes a non-slip sheet, attached with screws on the contour.

Fig. 7 - The leading platform

Fig. 8 - Driving platform

The fuel tank assembly consists of a 30-liter capacity tank, rear-mounted gripping elements, fuel level transducer, fuel filter and engine fuel supply pipe.

The engine hood assembly (Figure 9) is composed of a metallic support bracket attached to the welded platform and sheet metal panels covering the engine, fuel tanks and oil. The panel in front of the engine has cuts required to cool the engine, and the upper ones have cutouts required to exit the air filter, fill and check the fuel and oil level of the two tanks. On the rear panel, holes are provided to fasten the rear lamps of the car. For easy removal, the panels are fastened to the support with screws.

Fig. 9 - Engine hood assembly

The equipment for cutting and supporting the equipment (Figure 10) performs the support and positioning of the cutting equipment, assembled and bonded by the sheaves, being placed between the welded platform and the equipment. It is made of a deformable parallelogram, made of round Ø32 mm pipes and fastening bolts.


Fig. 10.a - Side view


Fig. 10.b - Front view

RESULTS

Overall gauge machine:

- length: 6260 mm;
- Width: 3.4 m;
- height: 3230 mm;
- Machine weight loaded with reed: G = 2400 daN;
- Rake weight: 750 daN;
- Engine power: 36.5 kW;
- Hydrostatic transmission;
- The size of the reed storage platform:
- platform length: 3.6 m;
- platform width: 3.2 m;
- Load height: 1.8 m
- Maximum slope: α = 150;
- Maximum working speed: 5 km / h;
- Maximum displacement speed: 10 km / h;
- Tire air pressure: 0.3-0.5 bar.


Fig. 11- Reed harvesting machine in field

Table 1

Working conditions

Nr. crt	Specification	U.M.	The determined value
1	Culture harvested	-	Dried reed strains
2	Vegetable mass production	t/ha	7.85
3	Year of vegetation	-	four
4	The vegetation stage	-	dried stems
5	The appearance of the cornfield	-	uniform without plants lying down
6	Cornfield Height (Medium)	mm	1500 – 2600 (2000)
7	Average plant thickness at cutting height	mm	~ 8.5
8	Number of plants per m2.	buc.	25
9	Plant humidity harvested	%	~ 18

Table 2

Qualitative work indexes

N r. crt.	Specification	U M	Values
1	Working width	mm	1600
2	Cutting height of plants	mm	140-150
3	Knife speed	rot/min	500
4	Working capacity	t/h	5
5	Loss of material	%	5 <

Table 3

Indices of exploitation

Nr. crt	The determined size	U.M.	Values
1	Speed of work	km/h	~ 3 - 4
2	Effective working capacity	t/h	~ 7,9
3	Effective hourly working capacity	ha/h	~ 0,7
4	Fuel consumption	l/ha	~ 17

CONCLUSIONS

Reed harvesting machines represent a worldwide necessity, for our country the situation being urgent due to protection requirements specific for an UNESCO heritage area.

The reed harvesting machine will harvest reed situated in dry areas as well as the one situated on the banks of channels and ponds (floating reed islets), in the specific conditions of Danube Delta Biosphere Reservation. The reed harvester is going to be improved in the next period.

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CONSIDERATIONS ON THE ADVANTAGES OF USING NUMERICAL CONTROL MACHINES TO PROCESS PRECISION PARTS / *CONSIDERATII PRIVIND AVANTAJELE UTILIZARII MASINILOR CU COMANDA NUMERICA IN VEDEREA PRELUCRARII PIESELOR DE PRECIZIE*

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Keywords: *CNC machining, automation, manufacturing, machine tool, CNC technology*

ABSTRACT

The future development of the production process is bound to complete automation, intelligent technologies, the ability to detect errors, and, most importantly, to minimize the impact of human factors. This paper deals with the concept of building a personalized WEB application for machine tool control that provides flexibility, operation from any remote location, ensures platform independence and low cost due to the use of Open Source Architecture, although with this technology is not enough mature for the total exclusion of the worker from the processing. It provides a demonstration of the use of the power of the Internet to enable collaboration in such a configuration where key components such as man and manufacturing equipment are geographically separated. Computer Numeric Control abbreviated as CNC is a manufacturing process that incorporates automation, artificial intelligence that replaces the traditional process and machines used in the manufacturing industry. The present scenario of CNC manufacturing is limited to the worker being present at the location where the manufacturing takes place. Thus, an infrastructure to allow remote access will allow manufacturers to process a product as well as monitor real-time manufacturing.

REZUMAT

Dezvoltarea viitoare a procesul de producție este îndreptat obligatoriu spre automatizare completă, tehnologiilor inteligente, abilitatea de a descoperii erorile, și, cel mai important, să minimalizeze impactul factorilor umani. Aceasta lucrare se ocupă cu conceptul de construire a unei aplcatii WEB personalizata pentru controlul mașinii unelte care oferă flexibilitate, funcționare de la orice localizarea la distanță, asigură independența platformei și costul redus din cauza utilizării Open Source Architecture, deși cu acest lucru tehnologia nu este suficient de matură pentru excluderea totală a lucrătorului din procesul de prelucrare. Acesta oferă o demonstrarea a valorificării puterii internetului pentru a permite colaborarea într - o astfel de configurație în care componente cheie precum omul și fabricării echipamentele sunt separate din punct de vedere geografic. Computer Numeric Control abreviat ca CNC este un proces de fabricație care încorporează automatizarea, inteligenta artificiala care înlocuiește procesul traditional și mașinile utilizate în industria prelucrătoare. Prezentul scenariu al fabricării cu ajutorul CNC este limitat ca lucratorul sa fie prezent la locația unde fabricarea are loc. Astfel, o infrastructură pentru a permite accesul la distanță, le va permite producătorilor prelucreze un produs precum și pentru a monitoriza procesul de fabricație în timp real.

INTRODUCTION

It can be said that a device is numerically controlled if the instructions that allow the operation of the machine are transmitted in encoded form. According to this definition, the first numerically controlled machine was Jacquard's (1800) tissue warfare which had a perforated band port program.

The first machine-tool with numerical control (prototype) appeared in 1952 (MIT). It has been developed in the USA since 1942 to meet the needs of the aeronautical industry: making complex surfaces such as helicopter propeller blades or pockets of various shapes in large aluminium panels. Initially, this equipment had cable-powered control elements, and data was input through perforated cards. With the emergence of microprocessors and the advancement of electronics, the cost of these equipment declined until 1970. Supports and data transmission could be provided by means of diskettes, magnetic strips, etc.

This evolution, which provided real-time data processing, enabled the increase of this kind of command and favoured their integration into the construction of automated equipment. The use of the numerical control (CN) is not limited to machine tools with which the material is removed by means of cutting tools, but it is also present in the laser beam cutters, electro-erosion or electrode machining, at assembly operations, etc. She is also meeting today, commanding tables for three-dimensional machines, robots and other equipment.

With the invention of computers, their implementation in manufacturing industry has brought a revolutionary change in manufacturing industry. In this modern world the CNC machines have replaced the conventional machines.

MATERIAL AND METHOD

In the 1970 and 1980, it was common to assert the numerical command that it was only profitable to achieve large series of pieces or to generate complex surfaces with an evolving profile. This judgment was partly justified by the weight of manufacturing preparation and scheduling (many geometric calculations made by the hand, high technology switching times, and recording and reading devices were difficult and involved activities laborious).

At that time, the weak computing capabilities of the electronic control equipment did not allow real-time corrections to tool geometry and restricted the programmer from defining the axis trajectories for each tool or generator point on each tool. In other words, he had to write the program for a given tool, and the rewinding required the program to be corrected. Parallel to this, the high cost of equipment could only be accepted for large and consecutive manufacturing series.

CNC is the abbreviation for ―Computer Numerical Control‖. The idea of Computer Numerical Control is to position a computer right at the machine tool. Thus, CNC machines are those machines which are controlled by numbers while making use of computers for processing the information fed to these machines.

Machine Classification numerically controlled tools

A. Depending on the capacity of the computer There are two types of computer control systems of machine tools:

- Computerized Numerical Control (CNC) systems that use small-capacity computers (mini-computers) to control a single machine tool or several identical machines on which the same operations are performed;
- DNC (Direct Numerical Control) systems that use large capacity computers for centralized control of a group of numeric machine tools.

B. Depending on their processing, numerically controlled tools can be:

- lathes
- grinding machines
- milling machines
- drilling machines
- wire electrogene machines

The coordinate system of numerically controlled machine tools

In order to unify and facilitate the interchangeability of numerical programming data, the ISO-R 841 system for the standardization of coordinate axes and movements at MUCN has been developed and accepted. In the numerical control the axial notion was introduced as a linear displacement.

On all machine tools with numerical control:

- the Z axis coincides with the axis of the main shaft,
- the X axis represents the main axis of movement in the plane in which the positioning is performed

Coordinate axes are established according to certain rules, as follows:

• The Z axis is parallel to the axis of the main machine shaft. Thus, in a drilling or milling machine, the main shaft trains the tool, while on a lathe, the Z axis coincides with the axis of the workpiece. If the machine does not have a main shaft, the Z axis is chosen perpendicular to the work surface. The positive direction of the Z axis corresponds to the movement by which the distance between the workpiece and the tool increases.

• Axis X is generally horizontal and parallel to the work surface. It is the main axis of movement in the plane where the piece is positioned relative to the tool.

• *The Y axis is chosen to form with the other a right orthogonal system, which can also be determined with the rule of the right hand in physics.*

To minimize the manufacturing errors, the cutter contact point must be localized on the designed portion. Also, the CC points be able to transformed to CL points to reduce machining errors. With using ball cutter in 3-axis CNC milling machine, the CL point put along the typical direction of the surface's point.

RESULTS

Today, the numerical control can be used in an economical manner in the case of small series or for unique parts, even if the latter have complicated shapes.

In the example of Figure 1, relative to a plate that performs simple drilling and threading, it is noted that when making a piece we have a gain of 1h15 'compared to conventional machine tools, while the processing of 2 pieces the gain is 4h15 ', and a 10-track series already has a gain of about 40h.

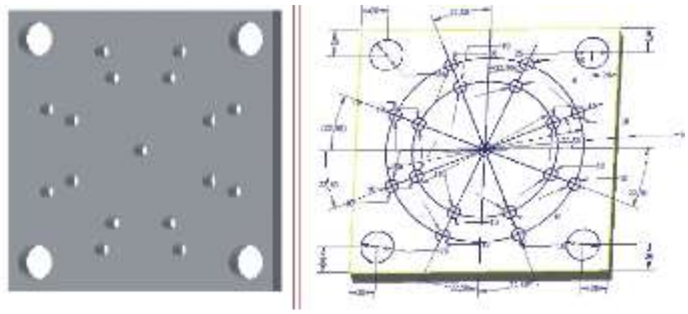

Fig. 1 – Example of the workpiece

These advantages are generally due to the technical input of the numerical control, but are much more visible in computer assisted programming that eliminates restrictions on programming times, allowing:
- the removal of tasks related to the geometric, kinematic and technological modelling of the processing process outside the workstation;
- reducing idle times by automating processing sequences, putting the tools at fast moving speeds into working position, automatically changing tools, automatically changing gears using engine control systems drive;
- reducing the number of operations required to perform accurate works: plotting, line usage, removing copiers;
- the realization of complex surfaces - by moving along several axes simultaneously and the possibility of making parts with surfaces much closer to the functional needs;
- defining optimum working conditions, because these machines offer the possibility to make it continuously varying the working speed and thus increasing tool life;
- diminishing the degree of involvement of the human factor by increasing the degree of automation of the equipment and by diminishing control tasks, which are carried out during the processing operations, of special equipment;
- the possibility of ensuring flexibility in relation to current technical developments in the area of tools for tool change, geometric and technological design, or the use of CFAC data processing systems (Computer-Assisted Manufacturing Concept).
- integration of peripheral equipment (tools for measuring instruments, manipulators, robots etc) or integration of MUCN in automated assemblies (flexible cells, manufacturing lines).

It can be seen in Figure 2 that a machine tool actually processes only 10-15% of the actual production time, the difference up to 100% being the time for adjustment, positioning, changing the tool or the piece.

Automation and numerical control allowed the real time of cutting to be increased from 15% to 35%. Automatic tool change, automatic adjustment, and piece change at the end of the machining process led to a real processing time of about 65%. Obviously, this analysis ignored the tool's durability and stops due to damage or organization.

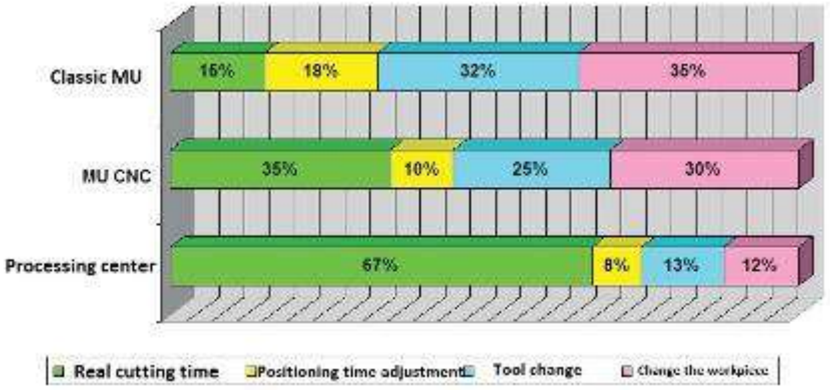

Fig. 2 – Example of the workpiece

CONCLUSIONS

These enhanced numerical control capabilities and trained units allow great flexibility and offer a wide range of workmanship that can be done with a lathe. The purpose of enlarging the range of possible machining on a lathe was on the one hand to reduce the number of machine tools needed to make complex markers, but to the same extent it was desired to make the piece from a small number of fasteners in order to increase the precision the pieces obtained.

Among the advantages of such a tool with the numerical control, we mention the disappearance of the need to use templates or models that can work very hard; the much easier and faster modification of numerical programs than rigid rigid cam programs, templates, templates; the ability to adjust at least a certain number of identical machine tools to process the same piece at the same time.

ACKNOWLEDGEMENT

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KINEMATIC ANALYSIS OF A FOLDING BRIDGE USING COMBINED TRANSMISSION FUNCTIONS BY THREE SECTORS
/
ANALIZA CINEMATICĂ A UNUI POD ROTITOR UTILIZÂND FUNCȚIILE DE TRANSMITERE COMBINATE CU TREI SECTOARE

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Keywords: *combined transmission functions, folding bridge, structural analysis, kinematic analysis*

ABSTRACT
In a previous paper, the authors made the kinematic study of a folding bridge, using linear transmission functions for controlling hydraulic cylinders. These functions have the disadvantage that, at the beginning and end of the movement phase, they cause shocks in the operation of the mechanism. Therefore, in the present paper, the kinematic study is made using combined transmission functions to control hydraulic cylinders. These transmission functions have three sectors, namely: acceleration, uniform motion, deceleration, which means a more complex and relevant analysis of the folding bridge kinetics.

REZUMAT
Într-o lucrarea anterioară autorii au realizat studiul cinematic al unui pod rotitor, folosind pentru comanda cilindrilor hidraulici functii de transmitere liniare. Aceste funcții prezintă dejavantajul că, la inceputul şi sfârşitul fazei de mişcare, produc şocuri în funcționarea mecanismului. De aceea, în lucrarea de față se face studiul cinematic folosind, pentru comanda cilindrilor hidraulici, funcții de transmitere combinate. Aceste funcții de transmitere prezintă trei sectoare, şi anume: accelerare, mişcare uniformă, decelerare, ceea ce inseamna o analiza mai complexa şi relevanta a cinematicii podului rotitor.

INTRODUCTION
In order to ensure the passage over the water courses (rivers, irrigation channels, etc.) so-called folding bridges can be built. These folding bridges allow boats over a certain height to pass through that area. Among the most well-known bridges are: Rolling Bridge, England *(https://www.youtube.com/watch?v=x0Dj7XA77hw)*, Slauerhoffbrug, Netherlands *(https://www.youtube.com/watch?v=ftIpbQ4LiMY&t=85s)*, Scale Lane Footbridge, England *(https://www.youtube.com/watch?v=AtJCUihUvZc)*, Rhyl Foryd Harbour Bridge *(https://www.youtube.com/watch?v=rOx_ZGLrgv4)* etc.

For proper operation of the mechanisms at the basis of the construction of these folding bridges, appropriate transmission functions should be used. This means that the independent parameters for actuating the drive motors must be selected so that the operation is free from shocks in the starting and stopping phases. In this respect, the kinematic study of the mechanisms of folding bridges similar to the one in London *(https://www.youtube.com/watch?v=x0Dj7XA77hw)* will be made in the paper.

MATERIALS AND METHODS
For this study, several combined transmission functions (acceleration, uniform motion, deceleration) were chosen, the equations of which are presented in the paper.

The mechanisms at the basis of the construction of the respective bridges include the motor dyads RRTaR and the passive dyads RRR (*Duca C., Buium Fl., Pârăoanu G., 2003; Moise V., Simionescu I., Ene M., Rotaru A., 2015; Pelecudi Chr., 1975; Pelecudi Chr., Maroş D., Merticaru V., Pandre N., Simionescu I., 1985; Pelecudi Chr., Maroş D., Merticaru V., Pandre N., Simionescu I., 1985; Simionescu I., Moise V., 1999*). In order to determine the kinematic parameters of these modular groups, the related calculation procedures will be applied *(Moise V., Simionescu I., Ene M., Rotaru A., 2015)*.

1. Combined transmission functions
Combined transmission functions are used to generate generalized co-ordinates of motor couplings from various drive systems of the mechanisms.

a) **Transmission function lr3 (Figure 1)**

Figure 1 shows the variation diagrams of the zero, one and two order transmission functions for the lr3 transmission function.

The curve representing the zero order transmission function consists of three portions connected in the abscissa points u_1 and $1-u_2$, namely: cubic parabola - linear - cubic parabola.

Expressions of the zero, one, two, and three order transmission functions are given by portions, namely:

- for $x \in [0, u_1]$: $$y = \frac{1}{u_1(3-u_1-u_2)}\left(3x^2 - \frac{x^3}{u_1}\right); \quad y' = \frac{3}{u_1(3-u_1-u_2)}\left(2x - \frac{x^2}{u_1}\right);$$

$$y'' = \frac{6}{u_1(3-u_1-u_2)}\left(1-\frac{x}{u_1}\right); \; y''' = -\frac{6}{u_1^2(3-u_1-u_2)};$$

- for $x \in [u_1, 1-u_2]$: $y = \frac{3x-u_1}{3-u_1-u_2}$; $y' = \frac{3}{3-u_1-u_2}$; $y'' = 0$;

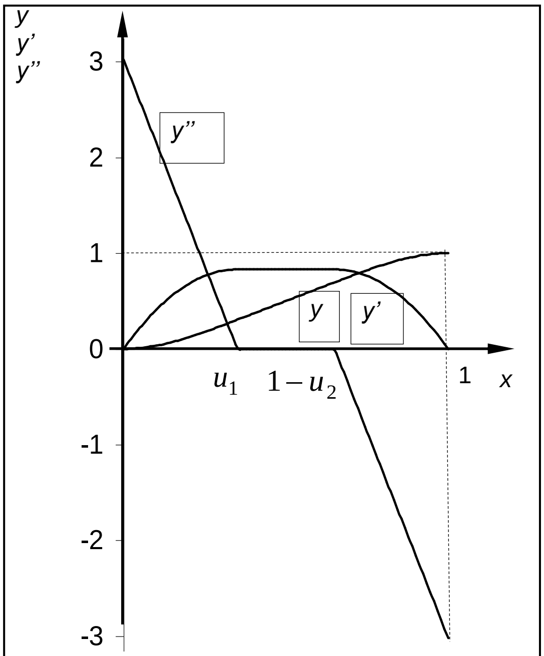

Fig. 1 – Variation diagrams of transmission functions y,y',y''

- for $x \in [1-u_2, 1]$

$$y = 1 - \frac{1}{u_2(3-u_1-u_2)}\left(3(1-x)^2 - \frac{(1-x)^3}{u_2}\right);$$

$$y' = \frac{3}{u_1(3-u_1-u_2)}\left(2(1-x) - \frac{(1-x)^2}{u_1}\right);$$

$$y'' = \frac{-6}{u_1(3-u_1-u_2)}\left(1-\frac{(1-x)}{u_1}\right);$$

$$y''' = \frac{-6}{u_1^2(3-u_1-u_2)}.$$

It is mentioned that the expressions of the transmission functions are given in the dimensionless quantity (the intervals of the dependent and independent variables are [0, 1].

b) Transmission function lrcos (Figure 2)

Figure 2 shows the variation diagrams of the zero, one and two order transmission functions, for the lrcos transmission function.

The curve representing the low acceleration, "y", is composed of three portions connected in the abscissa points u_1 and $1-u_2$, namely: cosinusoidal acceleration - zero acceleration – cosinusoidal acceleration.

Expressions of the zero, one, two, three and four order transmission functions are given by portions, namely:

- for $x \in [0, u_1]$:

$$y = \frac{2u_1}{\pi - (\pi-2)(u_1+u_2)}\left[1-\cos\left(\frac{\pi x}{2u_1}\right)\right]; \; y' = \frac{\pi}{\pi-(\pi-2)(u_1+u_2)}\sin\left(\frac{\pi x}{2u_1}\right);$$

$$y'' = \frac{\pi^2}{2u_1\left[\pi-(\pi-2)(u_1+u_2)\right]}\cos\left(\frac{\pi x}{2u_1}\right);\ y''' = -\frac{\pi^3}{4u_1^2\left[\pi-(\pi-2)(u_1+u_2)\right]}\sin\left(\frac{\pi x}{2u_1}\right);$$

$$y^{IV} = -\frac{\pi^4}{8u_1^3\left[\pi-(\pi-2)(u_1+u_2)\right]}\cos\left(\frac{\pi x}{2u_1}\right);$$

- for $x\in[u_1, 1-u_2]$: $y = \dfrac{\pi x-(\pi-2)u_1}{\pi-(\pi-2)(u_1+u_2)}$; $y' = \dfrac{\pi}{\pi-(\pi-2)(u_1+u_2)}$; $y''=0$;

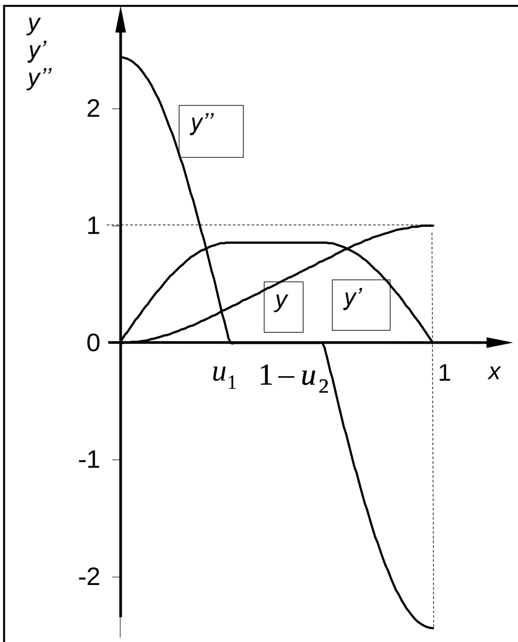

Fig. 2 - Variation diagrams of transmission functions y, y', y''

- for $x\in[1-u_2, 1]$:

$$y = 1-\frac{2u_2}{\pi-(\pi-2)(u_1+u_2)}\left\{1-\cos\left[\frac{\pi(1-x)}{2u_2}\right]\right\};$$

$$y' = \frac{\pi}{\pi-(\pi-2)(u_1+u_2)}\sin\left[\frac{\pi(1-x)}{2u_2}\right];$$

$$y'' = \frac{-\pi^2}{2u_2\left[\pi-(\pi-2)(u_1+u_2)\right]}\cos\left[\frac{\pi(1-x)}{2u_2}\right];$$

$$y''' = \frac{-\pi^3}{4u_2^2\left[\pi-(\pi-2)(u_1+u_2)\right]}\sin\left[\frac{\pi(1-x)}{2u_2}\right];$$

$$y^{IV} = \frac{\pi^4}{8u_2^3\left[\pi-(\pi-2)(u_1+u_2)\right]}\cos\left[\frac{\pi(1-x)}{2u_2}\right]$$

c) Transmission function Irsin (Figure 3)

Figure 3 shows the variation diagrams of the zero, one and two order transmission functions, for the Irsin transmission function.

The curve representing the low acceleration, "y", is composed of three portions connected in the abscissa points u_1 and $1-u_2$, namely: sinusoidal acceleration - zero acceleration - sinusoidal acceleration.

Expressions of the zero, one, two, three and four order transmission functions are given by portions, namely:

- for $x\in[0, u_1]$: $y = \dfrac{1}{2-u_1-u_2}\left[x-\dfrac{u_1}{\pi}\sin\left(\dfrac{\pi x}{u_1}\right)\right]$; $y' = \dfrac{1}{2-u_1-u_2}\left[1-\cos\left(\dfrac{\pi x}{u_1}\right)\right]$;

$$y'' = \frac{\pi}{u_1(2-u_1-u_2)}\sin\left(\frac{\pi x}{u_1}\right);\ y''' = \frac{\pi^2}{u_1^2(2-u_1-u_2)}\cos\left(\frac{\pi x}{u_1}\right);\quad y^{IV} = \frac{-\pi^3}{u_1^3(2-u_1-u_2)}\sin\left(\frac{\pi x}{u_1}\right);$$

- for $x\in[u_1, 1-u_2]$: $y = \dfrac{2}{2-u_1-u_2}\left(x-\dfrac{u_1}{2}\right)$; $y' = \dfrac{2}{2-u_1-u_2}$; $y''=0$;

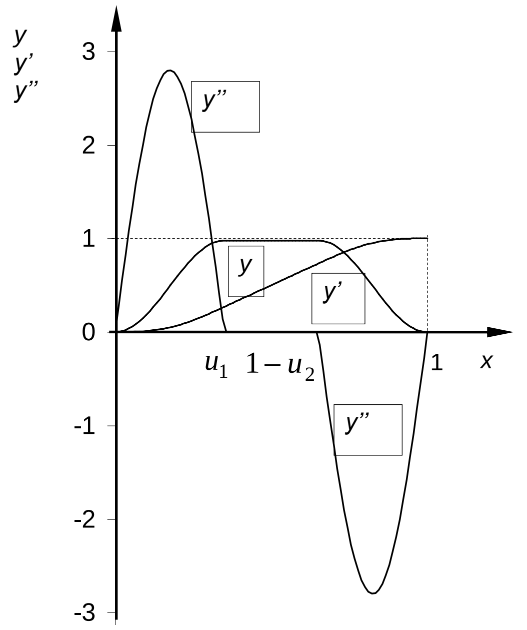

Fig. 3 - Variation diagrams of transmission functions y, y', y''

- for $x \in [1-u_2, 1]$:

$$y = 1 - \frac{1}{2-u_1-u_2}\left[(1-x) - \frac{u_2}{\pi}\sin\left(\frac{\pi(1-x)}{u_2}\right)\right]$$

$$y' = \frac{1}{2-u_1-u_2}\left\{1-\cos\left[\frac{\pi(1-x)}{u_2}\right]\right\};$$

$$y'' = -\frac{\pi}{u_2(2-u_1-u_2)}\sin\left[\frac{\pi(1-x)}{u_2}\right];$$

$$y''' = \frac{\pi^2}{u_2^2(2-u_1-u_2)}\cos\left[\frac{\pi(1-x)}{u_2}\right];$$

$$y^{IV} = \frac{\pi^3}{u_2^3(2-u_1-u_2)}\sin\left[\frac{\pi(1-x)}{u_2}\right];$$

2. Folding bridge variants

Folding bridges can be built with one or more folding segments, depending on watercourse width.

Figures 4, 5 and 6 illustrate the kinematic scheme of a folding bridge consisting of four, six and eight segments, in extended position. One of the respective segments of each bridge is fixed at the base.

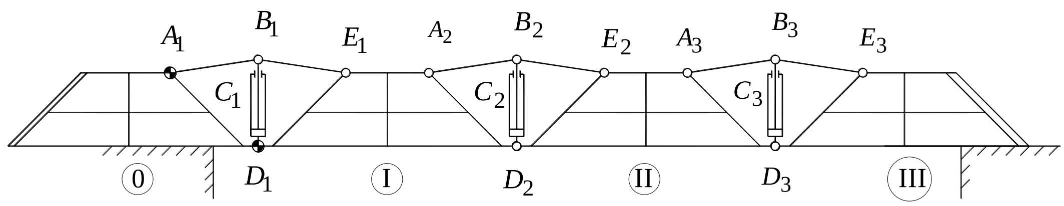

Fig. 4 - Kinematic scheme of a folding bridge consisting of four segments (extended position)

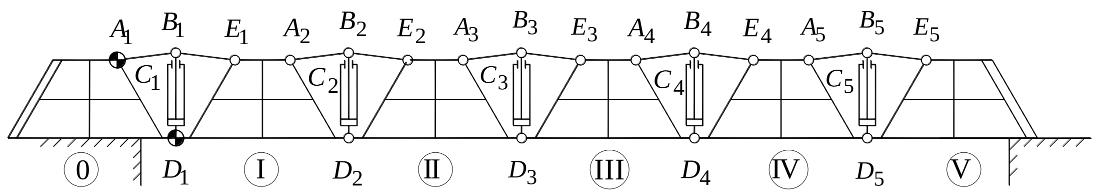

Fig. 5 - Kinematic scheme of a folding bridge consisting of six segments (extended position)

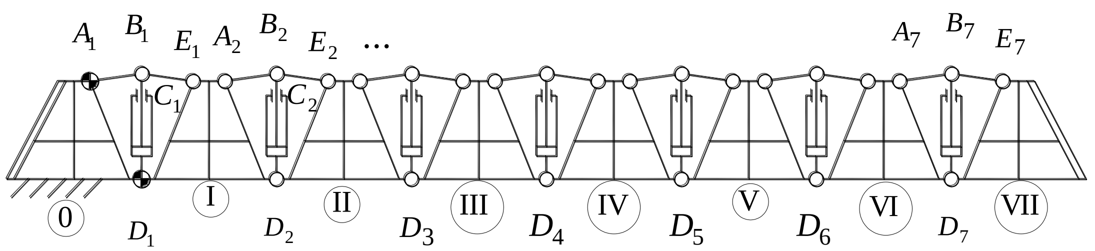

Fig. 6 - Kinematic scheme of a folding bridge consisting of eight segments (extended position)

Figures 7, 8 and 9 illustrate the kinematic scheme of a folding bridge consisting of four, six and eight segments, in folded position.

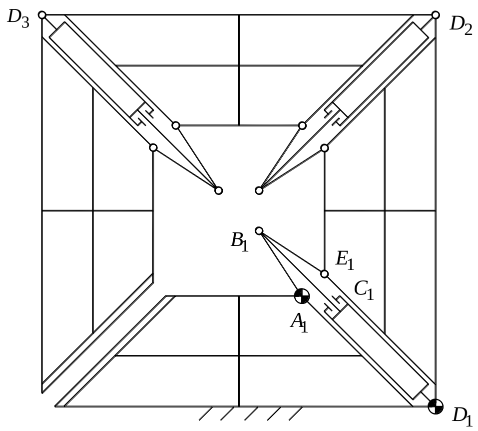

Fig. 7 – Kinematic scheme of a folding bridge consisting of four segments (folded position)

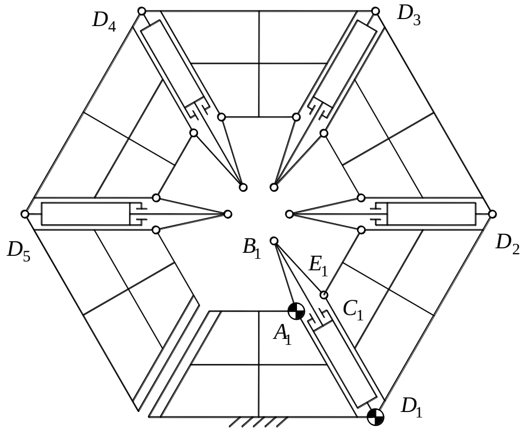

Fig. 8 - Kinematic scheme of a folding bridge consisting of six segments (folded position)

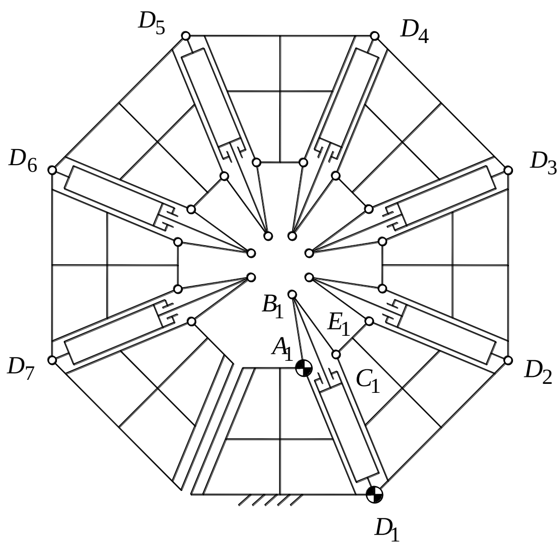

Fig. 9 - Kinematic scheme of a folding bridge consisting of eight segments (folded position)

3. The kinematic analysis of the mechanisms of the folding bridges presented

From the structural analysis of the folding bridges presented [13], it is found that they consist of a coupling of RRTaR motor groups and passive dyads of aspect 1, RRR [9, 10, 11, 12, 14, 15].

For the kinematic analysis of the mechanisms at the basis of the construction of the mentioned bridges, the procedures for the RRTaR and RRR modular groups are applied. The kinematic schemes of the RRTaR and RRR modular groups are shown in Figures 10 and 11.

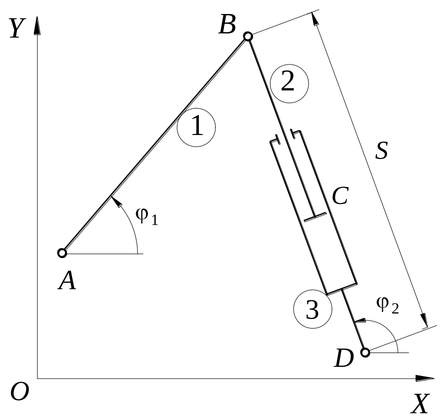

Fig. 10 – Kinematic scheme of RRTaR motor group

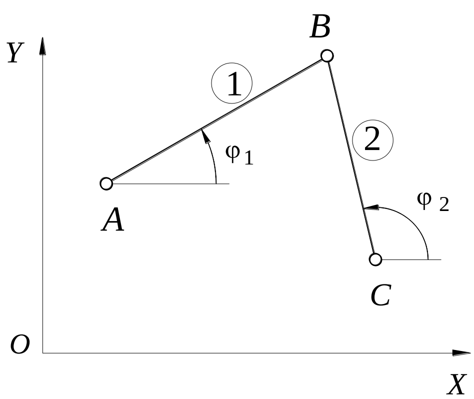

Fig. 11 – Kinematic scheme of RRR dyad

RESULTS

In the theoretical research carried out, the kinematic analysis of the folding bridge mechanism shown in Figure 8 was made, the simulation being performed by using factual data, as follows.

The dimensions of the components of the folding bridge mechanism are:

- XA1 = (E1A2)/2 m; YA1 = 0.9 m; XD1 = (D1D2)/2 m; YD1 = 0 m; A1B1 = 0.47 m; B1E1 = 0.47 m; E1A2 = 0.3 m;
- the working stroke of the hydraulic cylinders' pistons was 0.540 m;
- the initial lengths of the hydraulic cylinders are 0 m, the cylinders being completely closed;
- the transmission function corresponding to the motor coupling is LRCOS (cosinusoidal acceleration - zero acceleration – cosinusoidal acceleration);
- the folding time of the bridge was 20 seconds;
- the number of positions of the folding bridge considered is 40;
- 1 increment = folding time/(n-1).

The generalized coordinates (independent parameters) of the motor groups RRTaR are determined using the combined transmission function LRCOS presented in paragraph 1.

For exemplifying the notations, it is considered the kinematic scheme of a rotating bridge with two mobile segments (Figure 12).

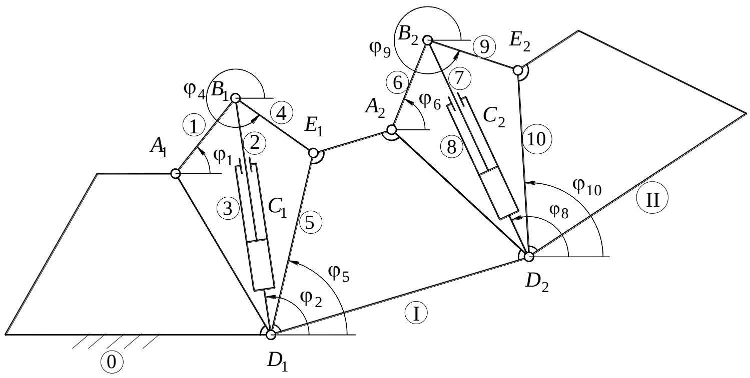

Fig. 12 - Kinematic scheme of a folding bridge with two mobile segments

Following the execution of the computational program, developed in the MATLAB syntax, the kinematic parameters (positions, velocities and accelerations) of all kinematic elements of the mechanism resulted.

Figures 13, 14 and 15 present the angles $\varphi_5 = \prec(\overline{D1E1}, \overline{OX})$, $\varphi_{10} = \prec(\overline{D2E2}, \overline{OX})$, $\varphi_{15} = \prec(\overline{D3E3}, \overline{OX})$, $\varphi_{20} = \prec(\overline{D4E4}, \overline{OX})$, $\varphi_{25} = \prec(\overline{D5E5}, \overline{OX})$, $\varphi_{30} = \prec(\overline{D6E6}, \overline{OX})$, $\varphi_{35} = \prec(\overline{D7E7}, \overline{OX})$, as well as the corresponding angular velocities and accelerations.

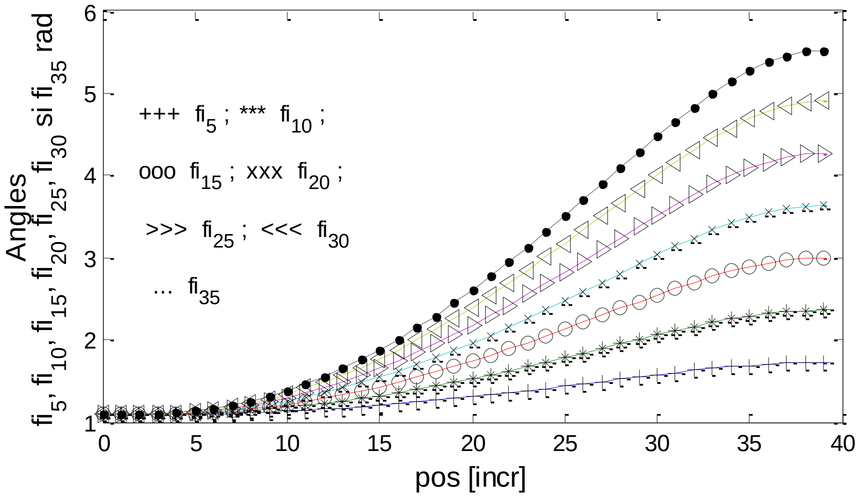

Fig. 13 - Angles $\varphi_5 = \prec(\overline{D1E1}, \overline{OX})$, $\varphi_{10} = \prec(\overline{D2E2}, \overline{OX})$, $\varphi_{15} = \prec(\overline{D3E3}, \overline{OX})$, $\varphi_{20} = \prec(\overline{D4E4}, \overline{OX})$, $\varphi_{25} = \prec(\overline{D5E5}, \overline{OX})$, $\varphi_{30} = \prec(\overline{D6E6}, \overline{OX})$, $\varphi_{35} = \prec(\overline{D7E7}, \overline{OX})$

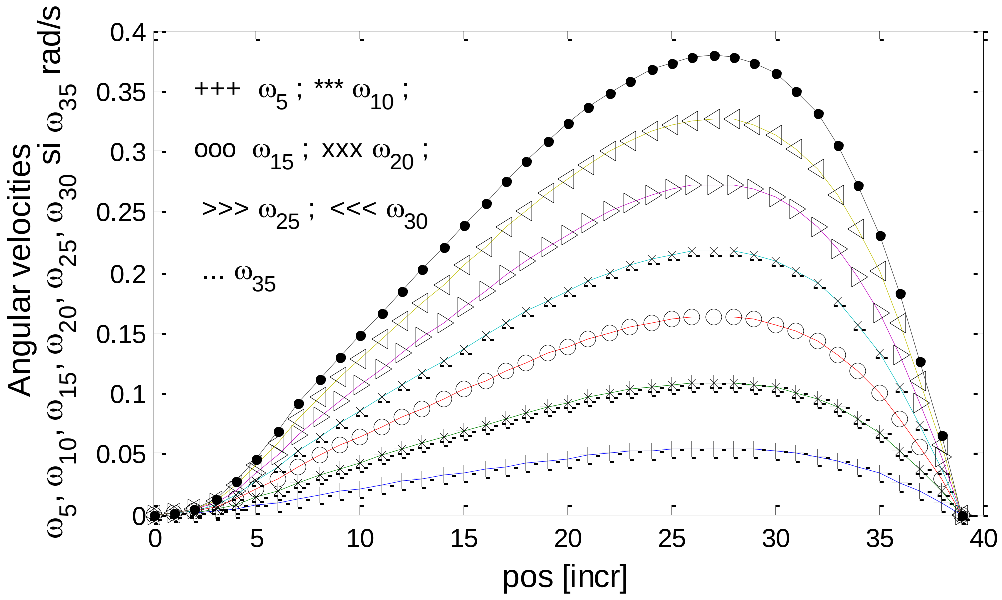

Fig. 14 - Angular velocities $\omega_5, \omega_{10}, \omega_{15}, \omega_{20}, \omega_{25}, \omega_{30}, \omega_{35}$

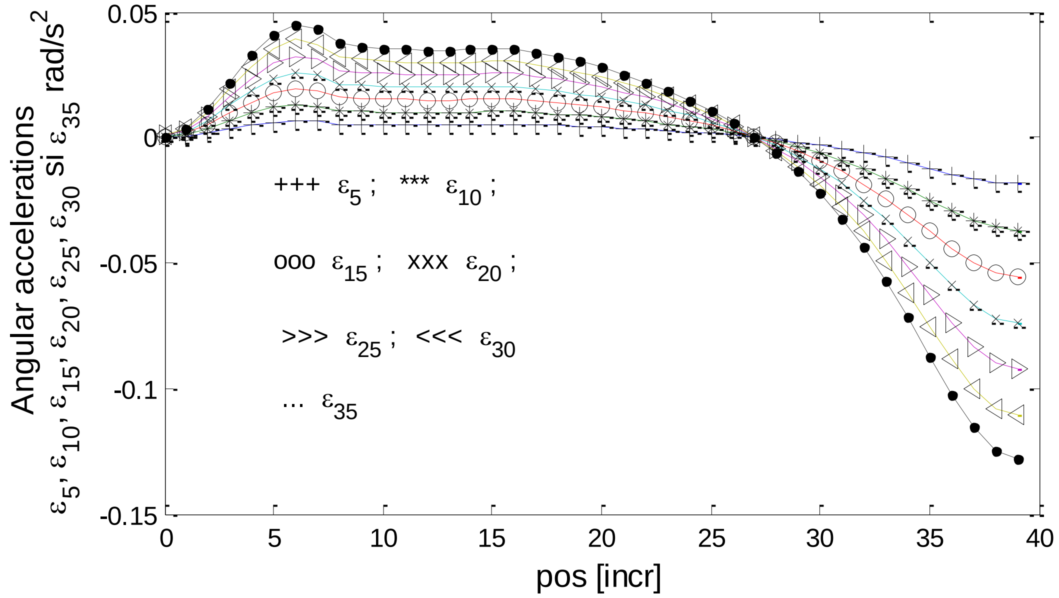

Fig. 14 - Angular accelerations $\omega_5, \omega_{10}, \omega_{15}, \omega_{20}, \omega_{25}, \omega_{30}, \omega_{35}$

CONCLUSIONS

The use of combined (three-section) transmission functions to control hydraulic cylinders leads to a silent operation of the entire mechanism. The calculation procedures for determining the independent parameters (the parameters of the motor couplings) can be easily handled, with the possibility of modifying the operating times per motion sector.

The kinematic analysis of the folding bridge mechanism results in kinematic parameters of all kinematic elements. These parameters are at the basis of the kinetostatic analysis of the mechanism, namely they are used for determining all the reaction forces in the kinematic couplings as well as the driving forces in the hydraulic cylinders.

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[13] *** https://www.youtube.com/watch?v=AtJCUihUvZc.
[14] *** https://www.youtube.com/watch?v=rOx_ZGLrgv4.

OPTIMAL SYNTHESIS OF THE MECHANISM WITH ROTATING DOUBLE CAM AND ROLLER FOLLOWER WITH ACTIVE CIRCULAR SURFACE
/
SINTEZA OPTIMALĂ A MECANISMULUI CU CAMĂ DUBLĂ DE ROTAŢIE ŞI TACHET CU MIŞCARE DE ROTAŢIE CU SUPRAFAȚĂ ACTIVĂ CIRCULARĂ (CU ROLĂ)

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Keywords: *double cam, roller follower, active circular surface, optimal synthesis*

ABSTRACT
The contact between cam and follower is done by force or shape. If the contact is maintained by force, there is the risk that the follower doesn't perform the transmission function imposed by the design theme. This is due to the fact that the spring used to maintain contact between the cam and the follower has a certain hysteresis curve. This can also lead to clearances (disconnected contact) between the cam and the follower. This paper presents the optimal synthesis of a mechanism with rotating double cam and roller follower with cylindrical active surface.

REZUMAT
Menținerea contactului dintre camă şi tachet se face prin fortă sau prin formă. În cazul în care menținerea contactului se face prin forță, există riscul ca tachetul să nu realizeze funcția de transmitere impusă prin tema de proiectare. Acest lucru se datorează faptului că arcul folosit pentru menținerea contactului dintre cama şi tachet are o anumită curbă de histerezis. Acest lucru poate conduce şi la apariția jocurilor (desfacerea contactului) între camă şi tachet. În aceasta lucrare se face sinteza optimală a unui mecanism cu camă dublă de rotație şi tachet cu mişcare de rotație cu suprafață activă cilindrică.

INTRODUCTION
As it is known from the literature *(Artobolevski I.I, 1976; Duca et al., 2003; Manolescu et al., 1972; Simionescu et al., 1996; Simionescu et al., 1999; Szekely I., 1972; Pelecudi et al., 1985)*, the contact between the cam and the roller follower is provided by force or shape. Studies on the analysis and optimization of the cam mechanism were done in the scientific works mentioned, as well as in the papers published during the various international scientific events *(Angeles and Lopez-Cajun, 1991; Cecarelli et. al., 2004; Dancea I., 1976; Lovacz et al, 2009; Moise et al., 2008).* In order to determine the minimum dimensions of the cam mechanisms, some restrictions imposed by the design theme are considered. Among the limitations of the problem are: the admissible values of the pressure angles, the size of the curvature radius of the cam direction curves, the maintenance of the sign of the curve on certain operating areas, the used transmission functions etc.

In this paper the optimal synthesis of the mechanism with rotating double cam and roller follower with cylindrical active surface is made, considering certain pressure angles and transmission functions with three sectors.

MATERIALS AND METHODS
In Figure 1 is presented the kinematic diagram of the double cam and roller follower mechanism.

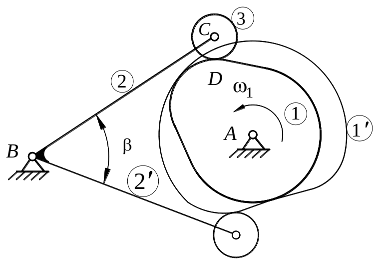

Fig. 1 - Double cam and roller follower mechanism

The optimization of the dimensions of the mechanism with rotating cam and roller follower with circular active surface consists in determining the length *L* of the follower and the angle dimension ψ_0, so that in the mechanism operation process the admissible pressure angles α_{max} and α_{min} are not exceeded. ψ_0 is the angle between vectors $\overline{BC_0}$ and $\overline{BA}$ (Figure 2). If it is considered the distance $AB = 1$, from ABC_0 triangle results:

$$r_0 = \sqrt{1 + L^2 - 2L\cos(\psi_0)} \tag{1}$$

and the sizes r_0 and L become dimensionless.

As shown in Figure 2 and in relation (1), the minimum radius of the cam depends on the length *L* of the follower and the angle ψ_0.

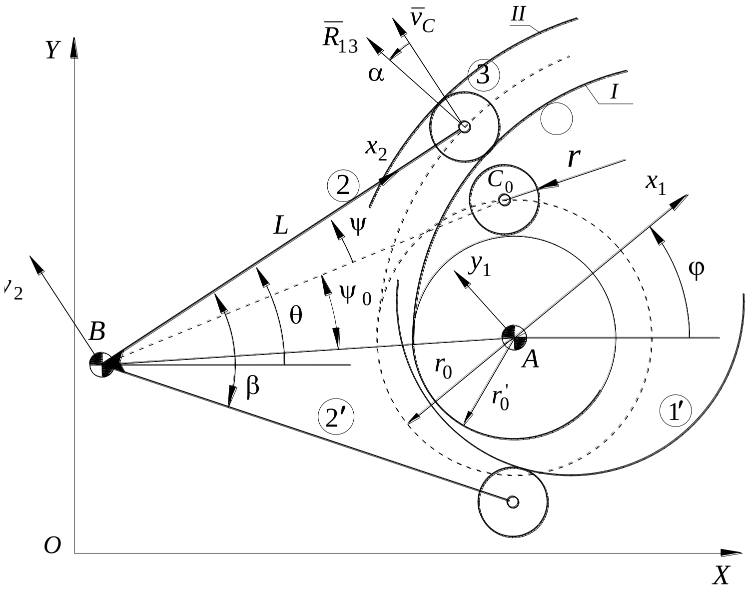

Fig. 2 - The kinematic diagram of the mechanism with rotating cam and roller follower

Minimizing the radius r_0 is done in the presence of limitations that take into account the maximum and minimum values of the allowable pressure angles in the lifting and lowering phases respectively. For the clarity of relations, we will note with ψ_1 the current angle of the follower with its initial position for the lifting phase and with ψ_3 the current angle made by the follower with its initial position for the lowering phase. In the lifting phase, the tangent of the pressure angle α, must be less than or equal with the tangent of the maximum pressure angle α_{max}, it was considered AB = 1:

$$\frac{1}{\sin(\psi_0 + \psi_1)}\left[\cos(\psi_0 + \psi_1) - L\left(1 - \frac{d\psi_1}{d\varphi}\right)\right] \le \tan(\alpha_{max}) \tag{2}$$

In the lowering phase, the tangent of the pressure angle α must be higher than or equal to the minimum pressure angle tangent α_{max}, namely:

$$\frac{1}{\sin(\psi_0 + \psi_3)}\left[\cos(\psi_0 + \psi_3) - L\left(1 - \frac{d\psi_3}{d\varphi}\right)\right] \ge \tan(\alpha_{min}) \tag{3}$$

Considering that the radical function is monotonous, the objective function has the form:

$$f(L, \psi_0) = 1 + L^2 - 2L\cos(\psi_0) \tag{4}$$

If the following notations are used we obtain:

$$g_1 = \frac{1}{\sin(\psi_0+\psi_1)}\left[\cos(\psi_0+\psi_1) - L\left(1-\frac{d\psi_1}{d\varphi}\right)\right] - \tan(\alpha_{max}) \le 0 \tag{5}$$

$$g_2 = \frac{-1}{\sin(\psi_0+\psi_3)}\left[\cos(\psi_0+\psi_3) - L\left(1-\frac{d\psi_3}{d\varphi}\right)\right] + \tan(\alpha_{min}) \le 0 \tag{6}$$

To minimize the function *f*, the method of Lagrange multipliers is used. Considering that the mathematical model contains two restrictions, two Lagrange multipliers will be used, namely λ_1 and λ_2. To convert inequalities (5) and (6) into equalities, add the variables w_1 and w_2 (it is specified that the equalities are made for the rotation angles φ_1^* and φ_3^*).

Using the following relations (1), (5) and (6), the Lagrange function is:

$$F(L,\psi_0,\varphi_1^*,\varphi_3^*,\lambda_1,\lambda_2,w_1,w_2) = f + \lambda_1(g_1+w_1^2) + \lambda_2(g_2+w_2^2) \tag{7}$$

or

$$\begin{aligned} F(L,\psi_0,\varphi_1^*,\varphi_3^*,\lambda_1,\lambda_2,w_1,w_2) &= 1 + L^2 - 2L\cos(\psi_0) + \\ &+ \lambda_1\left\{\frac{1}{\sin(\psi_0+\psi_1)}\left[\cos(\psi_0+\psi_1) - L(1-\frac{d\psi_1}{d\varphi})\right] - \tan(\alpha_{max}) + w_1^2\right\} + \\ &+ \lambda_2\left\{\frac{-1}{\sin(\psi_0+\psi_3)}\left[\cos(\psi_0+\psi_3) - L(1-\frac{d\psi_3}{d\varphi})\right] + \tan(\alpha_{min}) + w_2^2\right\} \end{aligned} \tag{7'}$$

For the minimum conditions, the identities will be considered:

$$\frac{\partial\psi_1}{\partial\varphi} \equiv \frac{\partial\psi_1}{\partial\varphi_1^*};\quad \frac{\partial^2\psi_1}{\partial\varphi^2} \equiv \frac{\partial^2\psi_1}{\partial\varphi_1^{*2}};\quad \frac{\partial\psi_3}{\partial\varphi} \equiv \frac{\partial\psi_3}{\partial\varphi_3^*};\quad \frac{\partial^2\psi_3}{\partial\varphi^2} \equiv \frac{\partial^2\psi_3}{\partial\varphi_3^{*2}}$$

The minimum of the function (7) is obtained by solving the nonlinear equations system (8).

$$\frac{\partial F}{\partial L} = 0;\ \frac{\partial F}{\partial\psi_0} = 0;\ \frac{\partial F}{\partial\varphi_1^*} = 0;\ \frac{\partial F}{\partial\varphi_3^*} = 0;\ \frac{\partial F}{\partial\lambda_1} = 0;\ \frac{\partial F}{\partial\lambda_2} = 0;\ \frac{\partial F}{\partial w_1} = 0;\ \frac{\partial F}{\partial w_2} = 0 \tag{8}$$

After solving the equation system (8) *(Dancea I., 1976; Demidovitch and Maron, 1976; Moise et. al., 2009)*, the ψ_0 angle and the length L of the follower are obtained. Using the relation (1), the minimum cam radius is determined. The relations *(Moise et al., 2011)* are used to synthesize the direction curves of the cam:

$$\begin{aligned} x_1 &= (XB-XA)\cos\varphi + (YB-YA)\sin\varphi + L\cdot\cos(\theta-\varphi) + \\ &\pm \frac{r}{\sqrt{A_1^2+B_1^2}}\left[A_1\cdot\cos(\theta-\varphi) - B_1\cdot\sin(\theta-\varphi)\right]; \\ y_1 &= -(XB-XA)\sin\varphi + (YB-YA)\cos\varphi + L\cdot\sin(\theta-\varphi) + \\ &\pm \frac{r}{\sqrt{A_1^2+B_1^2}}\left[A_1\cdot\sin(\theta-\varphi) + B_1\cdot\cos(\theta-\varphi)\right], \end{aligned} \tag{9}$$

where:

$$A_1 = (XB-XA)\cos\theta + (YB-YA)\sin\theta - L(\frac{d\psi}{d\varphi}-1);$$

$$B_1 = -(XB-XA)\sin\theta + (YB-YA)\cos\theta.$$

Taking into account the expressions of the parametric equations of the theoretical profile (punctiform follower), namely:

$$x_{1p} = (XB - XA)\cos\varphi + (YB - YA)\sin\varphi + L\cdot\cos(\theta-\varphi);$$
$$y_{1p} = -(XB - XA)\sin\varphi + (YB - YA)\cos\varphi + L\cdot\sin(\theta-\varphi). \tag{10}$$

result the parametric equations of the two profiles *I* and *II*:
Profile I

$$x_{1I} = x_{1p} - \frac{r}{\sqrt{A_1^2 + B_1^2}}[A_1\cdot\cos(\theta-\varphi) - B_1\cdot\sin(\theta-\varphi)];$$
$$y_{1I} = y_{1p} - \frac{r}{\sqrt{A_1^2 + B_1^2}}[A_1\cdot\sin(\theta-\varphi) + B_1\cdot\cos(\theta-\varphi)], \tag{11}$$

Profile II

$$x_{1II} = x_{1p} + \frac{r}{\sqrt{A_1^2 + B_1^2}}[A_1\cdot\cos(\theta-\varphi) - B_1\cdot\sin(\theta-\varphi)];$$
$$y_{1II} = y_{1p} + \frac{r}{\sqrt{A_1^2 + B_1^2}}[A_1\cdot\sin(\theta-\varphi) + B_1\cdot\cos(\theta-\varphi)], \tag{12}$$

Example of calculation:

In order to make the optimum synthesis of the mechanism with double cam and roller follower with cylindrical circular active surface (Figure 2), using the following data:

- $\psi_{max} = 0.1745329$ [rad] ($\psi_{max} = 10$ [deg]) – the maximum oscillating angle of the follower;
- $\alpha_{max} = 0.6108652$ [rad]($\alpha_{max} = 35$ [deg]) – the maximum pressure angle;
- $\alpha_{min} = -0.6981316$ [rad] ($\alpha_{min} = -40$ [deg]) – the minimum pressure angle;
- $\varphi_1 = 1.22173$ [rad] ($\varphi_1 = 70$ [deg]) – the cam rotation angle for the lifting phase;
- $\varphi_2 = 0$ [rad] – the rotation angle of the cam, for the upper dwell phase;
- $\varphi_3 = 1.22173$ [rad] ($\varphi_3 = 70$ [deg]) – the cam rotation angle for the lowering phase;
- $\varphi_4 = 3.839724$ [rad] ($\varphi_4 = 220$ [deg]) –the rotation angle of the cam, corresponding to the lower dwell phase;
- lrsin – the transmission function for the lifting phase
- lrsin – the transmission function for the lowering phase
- $XA = 0$ [mm], $YA = 0$ [mm] – the coordinates of the cam at its base, in relation to the fixed system *OXY*;
- $XB = -100$ [mm], $YB = 0$ [mm] – the coordinates of the follower at its base, in relation to the fixed system *OXY;*
- $r = (0.3 \div 0.35)r_0$ – the radius of the roller follower (r_0 is the minimum radius of the cam)

Are required:

a) the minimum size of the cam (L and ψ_0) using the Lagrange multipliers method, taking into account the imposed conditions of the design theme

b) the minimum radius, r_0 , of the basic circle of the cams, corresponding to the theoretical profile;

c) the values of the zero, one, two, three and four order transmission functions for a functioning cycle of the cam mechanism;

d) drawing the variation diagrams of the zero, one and two order transmission functions' values (dimensional)

e) the coordinates values of the direction curves of the two cams in the mobile coordinate system Ax_1y_1;

f) the direction curves of the cams.

RESULTS

a) Taking into account the coordinates of the basis joints of the cam and follower, the distance between the points *A* and *B* is *AB* =100 [mm]. Using the Lagrange multipliers method *(Moise, V et all, 2008)*, it results the minimum size of the cam, namely: *L*_dimensionless = 0.98173, $\psi_0 = 0.2386$ [rad]. The relation gives the length of the follower: *L* = *L*_ dimensionless**AB*, meaning *L*= 98.173 [mm]. Then, there are chosen $L = 98.000$ [mm] and $\psi_0 = 0.3$ [rad]. The angle β , from the two arms of the follower is given by the relation: $\beta = 2\psi_0 + \psi_{max}$. After that, it results: $\beta = 0.7745329$ [rad] ($\beta = 44.37747$ deg). In this case, the pressure angles are in admissible limits: $\alpha_{max\_\ resulted} = 27.708$ [deg] this is lower than $\alpha_{max\_\ imposed} = 35$ [deg], and $\alpha_{min\_\ resulted} = -36.920$ [deg] is higher than $\alpha_{min\_\ imposed} = -40$ [deg]. The pressure angles had been determined for a step of the rotation angle of the cam of 0.008726645 [rad].

b) For $L = 98.000$ [mm] and $\psi_0 = 0.3$ [rad], it results the minimum radius of the cam corresponding to the theoretical profile: $r_{0\,min} = 29.655$ [mm]. It was considered the radius of the follower's roller $r = 9$ [mm] ($r = \text{fix}\,(r_{0\,min} * 0.31)$.

c) There were determined the values of the transmission functions of zero, one, two, three and four degrees for a functioning cycle of the cam mechanism.

d) Figure 3 presents the variation diagrams of the transmission functions values of zero, one and two degrees (dimensional).

e) The synthesis of the directing curves of the two cams was made through Pelecudi-Sava (*Pelecudi et al., 1966*) method.

f) In Figure 4, the directing curves of the two cams are presented.

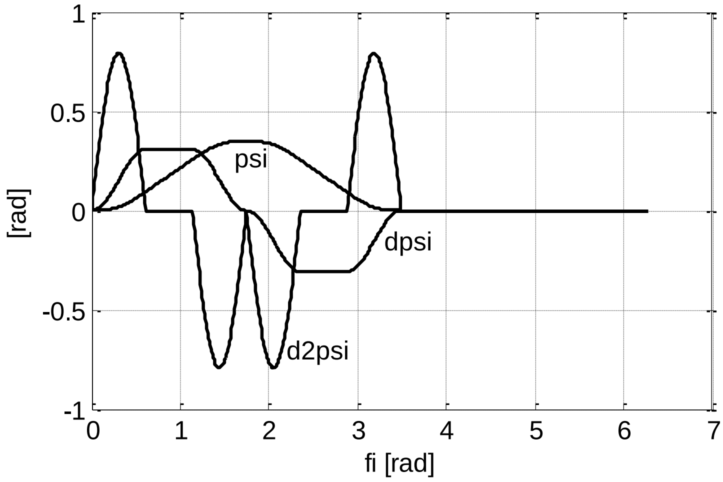

Fig. 3 - The variation diagrams of the transmission functions values of zero, one and two degrees

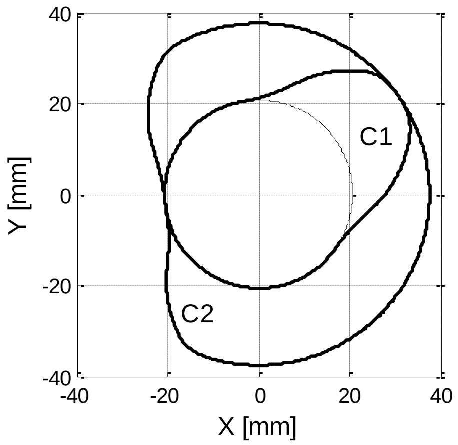

Fig. 4 - Rotation double plane cam

CONCLUSIONS

In order to maintain the contact between the cam and the follower, a double cam system was used. The Lagrange multipliers method was used to determine the minimum size of the cam. For the synthesis of the pitch curves of the two cams a transmission function with three sectors (acceleration-uniform motion-deceleration) was used.

In order to create a clearer view of the results obtained from the synthesis of the dimensions of the dual rotating cam mechanism, a whole animation program was developed using the MATLAB utility.

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ASPECTS ABOUT ORGANIC WASTE COMPOSTING IN BIOCONTAINER / *ASPECTE PRIVIND COMPOSTAREA DEȘEURILOR ORGANICE ÎN BIOCONTAINERE*

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ABSTRACT

Environmental pollution is a major issue in the modern world that is attentive to all the political and economic factors worldwide. Of the biodegradable pollutants degraded in an ecologically controlled system and by a natural process of slow aerobic decomposition, the natural fertilizer is called compost. The paper presented the technical solutions adopted for the realization of a biocontainer intended for the transformation of vegetable, food and animal waste into compost.

REZUMAT

Poluarea mediului înconjurător reprezintă o problematică majoră a lumii modern, care este în atenţia tuturor factorilor politici şi economici la nivel mondial. Din materialele biodegradabile poluante degradate într-un sistem ecologic controlat şi printr-un proces natural de descompunere lentă aerobă, se obţine îngrăşământul natural numit compost. În lucrare s-au prezentat soluţiile tehnice adoptate pentru realizarea unui biocontainer destinat pentru transformarea unor deșeuri vegetale, alimentare şi animale, în compost.

INTRODUCTION

In recent years, there has been a widespread opening of factors involved in the management of agricultural and domestic waste, adaptation to practices in the world, both technically and in terms of respecting environmental standards in the field. This is more common in zootechnical farms, especially in newly established farms, where the management of these wastes is at the level of the practices used in the European community.

There are several ways of eliminating biodegradable waste (vegetal, animal, food, etc.) with or without energy recovery, the most used being the following (*Zaica et al, 2014*): advanced thermal treatment / incineration; autoclaving (applies especially to medical waste); composting; and a less-favored method, given the large space required, the negative impact on the environment (soil, groundwater, air) and the disagreeable odor generated.

Composting represents the entirety of the microbial, biochemical, chemical and physical transformations that organic wastes suffer from their initial state until they reach different stages of humification, a qualitative state distinct from the original one. The newly obtained product is known as compost, which is a natural fertilizer with many soil benefits. If the substrate is sandy, the compost acts as a sponge and holds water, while on clay soils the compost adds porosities, protecting against water saturation or soil reinforcement *(Dobre R., 2015).*

The purpose of composting is to considerably reduce waste streams, respecting recycling / revaluation legislation and obtaining agricultural materials or land improvement works (*Zaica et al, 2014*).

Not all compost types are identical in terms of efficiency. The temperature, the humidity, the oxygen level and the materials from which it is made are critical factors in producing good quality compost. The stability and quality of composts depend on a multitude of parameters, such as the source of raw materials, the proportions used, the composting procedure and the aging time (*Arrigoni et al., 2018, Muscolo et al., 2018*).

The choice of optimal composting technology should be made on the basis of technical and economic criteria and efficiency in achieving environmentally friendly environment, as claimed by Cristescu C., (2008).

Although countless research has been carried out so far and various composting processes have been established, the issue of composting remains topical, both independently and as part of an integrated waste management strategy.

Five methods of composting plant and animal waste, classified by location and handling-aeration method, are practiced worldwide (*Ciupercă et al, 2015*):

- passive composting in an open pile;
- composting on platforms in heaps or piles using the technical equipment for returning, mixing and handling;
- composting on the platform using special pile reshaping equipment;
- static aerated stacked systems using perforated pipes;
- container composting system

A particular interest is shown for decentralized composting considered as the best available practice with a very positive impact on municipal solid waste management plans (*Arrigoni et al., 2018*). Efficiency in reducing of organic waste collected by municipal services (*Vázquez and Soto, 2017*).

MATERIAL AND METHOD

The purpose of the research was to create a container for the composting of biodegradable waste from farms, individual households, restaurants, etc., studying how raw material components, composting procedure and parameters can affect the outcome of the composting process from such an enclosure, avoiding environmental pollution

The home composting technique is suitable for treating small amounts of organic household waste, involving biotransformation of the raw material into the aerobic system by microorganisms under controlled conditions, and the production of compost as a final product (*Guidoni et al., 2018*). Domestic composting can also promote a reduction in emissions of methane (CH_4) and nitrogen oxide (N2O) during decomposition and waste transformation (*Andersen et al., 2010*), besides ammonia (NH_3), in depending on the composting system and practice adopted (*Adhikari et al., 2013b*).

In Romania, the most used methods of composting plant and animal waste, as they are used, are: passive composting in an open pile and composting on a platform, in a row or in piles using a loader with return, mixing / handling equipment.

Composting in cells, halls, containers has been developed by the desire to monitor the alteration process, to add air and water under optimum conditions.

For decentralized composting at home, composting boxes and low-capacity composting compartments made of UV resistant polyethylene (Figure 1 and Figure 2) are frequently found at home.

Composting boxes can be mounted quickly and are easy to transport. The perforated upper part ensures air and humidity circulation. The cover helps to introduce organic waste into the composting unit and the sliding door at the bottom of the container helps to drain the compost. When the container is emptied, the lid can be removed.

Fig. 1 – Small capacity containers for home composting
1.- composting boxes; 2.- composting unit KOMPOLYT (SC POLYDUCT_SRL)

The upper composting unit is closed, the air layer between the wall and the compost provides the necessary oxygen, protects against dehydration, too much moisture and guarantees the composting of waste without unpleasant odors. At the same time keep away rodents and pets. The lid helps to introduce organic waste into the composting unit, and the sliding door in the bottom cylindrical side of the container helps to evacuate the compost.

Figure 2 shows the image of a cone-shaped, made of recycled PE and PP. The composting unit is equipped with a lid, a fine-masked steel net at the bottom, which prevents mice and rats from entering, a hatch where the mature compost can be withdrawn, and a net to prevent flies from entering. The bottom has plenty of holes from where the surrounding air can enter the composting unit).

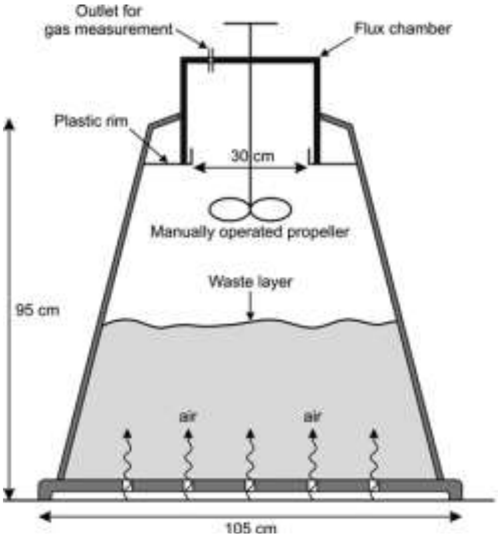

Fig. 2 – Sketch and image of a container for home composting (*Andersen et al., 2010*)

For intensive and decentralized composting of biodegradable waste in containers, composting units with a nominal loading capacity of up to 20m^3 have been made and researched. In operation there is one or two separate composting circuits with biocontainers.

Figure 3, pos. 1, shows a biocontainer with a composting circuit, is an independent technical equipment, all feeding, treatment, and automation systems are included in a service container connected by flexible, easily demountable biocontainer ducts. Such a system ensures the economical exploitation, while maintaining the functional independence of each container by the air / venting air intake ports necessary to carry out the process.

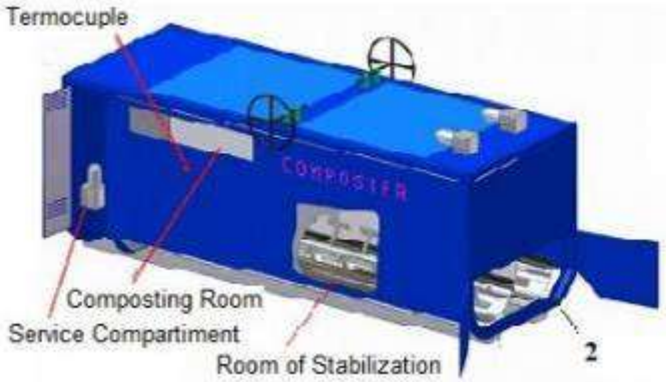

Fig. 3 – Biocontainere (*SC GLUON S.R.L*)

1. Unicameral Biocontainer; 2 - Biocontainer with two composting chambers

Figure 2 shows the sketch of the biocontainer with two composting chambers, it has two separate circuits one for intensive composting and the other for maturation, with its own loosening, aeration, exhausting, biofilter and levigated recirculation. The biocontainer works in -a continuous cycle of raw material loading-composting -maturation-discharge composting.

After loading, the composting process begins as a result of increasing the temperature in the mass of the material, the process being followed automatically by controlling the temperature and the exhaust gas. After 10 days the material is fermented and transferred to the maturing room, and new material will be brought to the first chamber.

The matured material is drained after about 10 days, resulting in a complete 20-day compost cycle. Repeat the same process for the second circuit, having the advantage that the container can work continuously.

Research by some specialists (*Muscolo et al., 2018*) shows that compost maturity does not mean the quality of compost, suggesting that the compost maturity is mainly related to composting parameters, while the quality of the compost is mainly related to the chemical composition.

During the fermentation process, the following composting parameters are monitored:

- temperature in the compost layer;
- the CO_2 and O_2 content of the exhaust gas;
- humidity of biocontainer material;
- pH of composite material.

The free volume in the container, after loading, is intended for the collection of fermentation gases and uniformity of the load.

In the composting chamber there are CO_2, CH_4, N_2O and carbon monoxide (CO) emissions, gas concentrations within the composting units being quite high.

The gas emission determines the linear increase of the gas concentration over time and can be determined, according to the relationship (1) suggested by *Andersen et al. (2010),* when the total volume of air inside:

$$E_{gas} = \frac{dC_{gas}}{dt} x(V_{total}) \tag{1}$$

Under:

V_{total} – total volume [m^3]

E_{gas}- gaz emission [kg/h]

$\frac{dC_{gas}}{dt}$- gas over time concentration.

The resulting waste gases are directed to a biofilter to reduce or eliminate unpleasant odors.

In the technological process of composting the following technological phases go through:

Sorting selectively collected material to remove pieces of plastic, glass, metal, unfermented packaging, misplaced by the population. As the selection of the population has a high degree of uncertainty, it is appreciated, from the experiments with applied long-term technologies, that about 30% non-compostable is sorted.

• grinding raw material to a grain size <50 mm

• seeding (optional) to remove the small fraction, <5 mm, which worsens the air permeability of the fermentation layer, eliminated approx. 2%.

• optimizing the composition of the material entering the composting by:

- producing a 70-80% biofermentable material from the collects and 20-30% of the structure material to ensure the fermentation of the evaporation mass;
- adding water if the humidity is below 55%;
- adding straw, dried leaves or paper if the humidity is over 55%;

• composting process in biocontainer with loss of moisture and carbonated mass approx. 55% (37% based on baseline mass).

The final useable compost, based on the initial mass of the primary waste selected in the wet grate, will be about. 31%.

RESULTS

Based on the analysis of the constructive solutions of the organic waste transformation systems in the compost, INMA Bucharest intends to address the issues of organic waste management in agricultural farms, individual households, shopping centers, restaurants etc. by making a biocontainer to be manipulated and placed in the desired places.

The biodegradable waste composite container, shown in Figure 4, is designed in a compact form and consists of the following main assemblies: stainless steel composting vessel, stainless steel mixing and homogenization system, aeration system, wetting plant, heating, control and automation systems.

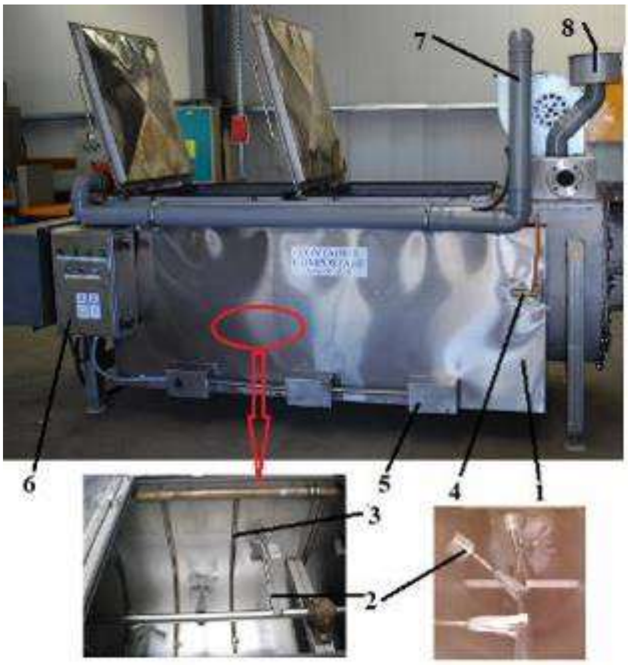

Fig. 4 - Biodegradable waste composting container, CC symbolized

1 - composting tank; 2 - mixing and homogenization system; 3 - the aeration system; 4 - wetting facility; 5-heating installation; 6 - control and automation system; 7 - air ducts; 8 - biofilter

The cuvette has two upper hinged lids and fastening and securing elements that close and open two composite material feed openings and at the back two doors: one (top) and one compost evacuation (at the bottom). In the cuvette, two separate pipes with holes are welded to the top to wet the composite material. A reservoir is provided on the walls of the tank at the bottom and on the side walls, in which water is introduced through the bottom right tap, until the filling, in case of choosing the heating of the composite material, at the initiation of the fermentation process. The degree of filling of the compartment is followed by a level indicator located on the left-hand side to the rear.

The Control and Automation System - is a complex assembly consisting of the power supply and power supply system of the mixing and mixing shaft control circuitry for actuating the fan and heating system, control panel and control. The frequency converter and control, signaling and control elements are assembled in a control and control panel mounted on the composting bin (fig.4, pos.6). On the cover of the panel are placed for information and warning light indicators indicating: presence of voltage (red); supply control circuits (green); fan operation (green), heating operation (green). Also on the lid are: a working cycle switch, a potentiometer for fan speed control, and a switch for the compost removal process.

At this biocontainer the loading can be done in a single batch at the maximum capacity of the fermentation compartment or by several batches of smaller quantities.

The fermentation process will begin as a result of increasing the temperature in the mass of the material and will be maintained by mixing, homogenization, aeration and wetting. Control of the composting process will be done by monitoring the temperature, humidity and pH:

The main technical characteristics of the biocomponent, CC, are as follows:

Gauge Dimensions (Length x Width x Height), mm 3630x1410x2150

Load volume, m^3 , ... 2

Speed of axle with blades, min^{-1} .... 7...10

Operating temperature of the heating system, ^{0}C, ... 0....70 (adjustable)

Air flow rate, m^3/h, ... 100....200

Power installed, kW, ... 14,5

The energy source required to drive the biocomponent is 380 V, 32 A, alternating current.

CONCLUSIONS

Applying the composting process as a way of eliminating biodegradable waste from individual households, agricultural and zootechnical farms, restaurants etc. is becoming more and more widespread because it is a method of ecological treatment.

The composting technique in the container is suitable for treating small amounts of organic waste involving the biotransformation of the raw material by aerobic microorganisms under controlled conditions and the production of compost, a natural fertilizer used to increase organic matter in the soil, improving the functions and physical and chemical properties of the substrate.

Following the analysis of container-type equipment built and used nationally and internationally, a small 2 m^3 capacity biocontainer designed, equipped with aeration, heating, wetting, control and control, compact and easy to transport, handled and to be located at work locations.

The realization of the biodegradable waste fermentation process inside a container determines the following advantages for the user: intensive fermentation, in short time (10-14 days); the final product is biologically stabilized; the exhaust gases are purged centrally.

Biocontainer takes a little seat and modulated development is unlimited.

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CONSIDERATIONS REGARDING THE CONSTRUCTION AND OPERATION OF AN EQUIPMENT DESIGNED TO MODEL THE SOIL IN COMPARTMENTED FURROWS IN VINEYARDS AND ORCHARDS
/
CONSIDERATII PRIVIND CONSTRUCTIA SI FUNCTIONAREA UNUI ECHIPAMENT DE MODELAT SOLUL ÎN BRAZDE COMPARTIMENTATE LA PLANTATII VITI-POMICOLE

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Keywords: *water, soil, interrupted furrows.*

ABSTRACT

Recently, the climate changes have more and more manifested by prolonged draught periods, while population number is continuously growing, therefore the agricultural production per surface unit should be increased, in order to cover the people food needs. View the reduce water resources, promoting new techniques and technologies able to efficiently valorize the water coming from different sources, with reduced energy consume, is very important. In vineyards and orchards, water is conducted along the row or is uniformly stocked by means of continuous or interrupted (compartmented) furrows. This paper aims at analyzing the construction and operating method of a soil modelling equipment in compartmented furrows, simultaneously in two furrows in a single interval, PCVM2,2+EMBC2-0, in tree and vine plantations.

REZUMAT

In ultima perioadă, schimbările climatice au început să favorizeze din ce în ce mai mult perioadele cu secetă prelungită, în timp ce populația crește, astfel fiind necesară creșterea producției agricole pe unitatea de suprafață pentru acoperirea nevoilor de hrană. Resursele de apă sunt reduse și de aceea este importantă promovarea de tehnici și tehnologii care să valorifice eficient apa provenită din diverse surse, cu consum redus de energie. În plantațiile viti-pomicole, dirijarea apei în lungul rândului sau stocarea uniformă se realizează cu ajutorul brazdelor continue sau întrerupte (compartimentate). Lucrarea își propune să analizeze construcţia şi funcţionarea unui echipament pentru modelat solul în brazde compartimentate la plantații viti-pomicole, simultan în două brazde pe un interval, PCVM2,2+EMBC2-0.

INTRODUCTION

In order to supply additional water quantities (besides those naturally received through rains) to soil, quantities that were established according to soil, climate and plant requirements, supplementary works are necessary. When establishing the water additional quantity, it should take into account that the soil layer where roots develop keeps an optimum humidity. Having in view the decrease of arable surface comparing to population increment, increasing the agricultural production per surface unit remains the main solution able to meet the many and high-quality food requirements.

In order to achieve high agricultural yields, it should take into consideration a lot of factors (mechanization, fertilization, weed and pest control, soil biological potential, seed quality), each having its importance, but the lack of water in soil, during periods that overlap the plant critical growing phases, diminishes the harvest and even destroys it because of draught.

In Romania, the surface with economic irrigating potential is estimated at 3 million ha, out of which 1.5 mill ha. are highly efficient. In this context, irrigations will become the most important consumer of water in agriculture and one of the main national consumers, requiring approximately 35-45% out of Romania water resources. Romania water resources are rather reduced, of about 1660 m3/habitant, and in other European countries they are 2.5 times bigger. Thus, it is very important to promote techniques and technologies able to efficiently valorize water coming from different sources, with reduced energy consume. Water from soil and its circulation is mainly important, as approximately 41% out of Romania arable surface is affected by an excessive humidity in certain periods of the year and during the same year, short or long periods of draught are present; so, the irrigation with variable norms should be applied. At the same time, erosion phenomena are manifested on 35% out of the entire agricultural surface.

Water stock in Romania is rather modest comparing to other countries in Europe (the 11th place for local resources and 21st place for resources formed on its territory) (*Biolan et. al., 2015*). Gravity wetting is the oldest irrigation form. Surface drip consists in the fact that water is distributed on the field by free flowing in furrows or stripes concomitantly with water infiltration into soil. Method extended also to hoeing crops sown in stripes or at bigger distances between rows with a minimum slope necessary to free water drip into the furrow (*Biolan et. al., 2016*). The opening of interrupted furrows is necessary in the following situations:

✓ In unevenness or sloped (that determine the water dripping and stagnation in micro-depressions) fields designed to be irrigated by fixed and mobile spraying installations;

✓ In broken relief and little slope fields, non-arranged for irrigation and where the rain water drips rapidly downstream, not being used by plants and determining the erosion phenomenon.

Farmers are interested in preserving soil humidity and, therefore, they searched for appropriate methods to collect and stock a maximum quantity of water in soil, in order to meet the crops requirements. They recognize that during several years, crops yield was limited because of draught in majority of area in the country. Rains fall randomly, so the water quantity does not comply to plants requirements. Majority of rainfalls during the vegetation season happen during great intensity showers. Only a small part of rainfalls infiltrates into the soil, the rest of it provoking excessive drippings and erosion. Thus, a method of collecting rainfall water consists in culture practices, namely creating compartmented furrows (*Song et. al., 2014*). Little dams are performed by an agricultural machine endowed with working sections, each of them breaking the soil with a chisel, scraping it with a hoe and forming from place to place, at established distances, little dams that gather the rainfall water.. Machine is used in a reduced slope field, in arid or semi-arid areas, where is a shortage of water in crops.

MATERIAL AND METHOD

Irrigation represents an important technological phase in crop plants agro-technology, and also the most important technical mean of eliminating the soil water shortage, constituting the infrastructure of a sustainable development. Technologies of fighting against the climate change effects have importantly evolved through the reduction of water consume for plants (dripping, micro-spraying), high valorization of water by losses diminishing and performing agricultural works such as fertilization, herbicide applying, etc and utilization of other sources of water (wastewater coming from animals or rural, urban and industrial environment). Furrows used in agriculture are extremely important for agricultural production and represent a main component of agricultural ecosystem (*Guo et. al., 2009*; *He et. al., 2006*; *Li, 2016*; *Song et. al., 2014*). It is estimated an increased agricultural production per hectare by 20% for agricultural crops, where interrupted furrows are performed. This is explained by a big quantity of water that infiltrates at plants roots and also by reducing soil erosion (*Biolan et. al., 2015*).

When performing continuous or interrupted furrows, it is aimed to obtain large sections of furrow necessary to transport and respectively to accumulate a big volume of water. For low-drainage soils, farmers prefer to use alternative furrows.

Fig. 1 - Continuous and compartmented furrows after rain

Fig. 2 - Alternative furrows (*Edwin and Alexander, 1986*; *Biolan et. al., 2016***)**

The opening furrow work is named rarefying (soil modelling) and, at first was performed by little plows pulled by animals. Now, this is performed by the machine working in aggregate with a tractor; an equipment designed to perform continuous furrows or an equipment specialized in performing interrupted furrows being mounted on the machine.

The machine equipped to perform continuous furrows comprises small plows performing the furrow triangular section, and modelling devices performing parabolic section and furrow finishing; the machine designed to perform interrupted furrows comprises the main small plows, blade rotors and a mechanism that controls the rotors designed to interrupt the furrows and make small dams (stoppers); both equipment is mounted on a frame with supporting wheels.

RESULTS

Equipment for soil modelling in compartmented furrows in vine and tree plantations, simultaneously in two furrows in the same space, PCVM2,2+EMBC2-0 (Figure 3) performs compartmented furrows at a distance of 20-40 cm in row, in order to accumulate rainfall water into the soil on which surface the drips fall, thus avoiding the water dripping outside the cultivated area or water accumulation in depressing areas, on sloped fields of up to 5 %, with light, medium or heavy texture soils, ploughed at minimum 250 mm depth, at a humidity close to minimum extreme limit.

Fig. 3 - Equipment for soil modelling in compartmented furrows in vine and tree plantations, simultaneously in two furrows in the same space, PCVM2,2+EMBC2-0

Equipment designed to model the soil in compartmented furrows simultaneously in two furrows in vine and tree plantations, PCVM2,2+EMBC2-0 comprises the following sub-assemblies: a left plough body, a right plough body, a device for forming compartmented furrows endowed with control mechanism and optionally, two arrow knives, if concomitant hoeing is desired.

Plough bodies with left and right supports are mounted on plough frame in lateral parts corresponding to ploughing with furrow overthrow to the row inner side, having the distorted body supports to outer frame.

Device to perform compartmented furrows (Figure 4) is formed of following main parts: command mechanism, rotor support, blade rotor and blade pressing mechanism on soil. Adjustment of mechanism designed to compartmented furrows will allow to create soil stoppers along the furrow at distances of 1.5; 3 or 6 m.

Fig. 4 - Device of forming compartmented furrows

Mechanism of command (Figure 5) comprises: spur wheel, a transmission system and a driving mechanism.

Fig. 5 - Command mechanism

Spur wheeel is metallic and is endowed with steel spurs on the rim aimed at increasing the wheel adherence to soil, avoiding its skidding. The spur wheel should be mounted in a hinged manner at frame central part, being able to vertically oscillate around the spindle that drives the cams, in order to „copy" the field during the working process. For transport position, the spur wheel should be fixed in vertical position.

Transmission is of chain type and aims at transmitting the movement from the spur wheel to the cam wheel spindle. Transmission is made of: support, chain wheels, chain 10 A and protection device.

Driving mechanism (Figure 6) aims at unlocking the blade rotor in order to form the soil cork on the furrow. Driving mechanism comprises:

- support of cam spindle- 3 pieces (2 pieces for cams and one piece for spur wheel),
-cam wheel,
- lever/cable and locking bolt.

Fig. 6 - Driving mechanism

The supports of cam spindle are mounted on rear bar of frame, behind the plough body, and the cam wheel and the lever are mounted on the support. Spur wheel support should be mounted on the bar behind the frame, in central position to the direction of spur wheel.

Cam wheel is made of one disk parallel with the disk with lever role, and cams (1,2 or 3) are mounted on cam wheel disk, according to distance chosen for creating the soil corks for furrow compartments. Lever is hinged on the support on the direction of cams and has at one end one reel and at the other end one bolt fixing the steel cable. The cable transmits the movement from the lever driven by cam to the bolt locking the blade rotor. The ratchet is made of an axle with a welded plate at its end. Axle slides in two couples represented by two steel thimbles fixed on rotor support. On the axle is mounted a spring that compresses when driving the locking mechanism and helps to lock the blade when driving mechanism does not work. This mechanism has a secure operating without blocking.

Support of the rotor is mounted on the lateral bar of the frame, behind the body. It comprises: a vertical axle, a fork and a bar supporting the spring that presses the blade rotor on soil. The fork is hinged at vertical support and can freely oscillate in vertical plan and supports the blade rotor, the lower end of pressing spring of scraping blade in soil and thimbles guiding the locking ratchet axle.

Rotor is made of 4 pentagonal-shaped blades fixed on an axle, the angle between two close blades being of 90^0. The blade has a vertical external side, position that enables the working section to approach the plant row without harming the plants with the blades.

Pressing spring on soil of scraping blade is mounted by means of a steel rod between the fork supporting the rotor and the bar endowed on vertical support.

CONCLUSIONS

Compartmented furrows are the result of a mechanical work of soil that performs furrows interrupted by soil heaps, at adjustable distances, for forming small basins of accumulated water. During the rainfalls, the excessive water is gathered in these basins so that it could be slowly absorb by the soil, thus removing the dripping outside the cultivated area. This is very important, because during strong showers, the intensity of rainfalls often surpasses the water speed of infiltration.

Experience has demonstrated that wind erosion can be also reduced. In sloped fields, by practicing compartmented furrows, prevention and reduction of water stagnation in low areas of cultivated field, can be achieved. The basins limited by small dams aim at temporarily stock the water coming from rains, (which, otherwise would flow outside the cultivated surface) that will infiltrate into the soil, thus increasing the soil water stock and capitalizing the rainfall water. This practice has been largely adopted due to new irrigation technologies, as well as, to equipment designed to perform compartmented furrows. This equipment performs small dams at 1-2m distance in the furrow. Some cultivators do not open furrows on the path crushed by tractor wheels when applying herbicides or during other agricultural operations.

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DIGESTER SYSTEMS FOR THE TREATMENT OF AGRICULTURAL AND NON-AGRICULTURAL WASTES USED FOR OBTAINING BIOENERGY (BIOGAS) BY WET DIGESTION
/
SISTEME DE DIGESTOARE FOLOSITE PENTRU TRATAREA DEŞEURILOR AGRICOLE ȘI NON-AGRICOLE UTILIZATE PENTRU OBȚINEREA DE BIOENERGIE (BIOGAZ) PRIN DIGESTIE UMEDĂ

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Keywords: *wet digestion, digesters, waste, bioenergy.*

ABSTRACT

The paper presents a synthesis of the bioreactor systems used for the treatment of waste in the production of bioenergy (biogas) by wet digestion. Biogas production is a very good way of meeting more restrictive national and European regulations on the use of organic waste for energy production, followed by their recycling as fertilizers. Biogas production technologies contribute to reducing the amount of waste, as well as the costs of removing these wastes.

REZUMAT

Lucrarea prezintă o sinteză a sistemelor bioreactoare utilizate pentru tratarea deșeurilor în producția de bioenergie (biogaz) prin digestie umedă. Producția de biogaz este o modalitate foarte bună de a respecta reglementările naționale și europene mai restrictive privind utilizarea deșeurilor organice pentru producerea de energie, urmată de reciclarea acestora ca îngrășăminte. Tehnologiile de producere a biogazului contribuie la reducerea cantității de deșeuri, precum și la costurile de eliminare a acestor deșeuri.

INTRODUCTION

Anaerobic digestion is a biochemical process, by which complex organic substrates (vegetative biomass and waste, animal waste (livestock manure), organic waste, wastewater, sewage sludge, etc.) are decomposed, in the absence of oxygen, to the stage of biogas and digestate, by various types of anaerobic bacteria. Numerous types of biomass can function as substrates (raw materials) for the production of biogas through anaerobic digestion. The most common categories of raw materials are: manure, agricultural residues and by-products, digestible organic waste from the food industry and agro-industries (of vegetable and animal origin), organic household waste and catering waste (of vegetable origin and animal), sewage sludge, energy crops (e.g., corn, Chinese cane - *Miscanthus*, sugar sorghum or fodder sorghum, topinambur, clover, etc.) (*Achour et al., 2000; Al Seadi, 2001*).

Substrates of the anaerobic digestion process can be classified according to their origin, dry matter content (DM), methane production, and also by other criteria. Substrates with less than 20% dry substance content are used for so-called wet digestion (some authors call it wet fermentation). This category includes livestock manure, as well as wet organic organic waste from the food industry.

Anaerobic digestion is a microbiological process of decomposition of organic substances, in the absence of oxygen. The main products resulting from this process are biogas and digestate. Biogas is a fuel gas, consisting mainly of methane and carbon dioxide, typically used to produce electrical current and heat, (*Al Seadi, 2001; Dotzauer et al, 2018)*. Subjected to a process of improvement, biogas can also be introduced into the natural gas network or used as fuel for motor vehicles, in electric piles or to produce other forms of energy.

After the production of biogas, the decomposed substrate (digestate) is recycled by introduction into the soil, being used as a fertilizer for crops. During the anerobic digestion process, a very small amount of heat is generated, compared to the case of aerobic decomposition (in the presence of oxygen), such as composting. The energy contained in the chemical bonds of the substrate remains, mainly, stored in the produced biogas, as methane.

The essential element of a biogas plant is the digester, a sealed tank to prevent air penetration, in which the raw material is subjected to the anaerobic digestion process, thus producing the biogas. The common features of all digesters, in addition to sealing, are: the existence of a feed system to supply the feedstock, as well as the presence of the biogas and digestate disposal systems. Worldwide, there is a wide constructive range of digesters for biogas. Thus, concrete, steel, brick or plastic digesters, are used, in the form of silos, troughs or ponds, located in the subsurface or on the surface. The dimensions of a biogas plant are determined by the dimensions of the digesters, ranging from a few cubic meters, in the case of small household plants, to large commercial plants, which have several digesters, each with volumes of thousands of m^3. Choosing of the construction type of the digester is mainly determined by the water content, respectively the dry matter content of the digested substrate. As mentioned above, the technology of anaerobic digestion operates with two basic systems: wet digestion, if the average dry matter content (DM) of the substrate is less than 15% and dry digestion when the content in the dry substance of the substrate is above this value, usually between 20-40% (*Achour et al., 2000; Al Seadi, 2001; Foreest, 2012)*.

Agricultural biogas plants mainly process the substrates from agriculture (e.g., manure, residues and by-products from agricultural crops, dedicated energy crops, etc.). Cattle and swine animal waste is the basic raw material for most biogas plants, although in the past two years, the number of plants using dedicated energy crops has increased. Raw manure is commonly used as an organic fertilizer, but the anaerobic digestion process improves its fertilizer value by:

- Animal manure of various origins (e.g., cattle, swine or poultry) is mixed in the same digester, which leads to a more balanced nutrient content.
- Through the anaerobic digestion process, complex organic substances are decomposed (including organic nitrogen), thereby increasing the amount of nutrients that are absorbable by crops.
- Co-digestion of animal manure together with other substrates (e.g., slaughterhouse waste, fats and residual oils, household waste, vegetable residues, etc.) adds a substantial amount of nutrients to the mixture of raw material (*Gunaseelan, 2012*).

MATERIAL AND METHOD

By their size, mode of operation and location, biogas agricultural plants (using the process of wet anaerobic digestion) are divided into three main categories:

- ✓ Family-level biogas plants (small scale).
- ✓ Farmer-level biogas plants (from medium to large scale).
- ✓ Centralized / co-digestion plants (from medium to large scale).

Family-level biogas plants. The technology used to build a biogas plant varies from one country to another, depending on the climatic conditions and the national context (e.g., energy policies, legislation, energy industry capability, etc.) In developing countries such as Nepal, China or India, millions of family-level biogas plants operate using very simple technologies. The raw material used in these biogas plants comes from households and / or their small farming activities, and the biogas produced is used for household and lighting purposes. Digesters are simple, inexpensive, robust, easy to handle, and they can be built with locally available materials. Usually, there are no control tools or CPU heating systems (psychrophil or mesophilic mode of operation), because many of these digesters operate in a warm climate and have a long HRT.

a) The Chinese type (Figure 1a) is represented by an subsurface (underground) reactor, usually with a volume of 6 to 8 m^3. It is fed with sewage sludge, animal manure and organic household waste. The reactor operates semi-continuously, and the new substrates are added once a day, with the same periodicity being discharged an equal amount of the decanted liquid mixture. This reactor doesn't have a stirrer, which is why the decanted solid suspensions must be removed 2-3 times a year, at which time most of the substrate is removed and only a small part (about one-fifth of the reactor content) is left as inoculum. The first Chinese reactor was built in 1958 (*Al Seadi, 2001)*.

b) The Indian type (Figure 1b) is similar to the Chinese type, i.e. it is an underground reactor for small-scale household and farm wastes. The difference is that the effluent is collected at the bottom of the reactor, and the floating bell with gas also functions as a biogas tank.

c) Another type of small-scale biogas plant is that of the mobile plant, which consists of a horizontal cylindrical reactor, fed with substrate at one end while the digestate is collected at the opposite end. The substrate moves through the reactor in the form of a block flow, a fraction of the discharged material being recycled, in order to dilute the newly added raw material, thereby inoculating it.

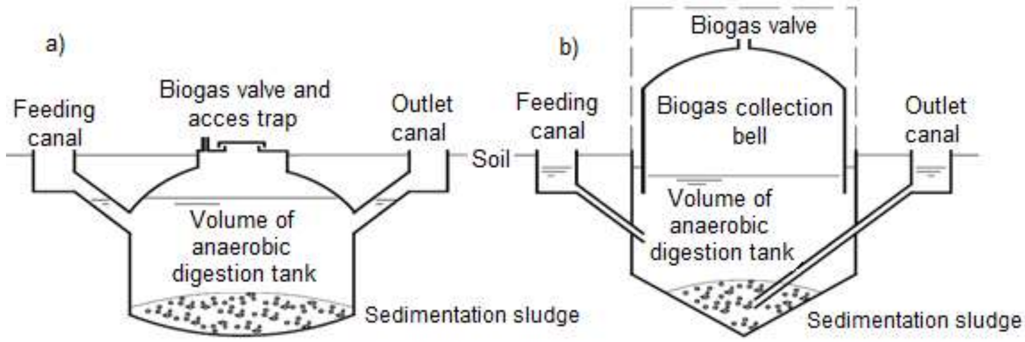

Fig. 1 - Types of rural biogas reactors: *(Al Seadi, 2001)*
a) Chinese type; b) Indian type

Farmer-level biogas plants. At present, the interest of farmers in the technology of anaerobic digestion is increasing. Biogas production creates new business opportunities, reduces the amounts of waste and produces high quality fertilizer. Worldwide, there are many types of farmer-level biogas plants. In Europe, countries like Germany, Austria and Denmark are among the pioneers of farm-scale biogas production. A farmer-scale biogas plant serves only one farm, digesting the raw material resulting from its own activity. Many biogas plants also use the co-digestion of small amounts of methane-rich substrates (e.g., oily waste from the fish processing industry, vegetable oil residues, etc.), aiming to increase methane productivity. It is also possible to feed animal manure from one or two neighboring farms (e.g., via pipelines).

Farmer-level biogas plants have different sizes, various construction types, and a whole range of processing technologies. Some of these factories are of very small sizes and they use simple technologies, while others are very large and complex, similar to centralized co-digestion factories. However, they all work along the same general constructive plan: the waste is collected in a pre-storage tank, located near the digester, which is fed by pumping pre-stored raw material. The digester is built in the form of a sealed tank, made of steel or reinforced concrete and thermally insulated, to maintain a constant temperature of the process (mesophilic at about 35^0C, or thermophilic at about 55^0C) (*Hanxi et al, 2018*).

The digesters may be horizontal or vertical, usually provided with mixing systems, in order to homogenize the substrate and to minimize the risk of formation of flotation and sediment layers. Mixing also assures the supply of microorganisms with all the nutrients they need. The average hydraulic retention time (HRT) is usually 20-40 days, depending on the type of substrate and the digestion temperature. The digestate is used as fertilizer on the agricultural field in the farm, and the surplus is marketed to nearby farms that have vegetal crops. The produced biogas is used as a fuel in a gas engine, aiming to produce electricity and heat. Approximately 10-30% of the heat and electricity produced in this way is used for the own needs of the biogas plant and for household consumption of the farm, while the surplus is sold to the energy companies, respectively to the consumers of thermal energy in the neighboring areas.

The basic scheme of a typical farmer-level biogas plant equipped with a horizontal stainless steel digester is shown in Figures 2 and 3.

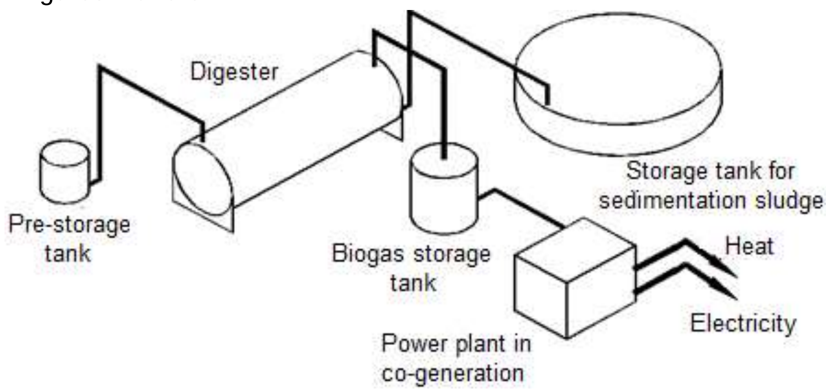

Fig. 2 - Schematic representation of a farmer-level biogas plant with horizontal steel digester *(Al Seadi, 2001)*

Besides the digester, having a volume of 100-200 m^3 and equipped with a slow stirring system, the factory also includes a pre-storage tank for waste, a storage tank for digested biomass, a biogas storage facility and a co-generation unit of electric and thermal energy (CHP). The temperature of the anaerobic digestion process may vary, from the mesophilic to the semi-thermophilic (35-48^{0}C) range, and the hydraulic retention time is in the range of 15-25 days. Biogas production is between 40-50 m^3 of biogas per m^3 of digested biomass.

Fig. 3 - Horizontal digester, built in Denmark (*Nordisk Folkecenter, 2001*)

The digester can also be built in the form of a vertical cylinder with a conical base (Figures 4 and 5) consisting of a so-called "two in one" tank, which is used both for the storage of raw feedstock and for the digestion. The digester is built inside the digestate storage tank, tangentially to its wall. and is covered with a gas-impermeable membrane, which will be maintained in tense state under the influence of the produced biogas. The tank is also equipped with an electric propeller stirrer. Also, the plant has a pre-storage tank for the co-substrate, as well as a CHP unit. The processing temperature is 22-25 ^{0}C and the hydraulic retention time is over 50 days (*Scarlat et. al., 2018*).

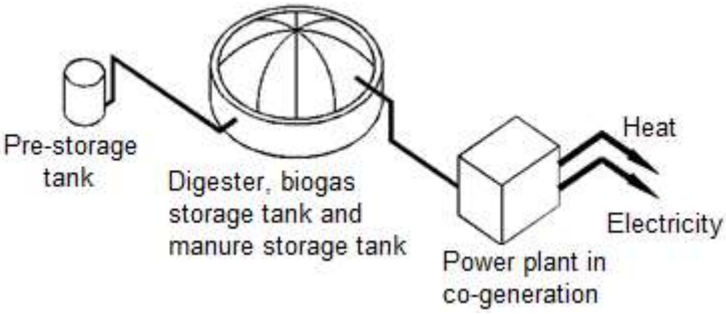

Fig. 4 - Schematic representation of a farmer-level plant, equipped with a "two-in-one" digester, covered with a light membrane (foil) *(Al Seadi, 2001)*

Fig. 5 - Image of a Danish farmer-level biogas plant, that co-digests animal waste and energy crops *(Al Seadi, 2001)*

Fig. 6 - Vertical digester in Germany, for the processing of manure from swine and poultry farms and silage *(Al Seadi, 2001)*

Recent developments in the field of biogas plants at farmer-level are those of using biomass from dedicated energy crops. The advantage lies in the energy content of this type of biomass, which is much higher than that of most organic waste. However, there are some limitations and problems regarding the operating costs, the mode of usage and field availability for this type of crop.

Fig. 7 - Vertical digester from Germany, built in 2005 for the digestion of biomass from energy crops *(Al Seadi, 2001; Hanxi et al, 2018)*

Centralized co-digestion plants. Centralized co-digestion is a concept based on the digestion of animal manure, collected from several farms, in a biogas plant located centrally to these. The central location of the biogas plant is made aiming to reduce the costs, time and labor force needed to transport the waste and the digestate between the farm and the biogas plant. Animal manure is subjected to co-digestion, mixed with a variety of feedstock (e.g., digestible agricultural residues, residues from food, fish and agro-industries, sorted organic waste or sewage sludge). Centralized co-digestion plants (also known as joint co-digestion plants) are widely used in Denmark (Figure 8), but also in other regions of the world with a developed zootechnical sector.

Fig. 8 - Image of a centralized co-digestion plant in Denmark *(Al Seadi, 2001)*

Animal manure (from cattle, swine, as well as manure from turkeys and poultry) is stored pre-storage tanks in the farm and in sludge collection channels. From pre-storage facilities, the manure is transported, according to a set schedule, to the biogas plant, in special sealed tubular containers. At the location, they are mixed with other co-substrates, homogenized and pumped into the digestion tank. The biogas plant is responsible for collecting and transporting of the fresh manure from farms to the plant, respectively of the digestate in reverse. The digestate is transported directly to field areas where it must be applied as fertilizer, where farmers have already set up a number of digestate post-storage facilities. The digestion process takes place at both mesophilic and thermophilic temperatures, and the HRT is 12-25 days (*Scarlat et al., 2018*). After digestion, it takes place a controlled hygiene process of the substrate, in order to achieve an effective reduction of pathogen populations and the germination capacity of the weed seeds, thereby ensuring a safe recycling of the digestate as a fertilizer.

The digester is continuously fed, the biomass mixture being pumped into the digester and discharged from it in equal amounts, in a strict pumping sequence. The discharged digestate is transported through pipelines to the storage tanks. In many cases, these tanks are covered with waterproof membranes, aiming to capture the biogas produced in the post-digestion phase (up to 15% of the total) at lower temperatures. The resulted biogas is collected together with that produced inside the digester. The digestate is then analyzed and characterized in terms of nutrient content (DM, VS, N, P, K, pH), after which it is transported to the farms (feedstock suppliers) and stored in the post-storage on the field. Farmers receive only the amount of digestate permitted by law to be dispersed on the agricultural field, and the excess is sold to neighboring farms. In all cases, the digestate is included in the fertilization plans of each farm, replacing mineral fertilizers. Thus, biogas production is a stage in the circuit of recycling nutrients from animal manure and organic waste (Figure 8). Many centralized plants are also equipped with facilities for separating liquid and solid fractions from the digestate.

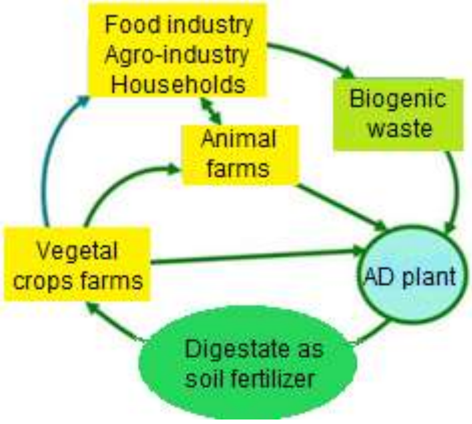

Fig. 8 - Schematic representation of the closed circuit of centralized biogas plant (*Achour et al., 2000; Al Seadi, 2001)*

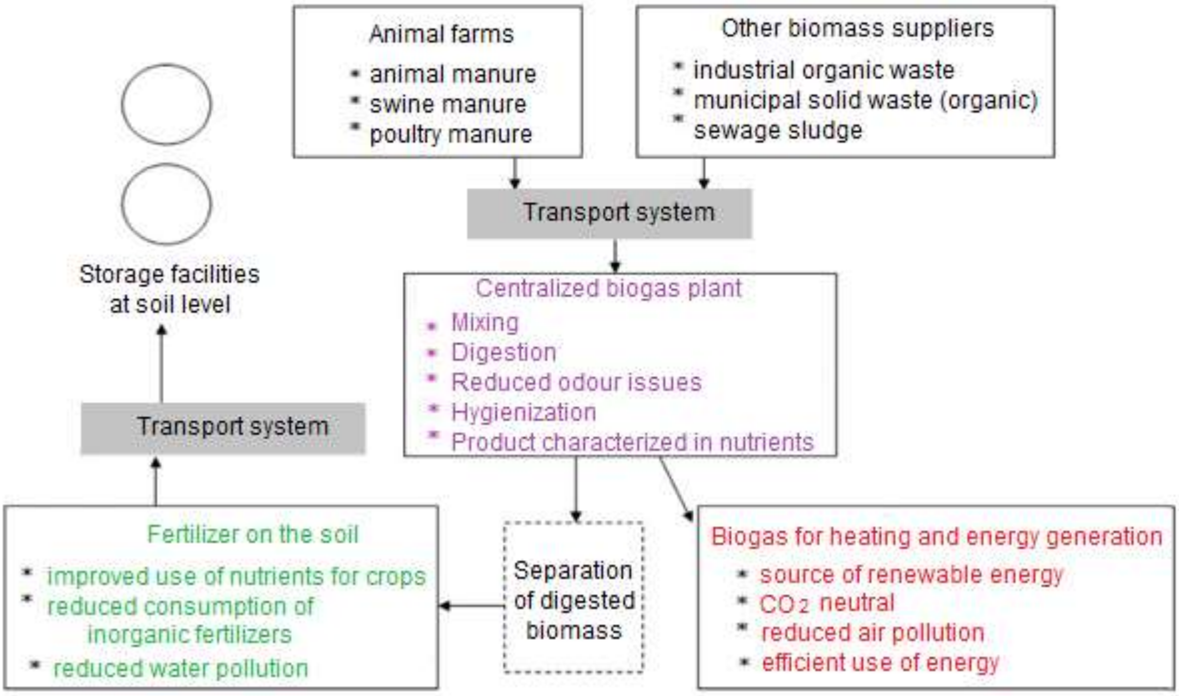

Fig. 9 - The main streams of the integrated concept of a centralized co-digestion plant (*Achour et al., 2000; Al Seadi, 2001)*

Centralized co-digestion is an integrated system for the production of renewable energy, for the treatment of organic waste and for nutrient recycling. This generates benefits at farm, environmental and economic level for the farmers, for the biogas plant operators and for the society as a whole, ensuring:

- Cheap and environmentally-friendly recycling of animal manure and organic waste.
- Production of renewable energy.
- Reduction of greenhouse gas emissions.
- Improved veterinary safety, by sterilizing the digestate.
- Improved efficiency of fertilization.
- Fewer inconveniences caused by unpleasant odors and insects.
- Economic benefits for farmers.

Most centralized co-digestion plants are organized as cooperative companies, in which the farmers who supply them with feedstock materials are at the same time shareholders and owners. Typically, these companies have a board of directors responsible with plant management, hiring the necessary staff and concluding all economic and legal cooperation agreements on plant construction, its supply with feedstock material, the distribution / redistribution of the resulting fertilizer, energy trading and financing. In Denmark, cooperative companies proved to be feasible organizational structures in economical and functional terms.

RESULTS

When the biogas leaves the digester, it is saturated with water vapors and contains, besides methane (CH_4) and carbon dioxide (CO_2), various amounts of hydrogen sulfide (H_2S). The latter is a toxic gas, with unpleasant odor, similar to that of rotten eggs, which, in combination with water vapors contained in the biogas, forms sulfuric acid. The acid has corrosive properties and attacks the generators of the power generation unit, but also other components, such as gas and exhaust pipes. Hence, desulphurisation and drying of biogas is mandatory.

Manufacturers of co-generation power units impose minimum conditions regarding the properties of fuel gas (Table 1). This also applies to the biogas. The combustion properties must be guaranteed, in order to prevent generators from being damaged.

Table 1

Minimum properties of combustible gases with relative O_2 content of 5% (*Achour et. al., 2000; Al Seadi, 2001*)

Energy value (decrease in energy value)	Hu	≥4 kWh/m³
Sulfur content (total)	S	≤2.2 g/m³ CH_4
or content of H_2S	H_2S	≤0.15 vol.-%
Chlorine content (total)	Cl	≤100.0 mg/m³ CH_4
Fluorine content (total)	F	≤50.0 mg/m³ CH_4
Sum of chlorine and fluorine content	(Cl + F)	≤100.0 mg/m³ CH_4
Dust (3...10 µm)	-	≤10.0 mg/m³ CH_4
Relative moisture (at the lowest temperature of the air allowed in the burner), or the degree of condensation in the supply pipeline and the gas flow control system	Φ	<90%
Gas pressure before entering the flow control system	p_{Gas}	20...100 mbar
Ffluctuationof gas pressure		<±10% of the set value
Gas temperature	T	10...50 °C
Hydrocarbon content (>C5)		<0.4 mg/m³ CH_4
Silicon content (at a content of Si > 5 mg / m³ CH4, analysis of metal content in the oil showed a value <15 mg / kg of oil)	Si	<10.0 mg/m³ CH_4
Methane index (MC biogas aprox. 135)	MZ	>135

Methane productivity of the substrates subjected to the anaerobic digestion process depends on the content of proteins, fats and carbohydrates, as shown in Table 2.

Table 2

Theoretical productivity in biogas of different substrates (*Achour et. al., 2000; Al Seadi, 2001*)

Substrate	**Liters of gas / (kg x tonne of substrate)**	**CH_4 [%]**	**CO_2 [%]**
Raw proteins	700	70-71	29-30
Raw fats	1.200-1.250	67-68	32-33
Carbohydrates	790-800	50	50

CONCLUSIONS

According to the new 2009 Council Framework Directive proposed for Renewable Energy Systems (RES), Romania must ensure by 2020: 24% energy distribution from RES of total electricity consumption and 10% of total energy consumption in transport by biofuels. The set of target indicators for electricity from RES foreseen in the 2001 European Directive provided that Romania should have achieved by 2010 the distribution of 33% of energy from RES, from the gross electricity consumption and according to the 2003 European Directive for biofuels, to reach in 2010 a consumption of 5.75% of biofuels, out of total fuels for transport.

So, the obtaining of bioenergy (biogas) through the processes of wet methanogenesis using the technologies and digestion systems (bioreactors) presented in the article it is seen as a key solution for encouraging the sustainable development of rural areas, that can support the production of non-food goods and growing of energy crops and reforestation of abandoned fields.

Thus, the integration of projects for biogas plants / development / into local / regional projects of sustainable development, especially in rural areas, is a viable and adequate alternative through which can be solved both energy problems and waste management issues and diminishing of chemicals in agriculture by using the digestate as fertilizer. As long as the potential for urban and rural waste is very high, it is expected that both the interest and investments in biogas area will increase, especially in rural areas, for biogas plants based on agricultural feedstock (both from primary and secondary production).

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A NEW MACHINE FOR GRASSLAND RESEEDING, MSPM-2.5 TYPE
/
NOUA MAȘINĂ DE REÎNSĂMÂNȚAT PAJIȘTI, TIP MSPM-2.5

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Keywords: *degraded grassland, improvement, reseeding, machine*

ABSTRACT

The improvement of degraded grasslands by reseeding method is the main technology, which is applied on grasslands with an advanced degree of degradation. The new machine for grassland reseeding, MSPM-2,5 type, is designed for the sowing of fodder grass plants (grass and legume plants) carrying out through one pass, three works strictly necessary for the reseeding technology of the grasslands: rolling before sowing, sowing of fodder grass plants and rolling after sowing. The paper presents the experimental trials results of agricultural aggregate consisting of a wheeled tractor and the new machine for grassland reseeding, MSPM-2,5 type.

REZUMAT

Îmbunătățirea pajiștilor degradate prin metoda de reînnoire este principala tehnologie care se aplică pe pajiștile cu un grad avansat de degradare. Noua mașină pentru recoltarea pășunilor, tip MSPM-2.5, este proiectată pentru însămânțarea plantelor de iarbă și legume printr-o singură trecere, trei lucrări strict necesare pentru tehnologia de reînnoire a pajiștilor: rulare înainte de însămânțare, însămânțarea plantelor de iarbă furajere și rulare după semănat.Lucrarea prezintă rezultatele experimentale ale agregatului agricol alcătuit dintr-un tractor cu roți și noua mașină de recoltare a pășunilor, tip MSPM-2.5.

INTRODUCTION

The mechanization of grassland farming involves the mechanization of all the necessary technological sequences, starting with the optimal conditions for the installation and development of the plants, continuing with sowing of the grassland forage mixtures and ending with the maintenance works of the grasslands after reseeding.

For this purpose, at the Research-Development Institute for Grassland Brasov, a special sowing machine, MSPM-2,5 type, was designed, realized and tested. It works in aggregate with wheeled tractors of 59-81 kW (80-100 HP) and is a carried out on the three point hitch.

As a result of the specific characteristics of grass and perennial legume seeds (*Ene and Mocanu, 2016*), the sowing machine was designed to meet the agronomic requirements for grassland establishment by total renovation, as sowing depth, inter row distance, sowing rate, the uniformity of the mixture that is suited to the area and destination, close contact between seeds and soil etc.

MATERIAL AND METHOD

The main components of the new sowing machine, MSPM-2,5 type (Figure 1), are: assembly frame (1), anterior roller (2), posterior rollers (3), sowing equipment (4), the mechanism of motion transmission to metering and stirring devices (5) and removal device of tractor wheel marks (6).

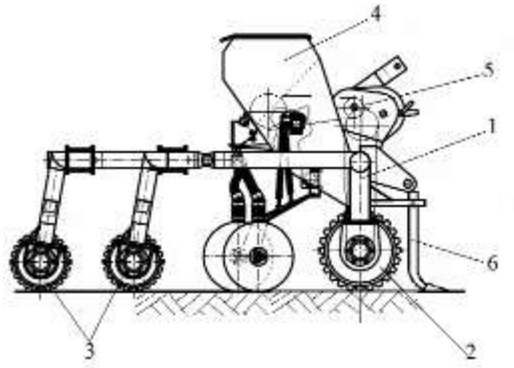

Fig. 1 - Schematic of the MSPM-2.5 machine

The assembled frame (1) has a rectangle shape and is made of welded or screwed steel profiles. The other component parts of the machine are mounted on the frame. The front part is fitted with the coupling triangle to the three-hitch point mechanism of tractor and two removal devices of tractor wheel marks (6).

The front roller (2), a spurs ring type, mounted on a pipe is fixed to the frame by means of two ball oscillating bearings. At the back of the roller is mounted a special shape scraper that acts in the space between the rings.

The rear rollers (3) are also of a spur rings type being mounted on a pipe, but with a smaller diameter than the previous roller. The assembling on the frame is articulated by means of two cylindrical joints mounted on the oscillant arms. Fastening the rollers at the bottom of the two arms by means of two roller bearings is done. The soil scraper acting behind the rollers, similar to the one used on the previous roller, is mounted on the two lateral oscillant arms of each roller.

The sowing equipment (4) consists of: a seed box with meter housings of double studded roller type; seed dropper housings, or collecting for spreading the seeds on the surface of the soil; the seed pipes that connect the meter housings with drill coulters, double disc type.

The mechanism for transmitting motion to dosing and shaking apparatus (5) consists of chain transmissions, unique sense coupling. The motion is transmitted from the front roller (2), to the Northon gearbox, to metering and stirring devices through a cylindrical gear mechanism. The sowing equipment is placed on the machine frame and distributes the seeds in the space between the previous roller and the two rear rollers. The technical constructive characteristics of the machine (*Mocanu V. and Ene T.A., 2017*) are presented in table1.

Table 1

The technical constructive characteristics of the machine

-energy source	- Wheeled or caterpillar tractors of 59-81 kW(80-110 HP)
-type of the machine	Rear carried
--overall dimensions: - length - Width -height	 1950 mm 2880 mm 1300 mm
- the number of coulters	20
- coulter type	- double disc - with a funnel-tray
- distance between rows:	-12,5 cm -at the soil surface
- depth of work, 0,5-5 cm range	0,5-2,0 cm - for surface sowing; 0,5-5,0 cm - for coulter sowing
- working width	2,5 m
- machine weight	1800 kg
- front roller diameter	410 mm
- rear roller diameter	300 mm
- seed box volume	340 dm^3
- adjusting seed rates	-72-speed rates by Northon gearbox; - adjustment of movable flaps - adjusting the shutter

Operation mode

When the aggregate tractor-machine is in operation, the front roller executes soil compaction over a depth of 3 cm, sowing equipment distributes through the delievery tubes and double-disc coulters or spreads the soil surface the seed mixture and the rear rollers cover the seeds with the soil and compress and realise the close contact between them and the soil.

By articulating the posterior rollers at the machine body by two cylindrical joints, two degrees of mobility are provided, creating the possibility for the machine to copy the ground vertically-longitudinally and vertically-transversely.

The working conditions during the trials were follows:
- sown field .... stubble of winter wheat;
- soil type .... chernozemomoid;
- the ground slope......... 0 ... 4^{0};
- performed works previously: - stubble-turning with disc harrows;
  - ploughing;
  -seed bed preparing with rotary harrow;

-seed quantity: 40 kg/ha;
- the seed mixture used: it is suitable for grassland farming and consists of 65 % perennial grasses (*Festuca pratensis; Festuca arundinacea; Phleum pratense; Lolium perenne* and *Dactylis glomerata*) and 35 % grass (*Trifolium pratense; Lotus corniculatus* and *Medicago sativa*).

RESULTS

The laboratory tests of the experimental seed drill consisted in determining the following indices regarding compliance with the agro-technical requirements imposed on the sowing of grasslands and fodder crops, with the indication that the values obtained are within the permissible limits:
- the ratio of seed distribution rate stability (95.5 %);
- seed distribution uniformity on working width (95 %);
- row seed uniformity (98 %);
- the depth of sowing is continuously adjustable between 0 and 5 cm;

Also, determinations have been made regarding the minimum and maximum pure crops seed rates that can be distributed to several species of grassland fodder plants under the conditions of appropriate adjustment of the movable flaps to the seed rollers (double studded roller).

The results of the laboratory trials are presented in Table 2.

Table 2

Determinations of minimum and maximum seed rates, grass and legume species in pure culture, kg/ha

Crop		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Position of movable flaps		1	1	1	1	1	1	1
Position of shutter		Intermed.	Intermed.	Open Completely	Intermed.	Intermed.	Intermed.	Open Completely
Position of the gearbox	**A-1**	2.9	3.3	2.2	2.1	2.2	2.0	2.1
	A-2	3.0	3.5	2.3	2.2	2.3	2.2	2.2
	...	...	...	...	...	...	...	...
	A-17	7.5	8.7	5.7	5.6	5.7	5.4	5.3
	A-18	8.1	9.4	6.2	6.0	6.2	5.8	5.7
	B-1	8.6	10.0	6.6	6.4	6.6	6.2	6.1
	B-2	8.9	10.3	6.8	6.6	6.8	6.6	6.5
	...	...	...	...	...	...	...	...
	B-17	22.7	26.3	17.3	16.9	17.3	16.0	15.9
	B-18	24.0	27.8	18.3	17.9	18.3	17.1	16.8
	C-1	25.8	29.9	19.7	19.2	19.7	18.2	17.9
	C-2	27.1	31.5	20.7	20.2	20.7	19.3	19.0
	...	...	...	...	...	...	...	...
	C-17	67.5	78.3	51.5	50.2	51.5	47.3	48.3
	C-18	109.8	83.8	55.1	53.8	55.1	50.9	51.7
	D-1	77.6	90.0	59.2	57.8	59.2	53.7	55.1
	D-2	81.0	93.9	61.8	60.3	61.8	56.1	58.1
	...	...	...	...	...	...	...	...
	D-17	202.7	235.0	154.7	150.9	154.7	134.6	144.4
	D-18	217.3	252.2	165.9	161.9	165.9	145.8	155.8

In the case of sowing mixtures of with perennial leguminous and grasses, in order to achieve the seed rate, it is required to make the drill sample.

The exploitation experiments of the machine were performed in an aggregate with a 4 WD tractor of 100 HP.

In order to have vertical-longitudinal stability the tractor was loaded with extra weight, mounted on its frontal three-point hitch mechanism (Figure 2).

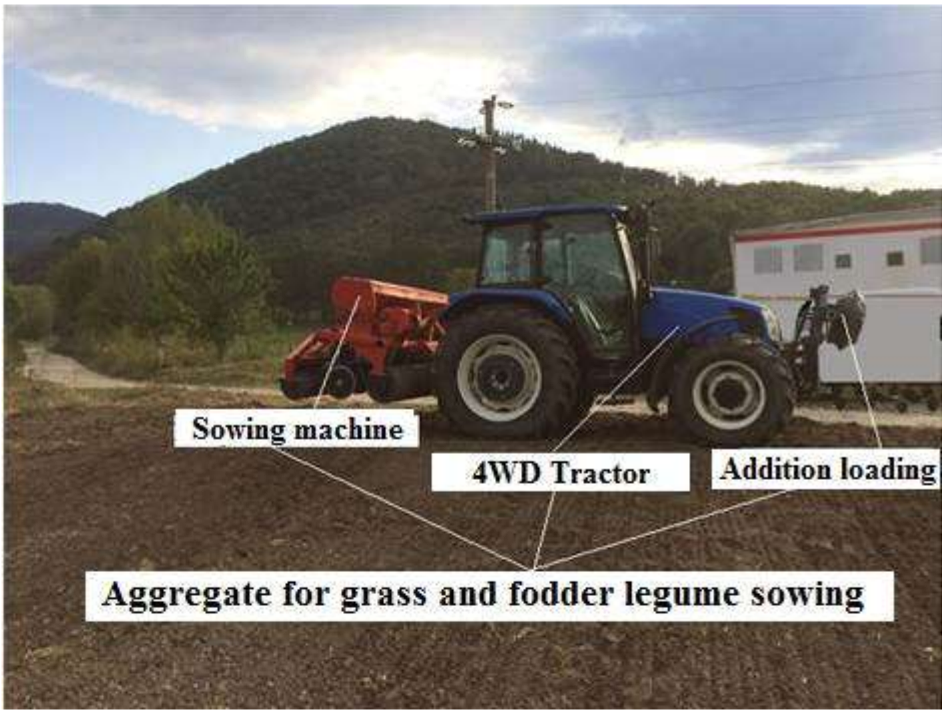

Fig. 2 - Aspect of front-weighted aggregate

The exploitation trials of the aggregate were carried out on a field of 10 ha (Figure 3), the sowing time being on the optimum sowing period of grasses.

Fig. 3 - View from trial time

The optimum working speeds of the aggregate have been chosen to fit the technological speed range recommended for the sowing, taking into account working conditions, reducing specific fuel consumption and achieving a high quality of seeding operation *(Mocanu and Hermenean, 2013)*.

The data obtained from the tests are presented in Table 3.

Table 3

Trials results

Specification	UM	The determined value		
Depth of sowing	cm	1.5-2.0		
Engine speed	rot/min	1500	2000	1500
Gear lever position	-	Rapid (R)	Rapid (R)	Rapid (R)
Speed gear level	-	I R	I R	II R
Real work speed	m/s	1,.2	2.30	2.60
	km/h	6.2	8.3	9.4
Real working width	m	2.45	2.42	2.40
Inter rows distance	cm	12.5 cm ± 1 cm		
Fuel consumption	kg/h	7.35	9.80	10.60
Effective working capacity	ha/h	1.52	2.01	2.26
Working capacity at production time	ha/h	1.20	1.64	1.85
Specific fuel consumption *	l/ha	7.20	6.95	6.67

* The real average consumption over the entire area was 7.25 l / ha, taking into account the repeated stops required to perform the tests.

Fig. 4 - View of sown field after 30 days from seeding time

From the analysis of the data in Table 3 it can be noticed that, under the given working conditions, different gears and different speeds of the energy source can be used.

With increasing work speed, fuel consumption (power consumption) also increases, but specific fuel consumption decreases due to increased working capacity at the production time.

Also, with increasing work speed, the effective work width decreases due to avoiding sowing deviations and a greater difficulty in tracking the mark.

When using the seed drill, it is advisable to check and correct in the field the working depth and the amount of seed incorporated in the soil immediately after the first surfaces sown and during work to see if the adjustments have been made correctly and if they are maintained.

After the sowing, plants have grown with a degree of over 95 % coverage (Figure 4), all the component species being present in the mixture.

CONCLUSIONS

On the basis of the results obtained during the laboratory tests of the experimental model of seed drills, it can be seen that the indices regarding the agronomic requirements (*I.C.P.C.P. Brașov and I.I.E.P. Hunedoara, 1989*) imposed on the sowing of the grasslands and fodder crops have values within the limits allowed by the literature;

- the minimum and maximum seed rates per unit area (kg/ha) for different pure crop species vary in a very wide range, depending on its multiple set-up possibilities;
- experimental trials have led to the determination of specific fuel consumption, working capacity at the production time, effective working width etc.
- with increasing the work speed, fuel consumption (power consumption) is also increased, but specific fuel consumption decreases due to increased working capacity at production time;
- when using seed drills, it is recommended to check and correct in the field the initial settings, immediately after the first surfaces sown and during work to see if they were correct and if they are maintained;
- after sowing with the new machine, the plants had a uniform growth (Figure 4).

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THE INFLUENCE OF A TECHNOLOGICAL LINK ON THE STEM AND SEED YIELD AT TWO MONOECIOUS HEMP VARIETIES, IN A.R.D.S SECUIENI CONDITIONS
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INFLUENȚA UNEI VERIGI TEHNOLOGICE ASUPRA PRODUCȚIEI DE TULPINI ȘI SĂMÂNȚĂ LA DOUĂ SOIURI DE CÂNEPĂ MONOICĂ, ÎN CONDIȚIILE DE LA S.C.D.A SECUIENI

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***Key words**: monoecious hemp, sowing norm, strains yield, seed yield*

ABSTRACT

This paper aims to analyze the agroproductive behavior of two monoecious hemp varieties for stems and fibers (Diana and Dacia-Secuieni), following the application of three sowing norms, 10 kg/ha, 20 kg/ha, respectively 40 kg/ha. The experience was conducted in an experimental field within the Agricultural Research – Development Station Secuieni, Neamț county, during two years (2016, respectively 2017), in classical culture (without the application of cuttings).

Regarding the production results, during 2016-2017, the combined influence between the variety and the sowing rate determined seed yields values ensured at a statistically level as very significant at the use of 10 kg/ha for Dacia-Secuieni variety (875.0 kg/ha), compared with the experience control variant (average – 709.2 kg/ha). Also, the Diana x 10 kg/ha (765 kg/ha) and Dacia-Secuieni x 20 kg/ha (760 kg/ha) combinations recorded production increases distinctly significant compared to the control variant.

Referring to the bifactorial experience, on average, the strain yields have clearly detached themselves in the case of the Dacia-Secuieni variety, the highest value of 13140 kg/ha, being achieved using a sowing norm of 40 kg/ha, the increase being very significant compared to the average of the experience (10968.3 kg/ha).

REZUMAT

Prezenta lucrare își propune să analizeze din punct de vedere agroproductiv comportamentul a două soiuri de cânepă monoică pentru tulpini și fibră (Diana și Dacia-Secuieni), în urma aplicării a trei norme de semănat, 10 kg/ha, 20 kg/ha, respectiv 40 kg/ha. Testele au fost derulate într-un câmp experimental din cadrul Stațiunii de Cercetare-Dezvoltare Agricolă Secuieni, județul Neamț, pe parcursul a doi ani (2016, respectiv 2017), în condiții de cultură clasică (fără aplicarea retezărilor).

În ceea ce privește rezultatele de producție, în perioada 2016-2017, influența combinată dintre soi și norma de semănat a determinat valori ale producției de sământă asigurate la nivel statistic foarte semnificativ în cazul utilizării unei cantități de 10 kg/ha pentru soiul Dacia-Secuieni (875,0 kg/ha), în urma comparației cu martorul experienței (media - 709,2 kg/ha). De asemenea, combinațiile Diana x 10 kg/ha (765 kg/ha) și Dacia-Secuieni x 20 kg/ha (760 kg/ha) au înregistrat sporuri de producție distinct semnificative comparativ cu martorul.

Făcând referire la experiența bifactorială, în medie, producțiile de tulpini s-au detașat în mod evident în cazul soiului Dacia-Secuieni, cea mai ridicată valoare, de 13140 kg/ha, fiind realizată în urma utilizării unei norme de semănat de 40 kg/ha, sporul fiind foarte semnificativ față de media experienței (10968,3 kg/ha).

INTRODUCTION

Hemp is a species that records more than 25,000 uses, being useful, among other things, for extracting fibers and oil, while distinguishing itself as a medicinal plant (*Șandru et al., 1996*).

High production of fiber and stems per hectare, as well as their valuable attributes represent valuable determinants of the importance of this plant in the future. Wood accounts for up to 55% of the weight of the strain and has a high calorific value (3300-3700 calories), the slurry resulting from processing being a very good fuel (*Şandru et al., 1996; Trotuş et al., 2015*).

Outstanding technological features of hemp fibers, such as resistance (tensile, torsion, friction, rotting, etc.), extensibility (elastic and plastic), spinning capacity and long length, determine their use in extremely varied fields, starting with the production of quality paper, braids and fabrics, fine fabrics, culminating with plastics castings (*Small and Marcus, 2002*), fiber-reinforced cement (*Zhijian et al., 2004*), thermal insulation, and so on. At the same time, the field of use of fibers has gained a great deal of expansion due to cotonization, process consisting in the separation of technical fibers into elementary fibers, the resulting material being soft, white and resistant (*Leonte A., 2017*).

Hemp seeds are a traditional source of food and not only, in many countries around the globe being valued for their essential fatty acid (EFA) content in balanced proportions for the human body, but also for the essential amino acids and dietary fiber needed by a body, and a healthy mind (*Găucă et al., 2015*).

The present paper presents the influence of a technological link (sowing norm) on the production of strains and seed on two monoecious hemp varieties for strains and fiber, Diana and Dacia - Secuieni, in order to optimize their cultivation technology.

MATERIAL AND METHOD

The researches were carried out between 2016 and 2017, in the experimental field of the Agricultural Research and Development Station Secuieni Neamt. The experience was of the bifactorial type (A x B), in the form of subdivided plots, where the A factor, with two graduations, was represented by the monoecious hemp genotype (a_1 = Diana, a_2 = Dacia – Secuieni), while the B factor was the sowing norm with three graduations (b_1 = 10 kg/ha, b_2 = 20 kg/ha, b_3 = 40 kg/ha).

Experienced biological material was represented by two varieties of monoecious hemp for fiber, Diana and Dacia - Secuieni.

Dacia – Secuieni – variety approved in 2012, obtained by direct crossing, backcrossing, followed by family selection of the monoecious plants with high seed productivity, high fiber content and low THC content (0.0134%). The vegetation period is of 115-120 days in the fiber culture and 145-160 days in the seed culture. It is a variety resistant to low temperatures, drought and disease, with a fiber content of 31-33%.

Diana – variety approved in 2001, obtained by repeated selection and crossing between the Hungarian dioecious hemp varieties with high yield in stems and fibers, but late and with coarse fiber and the monoecious selections from the laboratory's genetic resources (*Trotuș et al., 2015*). Thus, the productivity characteristics of the dioecious varieties and the quality characteristics of the monoecious varieties have come together, obtaining a particularly valuable variety for stem and fiber production, with a content of 31% quality fiber. The THC content is 0.02%.

The location of the experiment was carried out in the experimental field of the unit on a chernozem cambic soil with low acid pH (6.29) with a humus content of 2.5-3.1%, medium supplied in nitrogen and well supplied in phosphorus and potassium.

Fertilization consisted of N, P, K complex fertilizers (16:16:16) in an amount of 300 kg/ha, supplemented with 200 kg/ha of ammonium nitrate. Sowing was carried out at an optimum time on April 26 in 2016 and May 5 in 2017, and the emergence was recorded on May 5 in 2016 and May 16 in 2017. After the sowing, the Dual Gold herbicide was applied in the amount of 1.5 l/ha in order to form the weed-protectant film. During the vegetation, the Lontrel (for dicotyledonous) and Fusilade (for monocotyledonate) herbicides were applied.

During the entire growing season of the monoecious hemp (from sowing to physiological maturity), the deviation from the multiannual average of temperatures ranged between 3.3°C (2016) and 0.8°C (2017). From the temperature point of view, the monoecious hemp vegetation period of the experimental year, compared to the multiannual average, was characterized as very warm (2016) respectively normal (2017). In terms of precipitation, the deviation from the multiannual average varied between 21.1 mm (2016) and -73.1 mm (2017), the year being characterized as normal in 2016 and droughty in 2017. The meteorological data from the experimental period (2016-2017) are presented in Table 1.

The sampling was done manually on 26.09.2016 and 28.09.2017 respectively. The experimental data obtained were statistically processed by methods specific to bifactorial experiments, while production differences were appreciated by calculating the limit differences (*Săulescu and Săulescu, 1967*).

Table 1

Temperatures and rainfall recorded at A.R.D.S. Secuieni weather station

		Months									Average of veg. period	Deviation	Veg. period caract.
		Jan.	Feb.	March	April	May	June	July	Aug.	Sept.			
Average temp. (°C)	2016	-3.0	4.2	5.7	13.5	14.9	20.3	31.7	20.6	17.3	19.72	3.35	very warm
	2017	-5.7	-1.8	7.0	9.1	15.8	20.3	20.4	21.2	16.3	17.18	0.81	normal
	multiannual average	-3.8	-2.3	2.6	9.4	15.4	18.8	20.3	19.5	14.8	16.37	-	-
Rainfalls (mm)	2016	12.0	14.2	29.4	42.0	120.2	161.0	4.0	32.0	48.6	407.8	21.1	rainy
	2017	7.3	17.0	101.6	54.4	59.4	49.4	72.2	23.0	55.2	313.6	- 73.1	excessively dry
	multiannual average	20.5	19.6	25.4	46.8	64.8	84.3	84.0	61.4	45.4	386.7	-	-

RESULTS AND DISCUSSIONS

In 2016 experimental year, the influence of the variety revealed seed yields of statistical significance for both monoecious hemp genotypes, the differences being positively significant for Dacia - Secuieni (55 kg/ha) and significant negative for Diana (- 55 kg/ha), following comparison with the average (695.0 kg/ha), as shown in Table 2.

Table 2

The variety influence on seed production in 2016

No.	Variety	Seed production			Differences significance
		kg/ha	% vs. control	differences from control (kg/ha)	
1.	Diana	640.0	92.09	-55.0	*
2.	Dacia-Secuieni	750.0	107.91	55.0	0
3.	Average	695.0	100.00	control	

DL 5% = 44.8 kg/ha
DL 1% = 103.4 kg/ha
DL 0.1% = 328.9 kg/ha

The sowing norm in 2016 generated very significant positive seed yields for the 10 kg/ha variant, a very significant negative one for 40 kg/ha and insignificant for the 20 kg/ha. The results on seed production are presented in Table 3.

Table 3

The sowing norm influence on seed production in 2016

No.	Sowing norm	Seed production			Differences significance
		kg/ha	% vs. control	differences from control (kg/ha)	
1.	10	805.0	115.83	110.0	***
2.	20	695.0	100.00	0.0	-
3.	40	585.0	84.17	-110.0	000
4.	Average	695.0	100.00	control	

DL 5% = 23.3 kg/ha
DL 1% = 33.9 kg/ha
DL 0.1% = 50.9 kg/ha

The obtained results regarding the interaction of the studied factors revealed superior seed yields in the variant with Dacia - Secuieni variety, sown with 10 kg/ha, which resulted in very significant production increases (165.0 kg/ha) compared to the average (695.0 kg/ha). At the same time, variants with Diana and Dacia - Secuieni varieties sown with 10 kg/ha and respectively 20 kg/ha produced significant production differences. The rest of the combinations generated outputs with negative statistical significance compared to the average (Table 4).

In the second year of experimentation, the influence of the variety on the seed production registered values with no statistical significance compared with the average of the experience (723.3 kg ha), as can be seen in Table 5.

Table 4

Combined influence of variety x sowing norm on seed production in 2016

No.	Variety x sowing norm	Seed production kg/ha	% vs. control	differences from control (kg/ha)	Differences significance
1.	Diana x 10	750.0	107.91	55.0	*
2.	Diana x 20	640.0	92.09	-55.0	0
3.	Diana x 40	530.0	76.26	-165.0	000
4.	Dacia-Secuieni x 10	860.0	123.74	165.0	***
5.	Dacia-Secuieni x 20	750.0	107.91	55.0	*
6.	Dacia-Secuieni x 40	640.0	92.09	-55.0	0
7.	Average	695.0	100.00	control	

DL 5% = 40.4 kg/ha
DL 1% = 58.7 kg/ha
DL 0.1% = 88.1 kg/ha

Table 5

The variety influence on seed production in 2017

No.	Variety	Seed production kg/ha	% vs. control	differences from control (kg/ha)	Differences significance
1.	Diana	670.0	92.62	-53.3	-
2.	Dacia-Secuieni	776.7	107.37	53.3	-
3.	Average	723.3	100.00	control	

DL 5% = 68.4 kg/ha
DL 1% = 157.9 kg/ha
DL 0.1% = 502.4 kg/ha

The seed production obtained from the 10 kg/ha variant (835.0 kg/ha) was superior to the other two variants, the increases compared to the average (723.3 kg/ha) being very significant (Table 6). While the sowing standard of 20 kg/ha determined differences that were not statistically assured, for the 40 kg/ha standard, the differences were negative in relation to the average.

Table 6

The sowing norm influence on seed production in 2017

No.	Sowing norm	Seed production kg/ha	% vs. control	differences from control (kg/ha)	Differences significance
1.	10	835.0	115.44	111.7	***
2.	20	720.0	99.54	-3.3	-
3.	40	615.0	85.03	-108.3	000
4.	Average	723.3	100.00	control	

DL 5% = 22.0 kg/ha
DL 1% = 32.0 kg/ha
DL 0.1% = 48.0 kg/ha

Regarding the influence of seed x sowing norm interaction, in the second experimental year, there were recorded very significant production increases for Dacia - Secuieni x 10 kg/ha (166.7 kg/ha) interaction, with distinct significant differences in in case of Diana x 10 kg/ha (56.7 kg/ha) and significant for Dacia - Secuieni variety sown with 20 kg / ha (46.7 kg/ha).

The rest of the interactions generated yields with negative statistical significance compared to the average of the experience (723.3 kg/ha), as shown in Table 7.

Experimental hemp genotype influenced the production of seed obtained between 2016 and 2017. Compared to the control variant production (experimental average - 709.2 kg ha), the Dacia - Secuieni variety has achieved statistically assured increases at a significant positive level, compared to the Diana variety, with significant negative differences (Table 8).

Table 7

Combined influence of variety x sowing norm on seed production in 2017

No.	Variety x sowing norm	Seed production			Differences significance
		kg/ha	% vs. control	differences from control (kg/ha)	
1.	Diana x 10	780.0	107.84	56.7	**
2.	Diana x 20	670.0	92.63	-53.3	0
3.	Diana x 40	560.0	77.42	-163.3	000
4.	Dacia-Secuieni x 10	890.0	123.05	166.7	***
5.	Dacia-Secuieni x 20	770.0	160.46	46.7	*
6.	Dacia-Secuieni x 40	670.0	92.63	-53.3	0
7.	Average	723.3	100.00	control	

DL 5% = 38.1 kg/ha
DL 1% = 55.4 kg/ha
DL 0.1% = 83.2 kg/ha

Table 8

The variety influence on seed production, 2016-2017 average

No.	Variety	Seed production			Differences significance
		kg/ha	% vs. control	differences from control (kg/ha)	
1.	Diana	655.0	92.36	54.2	0
2.	Dacia-Secuieni	763.3	107.63	-54.2	*
3.	Average	709.2	100.00	control	

DL 5% = 51.7 kg/ha
DL 1% = 119.4 kg/ha
DL 0.1% = 380.0 kg/ha

During the experimental period, the influence of the sowing norm determined yields ranging from 600.0 kg/ha (SN - 40 kg/ha) to 820.0 kg/ha (SN - 10 kg/ha). The sowing norm of 10 kg/ha generated on average very significant positive yields (110.8 kg/ha) compared to the experience average (709.2 kg/ha), while the variant set up with 40 kg/ha showed very significant negative results. The second graduation of the B factor marked production differences with no statistical significance (Table 9).

Table 9

The sowing norm influence on seed production, 2016-2017 average

No.	Sowing norm	Seed production			Differences significance
		kg/ha	% vs. control	differences from control (kg/ha)	
1.	10	820.0	115.62	110.8	***
2.	20	709.5	100.04	0.3	
3.	40	600.0	84.60	-109.2	000
4.	Average	709.2	100.00	control	

DL 5% = 16.9 kg/ha
DL 1% = 24.6 kg/ha
DL 0.1% = 36.9 kg/ha

Due to the combined influence of the two experienced factors, between 2016 and 2017, seed yields ranging from 545.0 kg/ha (Diana x 40 kg/ha) and 875.0 kg/ha (Dacia - Secuieni x 10 kg/ha) were obtained. The variant in which the Dacia - Secuieni variety was sowed with a norm of 10 kg/ha recorded very significant production increases compared to the chosen control variant (average - 709.2 kg/ha), while Diana x 10 kg/ha and Dacia - Secuieni x 20 kg/ha interactions have achieved distinctly significant yields (765.0 kg/ha, respectively 760.0 kg/ha). The rest of the combinations realized productions with negative statistical significance, being below the average (Table 10).

Table 10

Combined influence of variety x sowing norm on seed production, 2016-2017 average

No.	Variety x sowing norm	Seed production			Differences significance
		kg/ha	% vs. control	differences from control (kg/ha)	
1.	Diana x 10	765.0	123.87	55.8	**
2.	Diana x 20	655.0	92.36	-54.2	00
3.	Diana x 40	545.0	76.85	-164.2	000
4.	Dacia-Secuieni x 10	875.0	123.38	165.8	***
5.	Dacia-Secuieni x 20	760.0	107.16	50.8	**
6.	Dacia-Secuieni x 40	655.0	92.36	-54.2	00
7.	Average	709.2	100.00	control	

DL 5% = 29.3 kg/ha
DL 1% = 42.6 kg/ha
DL 0.1% = 64.0 kg/ha

At the level of 2016, the influence of the variety generated results on the production of stems with statistical significance for Dacia - Secuieni variety, revealing a significantly distinct production increase (1380.0 kg/ha) compared to the average (10973.3 kg/ha), according to Table 11.

Table 11

The variety influence on stems production in 2016

No.	Variety	Stems production			Differences significance
		kg/ha	% vs. control	differences from control (kg/ha)	
1.	Diana	9593.3	87.42	-1380.0	00
2.	Dacia-Secuieni	12353.3	112.58	1380.0	**
3.	Average	10973.3	100.00	control	

DL 5% = 515.6 kg/ha
DL 1% = 1190.7 kg/ha
DL 0.1% = 3789.2 kg/ha

The experimental sowing norm influenced strain yields produced in 2016, ranging from 10200.0 kg/ha (10 kg/ha) to 11890.0 kg/ha (40 kg/ha). Among the graduations of the B factor, only the 40 kg/ha norm resulted in statistically assured production increases at a very significant positive level, while the variant sowed with 10 kg/ha produced yields below the experimental average (10973.3 kg/ha), the recorded differences being negative very significant compared to the experimental average (Table 12).

Table 12

The sowing norm influence on stems production in 2016

No.	Sowing norm	Stems production			Differences significance
		kg/ha	% vs. control	differences from control (kg/ha)	
1.	10	10200.0	92.95	-773.3	000
2.	20	10830.0	98.69	-143.3	-
3.	40	11890.0	108.35	916.7	***
4.	Average	10973.3	100.00	control	

DL 5% = 166.0 kg/ha
DL 1% = 241.4 kg/ha
DL 0.1% = 362.1 kg/ha

The combined influence between the variety used and the sowing norm determined very significant production increases for the Dacia - Secuieni genotype for each of the three experimental sowing norms (Dacia - Secuieni x 40 - 2226.7 kg/ha, Dacia - Secuieni x 20 - 1186.7 kg/ha, Dacia - Secuieni x 10 - 726.7 kg/ha), as compared to the experimental average (10973.3 kg/ha), as can be seen in Table 13.

Table 13

Combined influence of variety x sowing norm on stems production in 2016

No.	Variety x sowing norm	Stems production			Differences significance
		kg/ha	% vs. control	differences from control (kg/ha)	
1.	Diana x 10	8700.0	79.28	-2273.3	000
2.	Diana x 20	9500.0	86.57	-1473.0	000
3.	Diana x 40	10580.0	96.42	-393.3	0
4.	Dacia-Secuieni x 10	11700.0	106.62	726.7	***
5.	Dacia-Secuieni x 20	12160.0	110.81	1186.7	***
6.	Dacia-Secuieni x 40	13200.0	120.29	2226.7	***
7.	Average	10973.3	100.00	control	

DL 5% = 287.5 kg/ha
DL 1% = 418.2 kg/ha
DL 0.1% = 627.2 kg/ha

In 2017, the stems produced by the Dacia - Secuieni cultivar were positively significant (12314.9 kg/ha), while the production differences obtained by the Diana variety were very negative (- 1350.8 kg/ha), both following the comparison with the average (10964.1 kg/ha), as shown in Table 14.

Table 14

The variety influence on stems production in 2017

No.	Variety	Stems production			Differences significance
		kg/ha	% vs. control	differences from control (kg/ha)	
1.	Diana	9613.3	87.68	-1350.8	000
2.	Dacia-Secuieni	12314.9	112.32	1350.8	***
3.	Average	10964.1	100.00	control	

DL 5% = 107.0 kg/ha
DL 1% = 247.0 kg/ha
DL 0.1% = 786.0 kg/ha

The influence of the sowing rule generated statistically significant strain yields for the variant sown with 40 kg/ha, the difference being 859.9 kg/ha compared to the average of the experience (10964.1 kg/ha), according to Table15.

Table 15

The sowing norm influence on stems production in 2017

No.	Sowing norm	Stems production			Differences significance
		kg/ha	% vs. control	differences from control (kg/ha)	
1.	10	10115.0	92.26	-849.1	000
2.	20	10917.4	99.57	-46.7	-
3.	40	11860.0	108.17	895.9	***
4.	Average	10964.1	100.00	control	

DL 5% = 132.5 kg/ha
DL 1% = 192.8 kg/ha
DL 0.1% = 289.2 kg/ha

At 2017, the combination between the chosen genotype and the used sowing norm revealed yields ranging from 8600.0 kg/ha (Diana x 10 kg/ha) to 13080.0 kg/ha (Dacia – Secuieni x 40 kg/ha). As in the case of 2016, very significant production increases were recorded for the following interactions, following the comparison with the average of experience: Dacia - Secuieni x 40 kg/ha (2115.9 kg/ha), Dacia - Secuieni x 20 kg/ha (1270.6 kg/ha), Dacia - Secuieni x 10 kg/ha (665.9 kg/ha).

At the same time, the Diana variety determined production values with negative statistical significance for all three graduations of the sowing norm factor (Table 16).

Table 16

Combined influence of variety x sowing norm on stems production in 2017

No.	Variety x sowing norm	Stems production			Differences significance
		kg/ha	% vs. control	differences from control (kg/ha)	
1.	Diana x 10	8600.0	78.44	-2364.1	000
2.	Diana x 20	9600.0	87.56	-1364.1	000
3.	Diana x 40	10640.0	97.04	-324.1	0
4.	Dacia-Secuieni x 10	11630.0	106.07	665.9	***
5.	Dacia-Secuieni x 20	12234.7	111.59	1270.6	***
6.	Dacia-Secuieni x 40	13080.0	119.30	2115.9	***
7.	Average	10964.1	100.00	control	

DL 5% = 229.6 kg/ha
DL 1% = 333.9 kg/ha
DL 0.1% = 500.9 kg/ha

On average, during the experimental period, the Dacia - Secuieni variety recorded significant values of the strain production (12334.1 kg/ha) compared to the average (10968.3 kg/ha), while the Diana cultivar determined distinct negative productions (Table 17).

Table 17

The variety influence on stems production, 2016-2017 average

No.	Variety	Stems production			Differences significance
		kg/ha	% vs. control	differences from control (kg/ha)	
1.	Diana	9603.3	87.55	-1365.4	00
2.	Dacia-Secuieni	12334.1	112.45	1365.4	**
3.	Average	10968.3	100.00	control	

DL 5% = 280.2 kg/ha
DL 1% = 647.0 kg/ha
DL 0.1% = 2058.9 kg/ha

The conducted researches have shown on average that a sowing standard of 40 kg/ha produces very significant strain yields (11875.0 kg/ha) compared with the average of experience (10968.3 kg/ha), and a 10 kg/ha norm determines very significant negative yields (10157.5 kg/ha), according to Table 18.

Table 18

The sowing norm influence on stems production, 2016-2017 average

No.	Sowing norm	Stems production			Differences significance
		kg/ha	% vs. control	differences from control (kg/ha)	
1.	10	10157.5	92.61	-811.2	000
2.	20	10872.5	99.13	-95.0	-
3.	40	11875.0	108.26	963.3	***
4.	Average	10968.3	100.00	control	

DL 5% = 105.4 kg/ha
DL 1% = 153.4 kg/ha
DL 0.1% = 230.1 kg/ha

The interaction between the variety and the sowing norm influenced, on average, the production of stems, ranging from 8650.0 kg/ha (Diana x 10 kg/ha) to 13140.0 kg/ha (Dacia - Secuieni x 40 kg/ha). All graduations of the sowing norm with the Dacia - Secuieni genotype generated values of production positive very significant compared to the average (10968.3 kg/ha), while for the Diana variety the results had statistical but negative significance (Table 19).

Table 19

Combined influence of variety x sowing norm on stems production, 2016-2017 average

No.	Variety x sowing norm	Stems production			Differences significance
		kg/ha	% vs. control	differences from control(kg/ha)	
1.	Diana x 10	8650.0	78.86	-2318.7	000
2.	Diana x 20	9550.0	87.07	-1418.7	000
3.	Diana x 40	10610.0	96.73	-358.7	00
4.	Dacia-Secuieni x 10	11665.0	106.35	696.3	***
5.	Dacia-Secuieni x 20	12195.0	111.20	1228.6	***
6.	Dacia-Secuieni x 40	13140.0	119.80	2171.3	***
7.	Average	10968.3	100.00	control	

DL 5% = 182.6 kg/ha
DL 1% = 265.6 kg/ha
DL 0.1% = 398.5 kg/ha

CONCLUSIONS

1. The influence of the variety during 2016 - 2017 generated seed yields higher than the average (709.2 kg/ha) for the Dacia - Secuieni variety, the differences being positively significant (763.3 kg/ha).

2. Seed production was influenced, on average, by the experimental seed norm. Production values above the average level, ensured at a very significant level, were obtained by the variant set up with 10 kg/ha (820 kg/ha).

3. In the experimental period (2016 - 2017), the interaction between the selected monoecious hemp variety and the seed norm used resulted in very significant seed yields (875.0 kg/ha) compared to the experience average (709.2 kg/ha) for the variant where the Dacia - Secuieni genotype was sown with 10 kg/ha. In addition, Diana x 10 kg/ha (765.0 kg/ha) and Dacia - Secuieni x 20 kg/ha (760.0 kg/ha) were obtained production increases at a statistically significant level. The sowing norm of 40 kg/ha, regardless of the cultivar used, revealed seed yields below the experimental average, the differences being statistically assured.

4. From the biological material used, the Dacia - Secuieni variety determined, during the experimental period (2016 - 2017), yields of strains (12334.1 kg/ha) ensured at statistical level positive significantly compared to the average (10968.3 kg/ha).

5. On average, during the two years of experimentation, the sowing norm of 40 kg/ha produced strain yields superior to the control variant (10968.3 kg/ha), the obtained increases being very significant compared to the control variant (963.3 kg/ha).

6. For the 2016-2017 period, due to the combined influence of the variety with the sowing norm, the production of strains had positive values very significant compared to the average (10968.3 kg/ha) for the variants with Dacia - Secuieni variety set up with all three norms of experimental seed (Dacia - Secuieni x 40 – 13140.0 kg/ha, Dacia - Secuieni x 20 – 12195.0 kg/ha, Dacia - Secuieni x 10 – 11665.0 kg/ha).

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ESTIMATION OF EVAPORATION LOSSES AND ASSESSMENT OF SUBSTANCE USE FOR SPRAYING WORKS IN FIELD CROPS
/
ESTIMAREA PIERDERILOR PRIN EVAPORARE ŞI EVALUAREA CONSUMULUI DE SUBSTANTA PENTRU LUCRĂRILE DE STROPIT ÎN CULTURILE DE CAMP

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ABSTRACT

In modern agriculture, along with mechanization and irrigation, plant protection contributes to the continuous growth of yields and labour productivity. Quality of agricultural products is closely related to the soil and plants state of health. Through application of phytosanitary treatments, it's intended to reduce the substance quantity at the same time with increasing the treatment efficiency. The quality of phytosanitary treatments is influenced both by the technical characteristics of spraying equipment and by weather (pedoclimatic) conditions. The paper presents a mathematical model that allows the prediction of evaporation losses depending on the drop distance and the relative moisture in the air. The mathematical model was elaborated on the basis of the data obtained from the specialized literature, which was processed. The estimation of evaporation losses and assessment of substance use for spraying works in field crops was made in the view of improving them.

REZUMAT

În agricultura modernă, alături de mecanizare şi irigaţii, protecţia plantelor contribuie la creşterea continuă a producţiei şi a productivităţii muncii. Calitatea produselor agricole este strâns legată de starea sănătății solului și a plantelor. Prin aplicarea tratamentelor fitosanitare, se intenționează reducerea cantității de substanță în același timp cu creșterea eficienței tratamentului. Calitatea tratamentelor fitosanitare este influenţată atât de caracteristicile tehnice ale echipamentelor de stropit cât şi de condiţiile meteorologice (pedoclimatice). În lucrare este prezentat modelul matematic care permite predicţia pierderilor prin evaporare în funcţie de distanţa de cădere şi umiditatea relativă a aerului. Modelul matematic a fost elaborat pe baza datelor obținute din literatura de specialitate, date ce au fost prelucrate. Estimarea pierderilor prin evaporare şi evaluarea consumului de substanţă pentru lucrările de stropit în culturile de câmp s-a realizat în vederea îmbunătăţii acestora.

INTRODUCTION

Agriculture, with plant growing as main activity, represented the main development segment of mankind, providing both food and the specific context for social development (*Bungescu et. al., 2004*).

The objective existence of today shows that the 20th century is the period of the greatest discoveries and transformations of human civilization, the concerns for the protection of the natural environment being strongly felt. The demographic explosion and unprecedented development of all branches of activity has made the Earth's renewable natural resources no longer sufficient for the needs of mankind, the need for agricultural products to feed mankind growing year after year, and this growth can only be sustained by the development and optimization of agriculture (*Adrian N., 1997; Baicu T. 1980*).

Environmental protection is the primary requirement for sustainable development. Environmental protection determines sustainable development, automatically including the protection of the environment. Existing strict requirements require a new approach to these environmental issues, both in terms of environmental impacts and repercussions of socio-economic development (*Bobeș I., 2000*).

Agriculture is a base economic branch due to the impact on the social and of the surrounding environment, its practice also implying consequences on the environment (*Adrian N., 1997; Baicu T. 1980*).

The level of applied work technologies has a direct effect on agricultural productivity, phytosanitary protection held by a major place in these technologies (*Adrian N., 1997)*. The demand on the domestic and foreign markets for increasing and improving the quality and health of agricultural products is still a fact that at present the measures for combating diseases and pests in agricultural crops are indispensable (*Baicu T., 1980; Woo et al., 2017*).

From the complex of works that make up the technology of agricultural and horticultural crop maintenance, pest and pest control works have a special significance for the quantity and quality of production. It can be estimated that production losses due to diseases and pests can reach up to 35%, and in some cases, production can be totally compromised. Reducing production losses per hectare is only possible in integrated combustion, the method in which chemical treatments occupy the most important place (*Bran M., 2009; Costache N, Luca E., 1982*). Plants, during their lifetime, may experience various disorders in the functioning and structure of organs or of the whole organism. These disturbances can be determined either by internal causes related to plant constitution or by external causes, such as environmental conditions or the interference of various plant parasites (*Drocas et al, 2009; Ivascu et al, 2009*).

In the technological process of field crops, an important link is the application of phytosanitary treatments, the chemical method for combating diseases and pests being the most used method due to the high efficiency, the relatively low unitary cost, and the multiple possibilities of application, without neglecting the great disadvantage of this method - environment pollution. Any study on phytosanitary substances and their application should seek to achieve the best possible results in combating diseases and pests with minimal environmental pollution *(Cota et, 2006; www.pmb-cpp.ro/tratamente-fitosanitare)*.

Conducting works to combat diseases and pests by spraying involves the correlation of technical factors (machine) with organizational and methodological factors. An optimal treatment is obtained only if a more uniform coating with the phytosanitary substance of the target is ensured, and the losses due to derivation and evaporation are minimal. The "key" for the application of a minimum amount of phytosanitary substance with maximum efficiency is represented by the correlation of the two elements of the machine and the application system according to the specific conditions (*Cota et al, 2006; Jiang et al, 2016; Liu et al, 2017)*.

The climatic and edaphic conditions in Romania, particularly favourable for field crops, are also favourable for the development of a large number of phytopathogens, pests and weeds that cause significant damage both quantitatively and qualitatively. That is why it is necessary to draw up a program to control these organisms at the crop or farm level, taking into account the structure of the assortments, the phytosanitary status of the previous year, the climatic conditions (especially the temperature) during the vegetative resting period and the weather forecasting elements and warning *(Bobeș et al, 2000; Marian et al, 2016)*. Among the factors influencing field crops treatment works, weather conditions (wind speed, air temperature, air humidity) are found. A mathematical model has been developed, which will allow the prediction of evaporation losses of phytosanitary substances in order to improve the spraying process.

MATERIAL AND METHOD

In Romania, a set of mandatory criteria regarding the application of phytosanitary treatments has been established, depending on the weather, namely: no working when the wind speed is greater than 3 m / s, the air moisture is less than 60% and the temperature greater than 25 °C. If it is necessary to work at temperatures above 25 °C and humidity less than 60%, the rules must be adjusted in order to complete the evaporation quantities. In special situations and with the notice of the specialized institute (Research and Development Institute for Plant Protection), anti-evaporation solutions will be added to reduce the losses *(Popescu, 2006)*.

Weather (pedoclimatic) conditions

Air temperature, the temperature indicated by the thermometer that is thermally balanced with air, influences the spraying process in field crops.

The heat exchange between the air and the thermometer is of the kinetic and radiant type to make air temperatures comparable to those at sea level *(Popescu, 2006)*.

In order to determine the temperature a certain altitude Z, the following formula is used:

$$t_y = t + \frac{Z}{100} \cdot \gamma \ \text{[°C]} \tag{1}$$

Where: γ= 0,5 [° /m], represents the temperature gradient; t – temperature at level A.

The factors that modify air temperature are its nebulosity and moisture, the optimal temperature at which the phytosanitary treatments are performed is 20 °C *(Popescu, 2006)*.

Air moisture, the amount of water contained in a unit of volume or mass of air and expressed by water vapor tension.

Relative moisture is expressed by the ratio evaluated in percentage between the current tension ε and the maximum tension *E* of water vapours.

$$U(\%) = \frac{\varepsilon}{E} \cdot 100 \qquad (2)$$

The higher the relative moisture, the lower the losses by evaporation, the loses percentage from the mas of the falling drop being given in Table 1 *(Popescu, 2006)*.

Table 1

Loss (%) by evaporation depending on the falling distance of drops at different relative air moistures (%)
(Popescu, 2006)

Relative moisture (%)	Evaporation loss percentages depending on the falling distance of drops (%)				
	20	40	60	80	100
0	0.9 m	1.9m	3 m	4.3 m	5.8 m
60	1.2 m	2.6 m	4.1 m	5.6 m	7.7 m
90	4 m	8.5 m	13.3 m	19 m	25 m

RESULTS

By representing the data in Table 1 graphically, the loses by evaporation *p(%)* depending on the falling distance *d(m)* for the three values of relative air moisture *φ(%)*, Figure 1 is obtained.

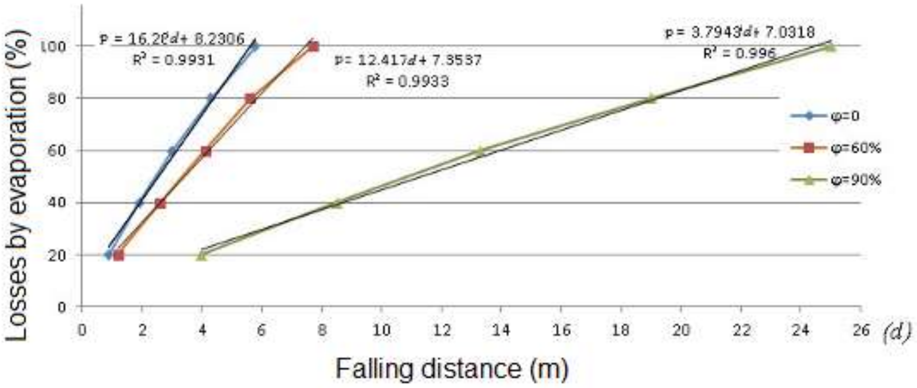

Fig. 1 - Variation of loses p(%) by evaporation depending on the falling distance d(m) f drops at three values of relative air moisture φ(%) (author processing)

It is found that the experimental points fit well on the straight lines, so they can be represented by the linear function of the form:

$$p = \alpha + \beta d \qquad (3)$$

Using the data in Table 1, through linear regression, using Microsoft Excel program, coefficients α and β were determined, whose values are presented in Table 2.

Table 2

Values for coefficients *α* and *β* from equation 3 for the data in table 1 for each of the three relative air *φ*

φ(%)	*α*	*β*	Correlation coefficient R^2
0	8.231	16.280	0.993
60	7.354	12.417	0.993
90	7.032	3.794	0.996

The correlation coefficient $R^2 \geq 0{,}993$ signifies that the linear function (relation (3)) describes very well the loses by evaporation *p* (%) depending on the falling distance *d* (m).

Looking at coefficients *α* and *β* as functions of φ, with the data in Table 2, by processing it, is found that the coefficient *α* is a linear function φ (%) and coefficient *β* is a parabolic function, respectively:

$$\alpha = a_1 + b_1\varphi \tag{4}$$

$$\beta = a_2 + b_2\varphi + c_2\varphi^2 \tag{5}$$

Using the data in Table 2, the values of coefficients a_1, b_1, a_2, b_2, c_2 are found, namely:

a_1 = 8.231; b_1 = -0.01384; a_2 = 16.28; b_2 = 0.842; c_2 = - 2.477.

In this case, a more general mathematical model can be proposed allowing the prediction of losses by evaporation depending on the drop falling distance and the relative moisture of the air, in the form of:

$$p = (a_1 + b_1\varphi) + (a_2 + b_2\varphi + c_2\varphi^2)\cdot d \tag{6}$$

The mathematical model for the data in table 1 is:

$$p = 8,\ 231\text{-}0{,}01384\varphi + (16{,}28 + 0{,}0842\varphi - 2{,}477\cdot 10^{-3}\varphi^2)\cdot d \tag{7}$$

where *p*(%), *φ*(%) and *d*(m).

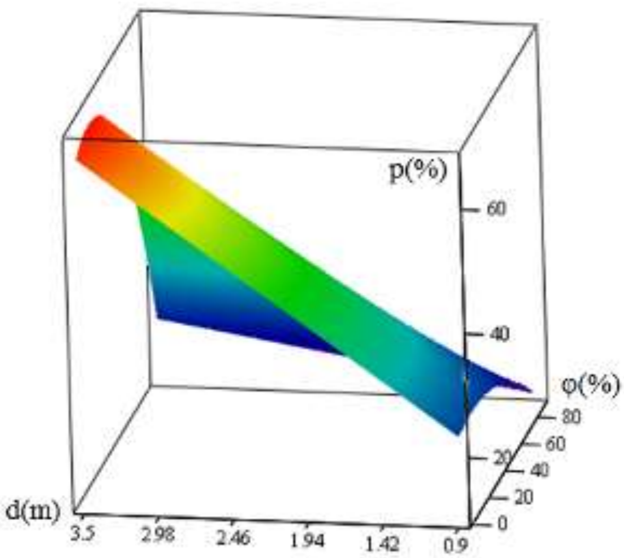

Fig. 2 – Variation of losses p(%) by evaporation depending on the falling distance d(m) of drops at three values of the relative air moisture φ(%) (author processing)

In Figure 2, equation (7) is presented graphically, where *p*=f (*φ, d),* for *φ* ∈[0, 90%] and d = [0.9 , 4 m]. It is noticed that for increased relative air moisture, losses by evaporation are lower due to the saturation phenomenon. Also, an increase in evaporation losses is observed as the droplet falling distance increases.

Equation (7) allows the prediction of losses by evaporation for any value of *φ*∈[0; 90%] and *d*∈[0.9; 25 m]. Values of *p* (%) estimated using equation (7) have a relative deviation compared to those measured, below 10%. The knowledge of model (7) will allow to estimate losses by evaporation and is useful in evaluating the substance consumption for the spraying work in given air moisture conditions.

CONCLUSIONS

Combating harmful organisms from field crops using phytosanitary substances is a global reality, with major advantages in quantitative and qualitative growth for agricultural yields. Field crop harmful elements are represented by diseases or organisms specific to the animal kingdom affecting crops and leading to yield decreases.

In order to obtain high and quality yields in conditions of economic efficiency and protection of plants in field crops and of the environment, the efficacy of the treatments depends, among others, on the manner of administrating the active substance, the distribution and its retention on the treated surface.

Both research on plant protection and on the mechanization of works must aim to develop new principles for the application of plant protection products so that pests and not the crop or soil are treated first.

Losses by evaporation occur during the spraying processes. By using experimental data in the paper regarding substance losses by evaporation, we can conclude that:

- The actual mathematical model (7) was established, allowing to evaluate these losses depending on the relative air moisture, giving the possibility to evaluate spraying substance consumption depending on given weather conditions;
- The utility of equation (7) on the anticipation of solution losses by evaporation during the spraying process is highlighted especially when the values of distance (d) from the nozzles and the relative air moisture (φ) often differ in real conditions from those during experiments, given in table 1. For example, the situation when φ=70% and d=50 cm = 0.5 m (values frequently found in practice);
- In the hypothesis that the validity of applying equation (7) can also be extrapolated for the values mentioned by replacing them and making calculation, we obtain p = 12.28%.
- Therefore, it results that in normal spraying conditions, substance losses by evaporation are important, and equation (7) estimates the size of this loss.

The data presented is important for all specialists in the agricultural field, especially for phytosanitary treatments applied in field crops.

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TECHNOLOGY FOR OBTAINING ENVIRONMENTALLY-FRIENDLY SEEDS AND SOWING MATERIAL FOR VEGETABLE SPECIES
/
TEHNOLOGIE PENTRU OBŢINEREA DE SĂMÂNŢĂ ECOLOGICĂ ŞI MATERIAL DE PLANTAT PENTRU SPECIILE LEGUMICOLE

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Keywords: *legume seeds, ecological seed, technology, processing.*

ABSTRACT
Vegetable growing represents a branch of agriculture that deals with theory and practice of legume cultivation. It is one of the most complex branches specialized in vegetal production, due to great diversity of plants cultivated and its permanent vitality, as a result of change of species and hybrids, but also due to the new technologies and related equipment recently appeared. Comparing to other vegetable crops, seeds produce in small quanities (excepting beans, peas, lentil, etc.) and their characteristics (length, width,thickness, etc.) are various. Therefore, the legume seeds conditioning involves compex technologies and installations able to provide a high quality sowing material.

This paper presents a technology and the equipment related to operations integrated within a technology that should ensure the processing of as many as possible legume species.

REZUMAT
Legumicultura este ramura agriculturii care se ocupă cu teoria și practica cultivării legumelor. Este una din cele mai complexe ramuri de specializare a producţiei vegetale datorită diversităţii mare a plantelor cultivate şi cu un dinamism permanent ca urmare a schimbării speciilor şi hibrizilor dar şi a apariţiei de noi tehnologii şi utilaje aferente culturilor specifice. În comparaţie cu alte culturi la legume seminţele se produc în cantităţi mici (excepţie fasolea, mazărea, lintea etc.)şi au caracteristici (lungime, lăţime, grosime etc.) foarte variate. Din acest motiv, condiţionarea seminţelor de legume presupune tehnologii şi instalaţii complexe care să asigure obţinerea unui material semincer de foarte bună calitate.

În lucrare este prezentată o tehnologie şi utilajele aferente operaţiilor integrate în tehnologie care să asigure procesarea cât mai multor specii de legume.

INTRODUCTION
To ensure the necessary quantity of biological material coming from valuable hybrids, that preserve their initial characteristics, certain measures scientifically based according to biological features of variety or hybrid, should be applied within a pre-established system named *"producing seeds and sowing material"* (*Ciofu et al., 2004*). Both the preparation of seeds and seedling production are very important because, the crop success and high-performance productions depend of them.

Knowing the legume seeds particularities is very significant, because it is the basis of conditioning technologies and crop technologies (that are coordinated in culture field and in protected areas). Seed quality is a rather relative concept, due to the fact that some species seeds can have different destinations: food or fodder consumption, sowing or industrialization (*Bucurescu et al., 1992*).

Producing seeds for legume plants is of a major importance, as the majority of species multiplies this way. View the connection between seeds quality and the obtained production, seeds coming from varieties and hybrids of high features and belonging to superior biological classes, should be used.

Ecological agriculture is based on solid objectives and principles, as well as on common practices able to reduce at minimum the human impact on environment, also ensuring a natural operation of agricultural system (*Hansen et. al., 2001*).

Ecological (biodynamic, organic or biological) agriculture appeared as an alternative to intensively chemified agriculture(industrial or conventional) and: .

- aims at non-conventional resources and recycling, thus returning to soil the nutritive elements coming from waste;

- ensures a natural development of plants and animals;
- respects the nature self regulation systems that control the plant pests and illnesses, avoiding the utilization of pesticides, herbicides, synthetic fertilizers, as well as, growing hormones or genetic modifications;

According to papers from specialty literature (*Bucurescu and Roman, 1992; Ţenu I., 1999*), for obtaining appropriate results within the activity of producing seeds and sowing material, ecologically certified, the operating quality of equipment and installations for seeds conditioning is very important, as well as the skillfulness of personnel involved.

In Romania, the environmentally-friendly crops of cereals, vine or legumes represent less than 3% out of the entire agriculture surface, according to information given by Agriculture Ministry. Surface cultivated with environmentally-friendly crops of dry legumes and crops designed to produce seeds is of 2,314 ha, and vegetable culture is of 1.928 ha (*Toncea I., 2002; Stoian L., 2005*). In our country, the first attempts of obtaining“ecological seeds” of legume plants have been achieved at S.C.L. Bacău, in 1997.

MATERIALS AND METHODS

Vegetables are part of numerous botanical families. Therefore, the seed structure, shape, size and chemical composition are very different (Figure 1).

a b c d

e f g h

Fig. 1 - Legume seeds

a-Beetroot; b-Celery; c-Pepper; d-Okras; e-Carrot; f- Parsnip; g-Parsley; h-Eggplant

From a botanical point of view, the vegetable seeds result from dry fruits (beans, okras, peas, etc.) or pulpous fruits (eggplant, tomatoes, cucumbers). This diversity of shape, size, structure and composition influences the technologies of harvesting, conditioning and conservation. A suitable preparation of seeds according to modern technologies should comprise a multitude of operations by which the impurities and inappropriate seeds are evacuated, optimum humidity is ensured as well as, the calibration, polishment, dragee method and chemical treatment (in case of industrial or conventional agriculture).

Starting from these above, different conditioning technologies can be applied at legume seeds conditioning. Figure 2 presents a technology designed for the industrial conditioning of the seeds of legumes and flowers.

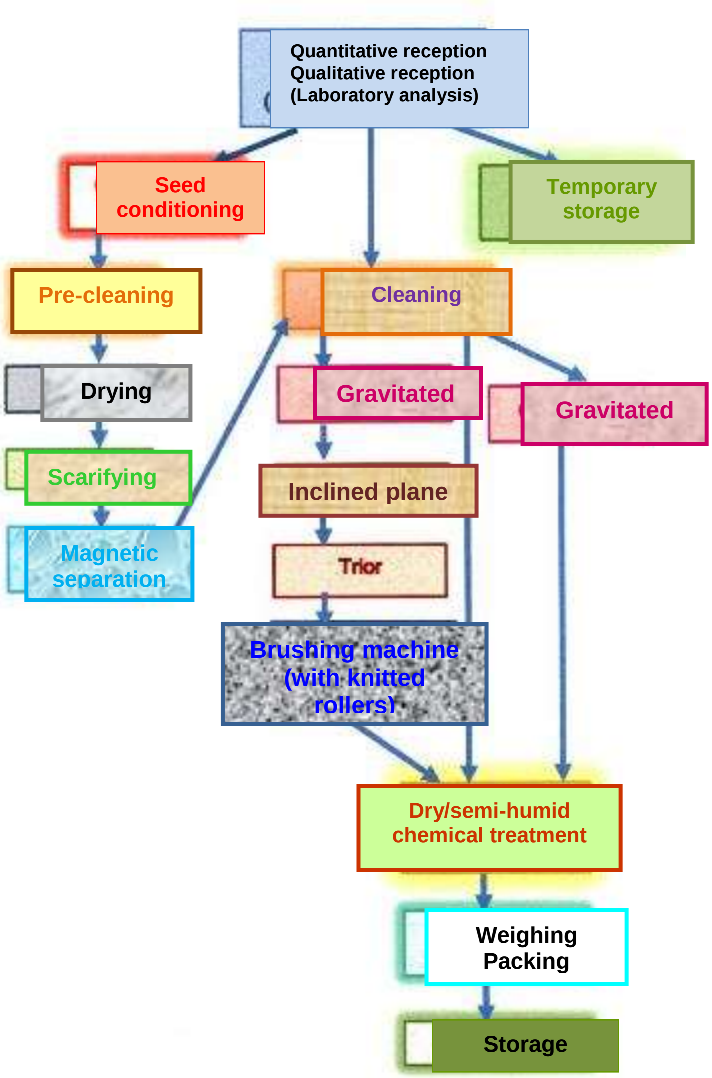

Fig. 2 - Technology for an installation of conditioning legumes and flowers

The technology shown in Figure 2 is a complex industrial technology aiming to produce seeds of legumes and flowers (small seeds) for commercializing them. It is a technology that includes a wide range of operations and their afferent equipment. This type of technology ensures the conditioning of a various spectrum of seeds if pre-cleaning and cleaning equipment is equipped with sieves with meshes specific to variety to be conditioned and sifters are endowed with cylinders with exchangable meshes appropriate to each variety. Therefore, this type of technology applies only at industry level. As a general rule, for conditioning smaller quanities, the technologies appropriate to small capacity machines able to easily control and clean, are preferable.

Technology from Figure 3 approaches this type of conditioning. It ensures the pre-cleaning and cleaning of legume and flower seeds, using only the airflow.

The separation product is brought in the feeding funnel from where, by means of cylinder and one valve, it is distributed uniformly into the sorting column. Under the influence of ascendant airflow, within the limits of floating, the heaviest foreign bodies fall at lower part, thus obtaining the fraction F1, the lighter foreign bodies climb until the first hole, where fraction F2 separates, up to the second hole, where fraction F3 separates, or they leave the column at its upper part, entering the decanting chamber, where fraction F4 of light bodies (impurities) deposit. The air sucked from decanting chamber is blown by the fan in the second decanting room, where dust and other light impurities forming fraction F5 are separated. The five fractions (among which three are useful) pass through the evacuation funnels and the two locks into the evacuation tubes and then into sacks.

Fig. 3 - Technology for obtaining ecological seed

RESULTS

According to the technology presented in Figure 1, the cleaning operation as first operation of technological conditioning flow needs cleaning and sorting equipment which working process is based on difference between seeds physical characteristics and foreign bodies characteristics.

The most used equipment comprises oscillating (vibrating) sieves, that must perform a certain sifting condition for removing the foreign bodies, based on difference between seed dimensions and impurity size (large or small). The foreign bodies are removed from cereals, based on a series of principles of separation, respectively the differencies between seeds and foreign bodies features. In most cases, when manufacturing technological equipment for primary processing, combined principles are used.

When choosing separation surfaces according to components of a mixture, we should take into account the granulometric composition of each component. Considering a mixture comprising two components whose particles size is represented by curves 1 and 2, the following situations may appear, Figure 4, (*INMA, 2014*).

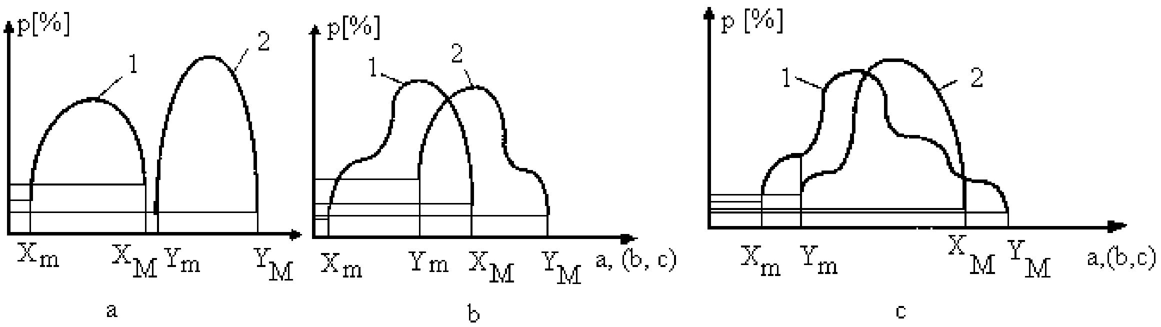

Fig. 4 - Granulometric curves (*INMA, 2014*)

Ideal situation is that when the two curves are separated, respectively:

$$X_m \leq X_M \leq Y_m \leq Y_M \tag{1}$$

Or the biggest dimension of component 1 is smaller than the smallest dimension of component 2, Figure 4a:

$$X_M \leq Y_m \tag{2}$$

In this situation, by using a separation surface which hole size frames between X_M şi Y_m, the complete separation of the two components is possible.

Another situation is that in which the two curves are crossing, respectively,

$$X_m \leq Y_m \leq X_M \leq Y_M \tag{3}$$

In this situation, the two components can be separated only partially, Figure 4b.

When the curves overlap (the worse case) in terms of particle size on a large area, respectively,

$$X_m \leq Y_m \leq Y_M \leq X_M \tag{4}$$

In this case, only small fractions can be separated from component 1, respectively the fraction framing between X_m and Y_m,, if a surface with holes of Y_M size is used, Figure 4c.

For the separation-calibration operation, within the technology from Figure 2 cylindical sieves, usually manufactured with oval holes are used. Thus, the separation is performed according to thickness.

Cylindrical sieve with uniform number of revolutions, without any other internal arrangements can ensure an increased productivity (productivity is proportional to the sieve speed), because when the speed is increased over a certain limit, the seeds remain on sieve surface, reducing a lot the working productivity, because of holes clogging. This shortcome can be avoided, namely the number of revolutions of sieve is increased (so, also sieve productivity) the relative rest does not appear by using special devices such as internal cylindrical screens, internal inclined surfaces, internal cylindrical screens with brushes,etc.

By applying the technology from Figure 3, the pre-cleaning (cleaning) operations are performed without sieves with holes, the separation being made only according to aerodynamic characteristics.

In case of equipment based on this principle of separation, the floating speed of seeds and impurities, as well as the aerodynamic coefficient should be taken into consideration, respectively (*Danciu I., 1997*):

$$v_p = \sqrt{\frac{\rho_p \frac{\pi d^3}{6}}{0.124 k \frac{\pi d^2}{4}}} \tag{5}$$

$$v_p = 2{,}4 \sqrt{\frac{\rho_p}{k} d} \tag{6}$$

where:

v_p- floating speed, m/s;

ρ_p – specific mass of a particle;

d - particle diameter;

k - aerodynamic resistance coefficient (depends on particle surface stopping)

Technology from Figure 3 is the basis of manufacturing an aerodynamic separator designed to condition legume seeds, flowers and cereals.

CONCLUSIONS

Complexity of technological process of seed conditioning differs from one technology to another and implicitly from one conditioning station to another, being influenced by the difficulty degree of pre-cleaning (cleaning) of seeds of different species and their subsequent destinations.

When implementing a technology within a conditioning station, the following requirements should be respected:

- Seeds should follow the technological flow operations in a logical sequence so that to avoid seed degradation or excessive handling;
- Impurities should be removed;
- When conditioning expensive seeds, that are produced in small quantity for sowing (legumes, flowers, medicinal plants, etc.) the valuable components swept during cleaning should be recovered and appropriately used as food or fodder.

As the legume seeds are of various shapes and dimensions, within the conditioning process should be used equipment that operates based on aerodynamic feature separation principle, because the sieve is very expensive. (sieves with holes suitable to each species are needed).

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THEORETICAL CONSIDERATIONS REGARDING THE ENERGETIC CONSUMPTION OF AN RECIRCULATING AQUACULTURE SYSTEM (RAS) FOR FISH BREEDING
/
CONSIDERAȚII TEORETICE PRIVIND CONSUMUL DE ENERGIE AL UNUI SISTEM ACVACOL RECIRCULANT (SAR) DE CREȘTERE A PEȘTILOR

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Keywords: *fish breeding, aquaculture system, energetic consumption*

ABSTRACT

The efficiency of the aquaculture using recirculating systems depends on many factors among which the most important it is the energy consumption of the system. To assure a high level of energy conservation in an aquatic recirculating system, the intensity of water recirculation must be maximized, but this leads to a increasing of the consumed energy for water circulation. This is why is required a rigorous analysis for the energetic consumption for a system of this type and establishment of optimum solutions to minimize the consumption. This paper presents an analysis of the energy consumption for a recirculating aquatic system for fish breeding.

REZUMAT

Eficienţa acvaculturii practicată in sistemele cu recirculare depinde de mai mulţi factori, printre care cel mai important este energia consumată de sistem. Pentru a asigura un grad de conservare al energiei ridicat, intr-un sistem acvacol recirculant, trebuie maximizat gradul de recirculare al apei. Dar acest lucru conduce la creşterea energiei consumate pentru vehicularea apei. Din acest motiv se impune o analiză riguroasă a consumului energetic al unui astfel de sistem şi stabilirea soluţiilor optime pentru diminuarea acestuia. Lucrarea prezintă o analiză a consumului de energie al unui sistem acvacol recirculant de creştere a peştilor.

INTRODUCTION

Traditional aquaculture production in ponds requires large quantities of water and as well as vast land surfaces. For flooding a pond with a surface of 1 ha are required approximately 9500 m^3 of water, and to compensate for evaporation and seepage a same amount of water is needed. In these conditions to produce 5000 kg fish/ha the water consume will be very high, about 0.9 m^3 water/kg of fish. That's why in many of Romania areas pond aquaculture is not possible due to the limited water reserves or the lack of fields suitable for pond construction *(David et. al., 2009)*.

Recirculating aquaculture production systems may offer an alternative to pond aquaculture technology. Through water treatment and reuse, recirculating systems use a fraction of the water required by ponds to produce similar yields. Because recirculating systems usually use different types of tanks dense populated, to obtained the culture product, the requirement concerning the area of land needed is also much smaller than in the traditional aquaculture *(David et. al., 2009)*. Aquatic crop production in tanks where the environment is controlled through water treatment and recirculation is an issue studied since the 70's, when the first types of this systems had developed. Although these technologies have been costly, claims of impressive yields with year-round production in locations close to major markets, are important arguments to approach aquaculture in recirculating systems *(David et. al., 2009)*. An aquatic recirculating system for fish breeding it's a partially closed system, which trough water treatment and recirculation allows the breeding of the aquaculture product in controlled environment conditions. Water treatment from the systems consist in solid waste removal, oxidation of ammonia and nitrite-nitrogen, carbon dioxide removal and water disinfection. In Figure 1 the technological scheme of an recirculating system for super intensive fish breeding is presented *(Bura M., 2008; David et. al., 2009)*.

The main technological equipments used for water treatment are: mechanical filters, biological filters, aeration/oxygenation devices and UV filters. To create the proper environment conditions for fish breeding it is necessary to assure a adequate quality of the recirculation water *(Bura M., 2008; David et. al., 2009)*.

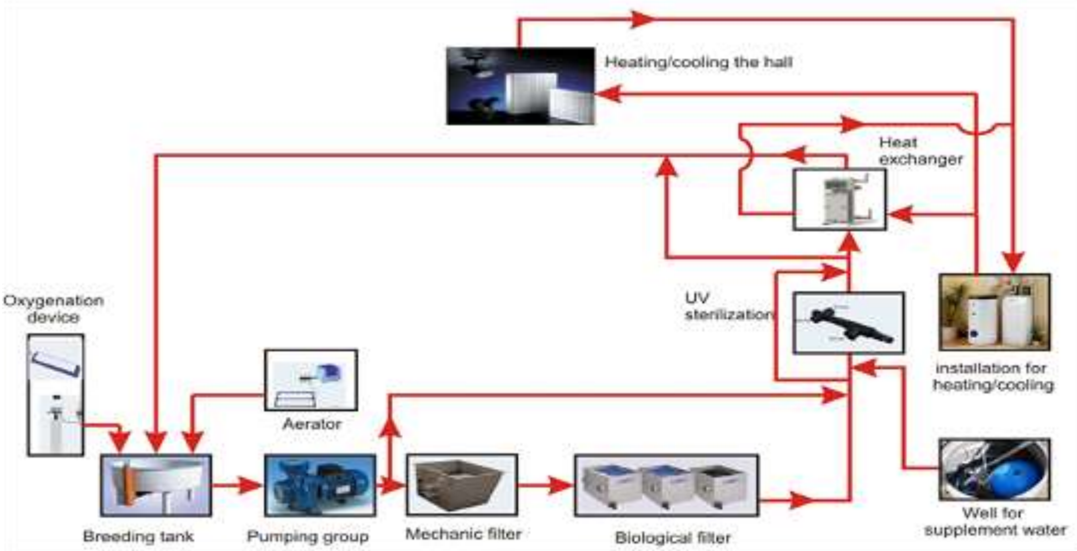

Fig. 1 - Technological scheme of an recirculating aquatic sistem for fish breeding

In the same time a constant and adequate temperature must be assured for every fish species. For example, for the sturgeons, the adult fish need a water temperature of 20 ºC. Also, the air from the breeding hall must have an adequate *temperature (Bura M., 2008; Lazu et. al., 2008; David et. al., 2009)*.

The energy required for functioning of a RAS is split in two categories, electric energy needed to power different technological equipments and calorific energy needed to heat/cool the water from the system and the breeding hall *(Cristea et. al., 2002)*. The equipments powered with electric energy are: recirculation pumps, mechanical filters (some types), aeration pumps, sterilization UV installation

The unit energy consumption (for 1 m^3 of water) of this equipments varies between large limits varying with the equipment type, the using method, the feed quantity and quality as well as the level of food consumption, the populating density and other factors.

Pumping group has the role to assure the circulation of water in the system. The energy consumption depends on the pump type, efficiency, pumping height and the hydraulic resistance of the system. To circulate 1 m^3 of water about 4,6 – 6 Wh/m^3 of electric energy is used. Radial, rotating and “drum” types of mechanic filters are mostly used for the recirculating systems, they use energy to realize rotation moves of the brake drum and to power the washing pump of the filtering material. The unit energy consumption depends on the dimension of the orifice of the filtering material and the washing intensity, the energy consumption being between 3,4 – 4,5 Wh/m^3. The aeration pumps have the role to introduce air in the water from the system to increase the quantity of dissolved oxygen in the water. The needed oxygen quantity for fish varies with the fish species, age and population density, but also with others factors like: water temperature and pH, ammonia, nitrite-nitrogen concentration, etc. For example, if for the sturgeon species (Acipenseridae) it is required a concentration of minimum 8 mg oxygen/l water, the African sheat fish (Clarias gariepinus) resist at concentration of under 1 mg/l of water *(David et. al., 2009)*. It can be admitted a unitary energetic consumption of 2, 5– 7 Wh/m^3. Disinfection process with ultra-violet light it is based on the property of UV radiation of penetration and elimination of all forms of bacteria, viruses and other small organism found in liquid or gazes *(Cristea et. al., 2002).*

The action is instantaneous, it doesn’t use chemical substances, no dangerous chemical compound, and the maintenance of the system is cheap. Unitary energetic consumption of a UV lamp depends on the turbidity of water, energy of the radiation and the wave of length used. To obtain a maximum efficiency about 5,5 Wh/m^3 energetic consumption is considered *(David P., 2007)*.

MATERIAL AND METHOD

The recirculating aquatic system for fish breeding on which were conducted the studies and research had a total water volume of 475 m^3 and the water surface of 555 square meters. Medium hydraulic resistance time of 60 minutes (one recirculation/hour). It’s was stipulated to achieve a density of the biological material of about 80 – 100 kg/m^3 of water. The total amount of water recirculation in the system is: Qt = 522,5 m^3/h, the supplement water volume QA represents approximately 10% from Vt.

Level difference between pump aspiration and the filling hole of the buffer tank is 6 m. Pumping height, taking in calculation the network hydraulic resistance is about 7 m. The electricity consumption of RAS equipment was measured using a wattmeter, after which the total electricity consumption for heating the water from the system and for heating the hall was calculated.

RESULTS

Annual energetic consumption of different equipment from the systems is: energy used by recirculation pumps, with a unitary water consumption of 5,3 Wh/m^3 is EP=165.582 kWh; energy used by mechanical filter, with a unitary water consumption of 4,1 Wh/m^3 EFM = 19.877 kWh and the energy consumed for disinfection with UV, with a unitary water consumption of 9,5 Wh/m^3 EUV= 45.582 kWh

The calorific energy used for heating the water from the system, E_{IA} was calculated with the formula $E_{IA} = e \cdot (t_a - t_f) \cdot Q_A \cdot \tau_1$ where: e = 1,16 kWh, calorific energy used for increasing with 1°C the temperate of a quantity 1m^3 water; t_a = 20°C, water temperature from breeding tanks; t_f = 12°C, temperature of water from the well; Q_A = 47,5 m^3/24h, quantity of supplement water; τ_1 = cca.180 days, number of days in a year when the water must to be heated; E_{IA} = 26.156 kW h

The calorific energy used for heating the hall E_{IH} was calculated with the formula $E_{IH} = c \cdot S \cdot \tau_2$

where: c = 40 kW/m^2, calorific energy necessary to heat a well-sealed place, according to DIN 4701 (for a standard height of 3 m); S = 2.175 m^2, area of the breeding hall; τ_2 = 120 days, the year period when the hall must be heated; E_{IH} = 251.570 kW h.

Table 1

Annual consumption value for the RAS equipment

Equipment	Annual consumption value kWh	Observations
Recirculation pumps	145.552	For H = 7m
Mechanical filters (drum)	18.766	For holes D = 0,07mm
Aeration pumps	10.512	
UV sterilization	43.482	
Total	207.800	

CONCLUSIONS

In conclusion we can observe in Figure 2 how the annual energy consumption of 508.767 kWh is composed from: Energy used by recirculation pumps E_P = 28%, Energy used by mechanical filter E_{FM} = 2.50%, Energy used for UV sterilization E_{UV} = 9.10%, Energy used to heat supplement water E_{IA} = 15,40%, Energy used to heat the hall E_{IH} = 45%. To decrease the energetic consumptions tight to filtration, aeration, disinfection and UV sterilization (which together represents about 11.6% from the total consumption), it can be interfered only in a limited manner, by using modern equipment's with high efficiency.

The main energetic consumer from a RAS (about 28%) it is represented by the energy used to circulate the water. This amount increase with the size of the system and with the intensity of recirculation, meaning the total of circulate water. The energy consumption for water circulation can be significantly decreased by developing a type of systems which requires a minimum pumping height, avoiding the useless pumping and by good design of hydraulic networks. In this way, for example, by eliminating the buffer tank and by reducing the pumping height with 1m, a decreasing with about 16.6% of the energetic consumption is obtained which means 4.5% from the total consume of the analyzed system and it means an economy of 24.300 kWh every year.

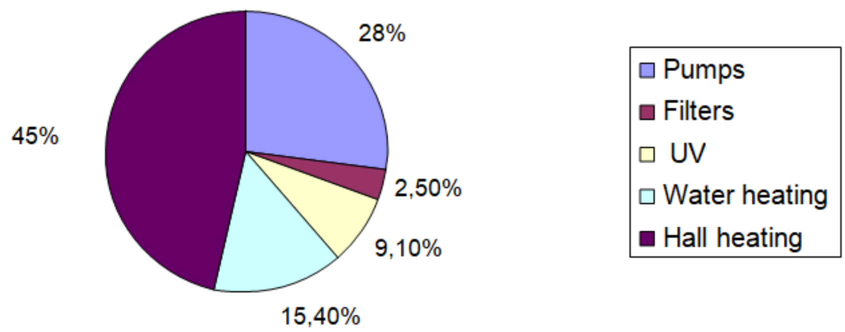

Fig. 2 - Annual Power consumption

Costs with thermal energy (E_{IA} and E_{IH}) are also an important part of the total energetic consumption (cca.60,4%). Decreasing of this consumption can be made by minimizing the lost of heat through a better seal off of the constructions and the external water networks (if there are any).
Another way to decrease the consumption of thermal energy is the use of alternative energy sources which use the environment energy to produce calorific energy.

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"HOW DIVERSE" ARE ENDOPHYTIC FUNGI IN CROPS?
/
"OARE CÂTĂ" DIVERSITATE PREZINTĂ COMUNITĂȚILE DE CIUPERCI ENDOFITE ÎN PLANTELE DE CULTURĂ?

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ABSTRACT
Although by definition an endophyte does not cause visible symptoms, its phenotypic spectrum may change over time inside same host and along with different hosts. Shifts also depend on the health state of the host and abiotic factors; hence crop management is a detailed subject in this review. Given that a plant individual can harbour up to hundreds of fungal species their identification fills the puzzle of the hosts one fungal species may have. The diversity survey reveals fungal endophytes traits as scarce or abundant and it can be used as a tool to explore their synergistic interactions with the host.

REZUMAT
Deși prin definiție, microorganismele endofite nu cauzează simptome vizibile, spectrul fenotipic poate să fie schimbător de-a lungul timpului în aceeași plantă gazdă sau pe masură ce se schimbă gazdele. Schimbările depind și de starea de sănătate a gazdei precum și de factorii abiotici. Prin urmare, managementul de cultură este un subiect detaliat în aceasta revizuire bibliografică. Un individ de plantă poate găzdui până la câteva sute de specii fungice, identificarea acestora completând un puzzle al posibilelor specii gazdă. Explorarea diversității relevă caracteristici ale ciupercilor endofite ca abundente sau rareori întâlnite și formeaza un instrument ce poate fi folosit în transpunerea interacțiunilor sinergice cu planta gazdă.

INTRODUCTION
One way to increase the availability of food is to develop the management of diseases and pests. Estimates reach over 6700 crop pests, diseases and weeds, which cause an estimated reduction of 40% of the world crop (*Oerke et al, 1994*) despite the exhaustive use of chemical phytosanitaries of synthesis that has been done in the last 50 years. The assessment of loss potential of pests – losses without mechanical, biological and/or chemical crop protection measures – worldwide varied from less than 50% (barley) to more than 80% (sugar beet and cotton) (*Oerke et al, 1994*). Organic farming and agroforestry are relevant crop production system approaches for sustainable intensification worldwide and in the EU (Me*yer et al, 2013*). Since 1960, the management of pests and diseases in industrial countries has been based on synthetic chemical pesticides. Advances in cultivation hybrids, mechanization, irrigation and fertilization have helped to increase crops up to 70% in Europe and 100% in the United States. However, the use of synthetic pesticides has become more and more difficult. It is an urgent condition to find alternative tactics helping to build more sustainable crop protection. Plants benefit from close associations with microorganisms, which for their own benefit, have evolved to develop mechanisms that increase fitness and survival of their host. Endophytic microorganisms are particularly well adapted to the host plant, since they spend at least part of their life cycle internally colonising living plant tissue, without causing any immediate, overtly negative effects *(Bacon and White, 2000; Hardoim et al, 2015)*. The endophytic fungi continuously demonstrate their candidacy for 'biotechnological machinery of high agricultural interest' being a source of new drugs and metabolites. Recently, the concept of the plant microbiome has led to a different view on plant evolution, a collaborative evolution, where plants receive flexibility (*Hardoim et al, 2015*). Endophytic fungi are involved in ecosystems and their relations with the host are considered specific, therefore research on endophytic communities of a plant genus is promoted. Furthermore, studies have shown a presumable specificity or preference of various endophytic taxa for their hosts (Das*togeer et al, 2018; Sun et al, 2012; Zhou and Hyde, 2001*). *Cosoveanu*

and Cabrera, (2018) raised a question regarding the difference in the distribution–abundance relationship between the rare and cosmopolitan taxa: what determines the exclusive occurrence of singletons; is it sampling size, host, or site?

In this short review, it is presented a glimpse of the diversity of fungal endophytes reported by far.

MATERIAL AND METHOD

Endophytic fungal diversity dependent on crop management

Fungal diversity associated with cultural management could be regarded as an indicator in programmes aimed at increasing soil fertility and health in intensively cultivated areas. Although the interest is relatively recent in soil and rhizosphere plant – microbiome, continuous research and dissemination of the results is needed so as to expose the consequences of mono-cropping and agro-chemicals on the microbiome ecology.

Results of *Pancher et al. (2012)* indicate that mycota in grapevines from organic farms form communities that are significantly different from those in grapevines from Integrated Pest Managament (IPM) farms. The majority of the fungi were isolated from IPM vineyards and may represent potential pathogens not detected in grapevines from organic farms. Crop management (IPM and organic) modifies the structure of fungal endophytic communities. The authors hypothesize that the use of synthetic systemic fungicides may have a role in these differences. Organic fertilizers may also be a source of microorganisms, which may establish them, subsequently as endophytes.

Data derived from culture dependent microbiological analysis suggested that biodynamic vineyard had a more diverse fungal community than both the conventional and IPM vineyard (*Setati et a*l, *2012*). Also, results showed that the epiphytic fungal community associated with the three vineyards was distinct from each other. Fungi that are potential grapevine pathogens accounted for 50% of the total population in the must from the biodynamic vineyard, while in the conventional and IMP, they accounted for 10 and 8%, respectively (*Setati et al, 2015*). The overall higher biodiversity within the biodynamic vineyard may indeed act as a protective element. Results suggested that several species are representative for the endophytic microbiome of the vineyards and that across continents are major differences, underlying a group of species that could be considered host specific. On the other hand, Kecskemeti et al. (2016) studied the composition of microbial communities on grape berries during the period of berry ripening. Viticultural management system (conventional, organic or biodynamic) had no significant effects on the abundance, diversity and richness of fungi or bacteria present in the grape carposphere. Viticultural management system had no significant effect on abundance of *Cladosporium* spp., *Aureobasidium pullulans*, *Alternaria alternata* and *Botrytis cinerea* with respect to year or sampling site, with the exception of *A. alternata*. It may be hypothesized that the diversity of the mycobiome existent in the fruits is more stable due to i) a limited number of species known for vertical transmission, ii) the limited physical space for survival and development and iii) the agricultural practices given the plant phenophase (less nutrients requirements and pesticides).

Farm practices were found to be relevant in both organic and conventional cultivation *(Ek-Ramos et al, 2013)* suggesting that specific organic farm practices may influence the prevalence of fungal endophytes. In the organic farms, fewer plant fragments yielded endophytic isolates overall compared to those from conventional farms. However, since different cotton varieties were grown in the organic and conventional farms, an effect of plant genotype cannot be ruled out. Although similar number of fungal strains was isolated both in irrigated ecosystem as well as dryland, when the total number of species was considered, 27 species were identified in the irrigated ecosystems, while only 18 species were found in the upland ecosystems *(Pili et al, 2016)*. Flooding may increase the frequency of infection of endophytic fungi *(de Battista, 2008; Manici and Caputo, 2009)* and also factors of the cropping systems like water regimes, rice cultivars, geographical locations and soil types (*Fisher and Petrini, 1992; Tian et al, 2004; Naik et al, 2009*).

Fungal community structure was found affected by the application of fungicides on wheat leaves. OTU (organizational taxonomic units) richness was lower for the fungicide-treated sample pool *(Karlsson et al, 2014)*. Fungicide treatment affected community evenness negatively, and there was no interaction with geographical area. Previous *in vitro* and leaf assays showed that broad-spectrum fungicides like metiram and captan had a detrimental effect on the growth of epiphytic bacteria, fungi, and yeasts with the latter being the most sensitive group of microbes (*Walter et al, 2007*). Foliage application of imidacloprid stimulated *Cryptococcus adeliensis* and *Cryptococcus ribotype*. *Cryptococcus* yeasts are common epiphytes (*He et al, 2012; Čadež et al, 2010*) and members of this genus are known to effectively transform phenolics (*Fonseca et al, 2000*) and benzene (*Middelhoven et al, 1992*). Thus it is probable that the stimulation of

Cryptococcus yeasts on the phyllosphere of pepper plants could be attributed to their involvement in the degradation of imidacloprid. Generally, pesticides induce subtle changes in the structure of the fungal community, with foliage application of imidacloprid inducing the most prominent changes *(Moulas et al, 2013)*.

Comparing the fungal communities of two vanilla culture systems, strong differences were observed between black pepper – vanilla and vanilla monoculture systems *Xiong et al. (2016).* The alpha diversity estimates of the fungal communities revealed that the black pepper-vanilla system had a significantly higher fungal diversity and evenness than the vanilla monoculture soil. However, the black pepper-vanilla system had no effect on the fungal population abundance in the bulk soil. Also, black pepper-vanilla system harboured a significantly lower abundance of *Fusarium oxysporum* in vanilla rhizosphere soil compared with the vanilla monoculture system.

Fungal host specificity was suggested in a study on potato where several endophytic species were observed along with the repeated presence of the crop in the soil (*Manici and Caputo, 2009*). Fungal root colonisation frequency was significantly higher in the monocrop system than the rotation crop system. Diversity profiles of potato and rotation cropping systems were independent, and diversity in rotation soil was higher than that of potato soils. Phytopathogens of potato, *Colletotrichum coccodes*, *Fusarium solani* and *F. oxysporum* were the most abundant species in potato sites with *C. funicola*. Moreover, most of the other species isolated from potato site samples belonged to the fungal root rot complex of herbaceous crops. Continuous potato cropping or potato short-term rotation has already been reported to increase soil-borne potato pathogens in temperate humid conditions (*Peters et al, 2003; Peters et al, 2004*).

Saucedo-García et al. (2014) found that the colonization rate and isolation rate of endophytic fungi are not necessarily related to the diversity found in coffee leaves between two agroforestry systems: rustic plantations versus polyculture plantations. However, they found higher colonization rate and isolation rate values in the rustic plantations (manual weed control and occasional pruning of coffee plants, with no addition of fertilizer) than in the simple polycultures (application of agrochemicals – fertilizers and pesticides).

Rhizosphere and its endophytic diversity

In the rhizosphere of many plants, shifts in the genetic structures of the fungal communities over time were observed (*Vallance et al, 2012*). These shifts were frequently related to the root exudates and physiology of plants, which change over a growing season, shaping the community of microorganisms that metabolize the exudates of the plants.

Endophytic populations were found to be equally or sometimes more genetically diverse than populations from the surrounding soil *(Demers et al, 2015)*. Shannon's diversity index indicated that overall, populations isolated from plants were significantly more diverse than populations from soil. Overall, the large amount of diversity observed among these populations highlights the importance of nonpathogenic lifestyles to the biology of *F. oxysporum*. Some results were suggestive of specialization of endophytic populations, but generally, they support the hypothesis that most, if not all, *F. oxysporum* isolates are capable of living as endophytes.

For arable soils, only a few studies (*Gomes et al, 2003; Xu et al, 2012*) have described that root, rhizosphere and the bulk soil contain distinct fungal communities. Multivariate analysis displayed main separation of fungal communities in the root compartment from those of the soil compartments (Moll et al, 2016). Hence, roots likely provide a distinct niche for specialized fungi. Those fungal taxa abundant in roots depended on easily accessible substrates from the root, thrive on recalcitrant dead plant roots or colonize roots as they were almost not observed in the soil compartments. In the study yeasts were among the most dominant fungal generalists obviously able to inhabit different compartments, although a main differentiation between root and the soil compartments could be determined.

Yeast ratio was lowest in roots compared to the soil compartments*. Xu et al. (2012)* reported that yeasts such as *Trichosporon* and *Cryptococcus* were almost exclusively present in the rhizosphere and bulk soil but not in roots. Rhizosphere of sugarcane seems to have a higher fungal diversity than root endophytes, although the values were not significantly different *(Romão-Dumaresq et al, 2016)*. The use of group-specific primers for methanotrophs showed that there was a decreasing trend in richness from the bulk soil to the rhizosphere soil to the root endophytic community for plants cultivated in the soil. In contrast, the fungal richness appeared to be higher for the endophytic community than for the soil communities (*Seghers et al, 2004*).

RESULTS

Host species and cultivars variation in fungal endophytes communities

Beyond the resident endophyte community: influence of plant functional traits on endophyte assemblages within neighbouring plants was investigated (*Saunders, 2010*). The authors presented two conceptual models which can be applied to fungal endophytes. The plant traits that act as habitat filters in pathogen colonization can have a spatial sphere of influence that extends beyond the individual plant to the neighbours of the focal host. Plants can experience ‘associational susceptibility’ or ‘associational resistance’ when presence of plant neighbours causes a change in the amount of herbivore- or pathogen- induced damage (*Power and Mitchell, 2004; Burdon et al, 2006*).

Differences between plant cultivars may drive a minor shift in endophyte composition, as seen for bean (Parsa et al, 2016), rice (*Fisher and Petrini, 1992*), wheat (*Crous et al, 1995*), ginseng *(Park et al, 2012)*, grapevine (*Cosoveanu et al, 2014*), cotton (*Li et al, 2014*) and other plant species (Manter et al, 2010). *Casieri et al. (2009)* investigated the fungi in the endosphere of five grapevine cultivars in Switzerland and found that the community composition across cultivars differed both when considering the phyla and the species of isolated fungi. Other researchers have analysed the endophytic mycota associated with grapevine in Spain, finding that the composition across cultivars differed when the order of isolated fungal taxa was considered *(González and Tello, 2011)*. Finally, some information is available on the cultivar influence on microbial communities associated with the roots (*Parker and Kluepfel, 2009*).

Given that plants can actively control the diversity of their microbial communities by recruiting beneficial microorganisms, especially from the soil *(Rosenblueth and Martínez-Romero, 2004; Hartmann et al, 2009)*, and through the production of intrinsic regulatory molecules and secondary metabolites, each cultivar, because of its genetic make-up, is assumed to select its own microbial community (Comby et al, 2016). Actually, many studies have shown that host genotype may influence, along with prevailing environmental conditions, the composition of endophytic communities, for example in potato plants (Manter et al, 2010), common bean *(de Oliveira Costa et al, 2012)*, or cotton seedlings (*Adams and Kloepper, 2002*), as well as the diversity of the rhizosphere microbiome in maize (*Peiffer and Ley, 2013*) or of the phyllosphere mycobiome in cereals *(Sapkota et al, 2015)*.

Variation in fungal endophytic microbiome - isolation method in/dependent

More and more studies show the need to employ both culture-dependent and –independent methods to reveal the fungal assemblages within plants *(Ben Chobba et al, 2013; Martins et al, 2016)* It has been suggested that some endophytic fungi could not be isolated from plant tissues using traditional cultural methods, presumably due to inherent limitations in those techniques. Conversely, the direct detection and identification of endophytic fungi from plant tissues using molecular techniques presents a number of limitations (*Ben Chobba et al, 2013; Avis et al, 2010; Horton, 2002; Avis et al, 2006*). Therefore, the taxonomically ambiguous entities (sometimes referred to as ribotypes) produced by ARISA fingerprinting are not reliable indicators of species richness (*Pancher et al, 2012*). Another equally important point concerns the treatment of the host tissue (*Guo et al, 2001*).

The DNA-dependent approach was found to be more powerful compared to the analysis of culturable fungi (*Pancher et al, 2012*). The authors developed a method which requires little hands-on labour, does not require separation of fungal mycelium from the agar medium, and is validated for a diverse array of fungal taxa. However, it must be admitted that the sterilization of roots as described in this paper as a technique will certainly kill all the microorganisms in the root surface, but the dead cells may still contain DNA that becomes extracted and thus amplified. However, the extraction of total endophytic fungal DNA is still considered to be reliable because some epiphytic fungi may also penetrate the cortex tissue and live endophytically (Santamaría and Bayman, *2005*). Conversely, *(Impullitti and Malvick, 2013)* observed a trend for greater diversity of fungal endophytes was detected in soybean stems using a culture-based method compared with a culture independent method, but differences were not statistically significant.

Metagenomics involves analysis of sequence information from microbial members of various ecological communities without the need for isolation and cultivation of strains. A metagenomics approach is quite helpful in unravelling the potential of uncultured microbial communities (*Dinsdale et al, 2008*), thus revealing the information beyond the genomic information of individual taxa *(Kaul et al, 2016)*. High throughput sequencing called next generation sequencing (NGS) has made metagenomic studies comparatively easier and catalysed the rapid, unprecedented characterisation studies of microbiomes

(Akinsanya et al, 2015). Metagenomic approaches have become an important tool for assessment of the grape microbiome.

Bokulich et al. (2014) examined the fungal and bacterial communities in crushed Chardonnay and Cabernet Sauvignon fruits in California using Illumina amplicon sequencing approaches and showed that the microbiomes not only differed by region, but were also conditioned by climate, year and cultivar. Similarly, *Taylor et al. (2014)* demonstrated regional distinction in fungal communities in vineyards across New Zealand. The authors considered that culture-based methods might lose up to approximately 95% of the community. Consequently, these methods are increasingly becoming the preferred tool to evaluate the grape microbial community structures. Recently, culture-independent methods including ARISA, DGGE, and CE-SSCP have been employed especially in comparative studies. However, confident identification of taxa represented in the community fingerprints is not always easy or reliable. Metagenomic approaches are the methods of choice for unravelling the microbiome associated with different ecosystems *(Setati et al, 2015).* The development of high-throughput sequencing, particularly Illumina MiSeq sequencing *(Metzker, 2010; Shokralla et al, 2012)*, offers an accurate, low cost and powerful strategy for uncovering the complex and diverse microbial communities (*Xiong et al, 2016*). Studies that have attempted to examine fungal endophytic communities using simultaneously cultivation-based and cultivation-independent approaches have indicated that, although the latter yielded greater diversity, the dominant taxa identified by cultivation-independent methods were also detected by culture-dependent methods (*Pancher et al, 2012; Ben Chobba et al, 201*3).

CONCLUSIONS

Continuously indexing species found in both cultivated and wild plant species offers a hint of the array of relations one fungal endophyte may have with plant hosts as most of the species found as endophytes in certain wild plants are known pathogens in crops. Overall, although many studies have shown that host genotype, phenophase and plant organs for sampling shape the microbial communities, environment and cultural practices seem to weigh more in the structure of the plant – microbiome. The early exploration of crops and their endophytic communities indicates diversity with promise of further significant biological activity.

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BENEFICIAL MICROORGANISMS WITH PLANT STIMULATING EFFECTS ON WHITE CLOVER *Trifolium repens* L.
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MICROORGANISME BENEFICE PLANTELOR CU EFECT STIMULATOR ASUPRA TRIFOIULUI ALB Trifolium repens L.

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ABSTRACT

Several beneficial microorganisms were used in this study, four strains of Bacillus amyloliquefaciens BIR, BPA, BW and OS17, and four strains of Trichoderma spp. Tk14, Tk20, T27 and T36. These were analysed in vitro for their biocontrol potential against the soil-born phytopathogens: Fusarium oxysporum, Rhizoctonia solani and Sclerotium bataticola. Two of these beneficial microorganisms, Bacillus amyloliquefaciens BIR and Trichoderma sp. T27, were studied for plant growth promotion of white clover (Trifolium repens L.).

REZUMAT

În cadrul acestui studiu au fost analizate mai multe tulpini de microorganisme benefice plantelor, patru tulpini de Bacillus amyloliquefaciens BIR, BPA, BW și OS17, respectiv patru tulpini de Trichoderma spp. Tk14, Tk20, T27 și T36. Acestea au fost analizate in vitro pentru a le determina potențialul de control biologic față de fungii fitopatogeni de sol: Fusarium oxysporum, Rhizoctonia solani și Sclerotium bataticola. Două dintre aceste tulpini benefice de microorganisme, Bacillus amyloliquefaciens BIR și Trichoderma sp. T27, au fost studiate și pentru a le determina capacitatea de stimulare a creșterii plantelor de trifoi alb (Trifolium repens L.).

INTRODUCTION

Microbial strains with biostimulation effects are beneficial microorganisms that applied as soil, seed or plant treatment can improve plant growth, quality and productivity. These favourable effects are generated by an increased nutrient availability and uptake, and induced tolerance to biotic and abiotic stress (*Figueiredo et al., 2016*).

Bacillus spp. and *Trichoderma* spp. are highly appreciated plant growth promoting and biocontrol microorganisms for agriculture. These microorganisms are involved in biological control by reducing plant pathogenic populations or inhibiting phytopathogenic growth. In this case, selected *Bacillus* and *Trichoderma* strains produce active metabolic compounds and enzymes with antagonistic activity against plan pathogens (*Sicuia O.A, 2013; Siddiqui Z.A, 2005*). Other plant beneficial strains could activate several defence mechanisms in the inoculated plants, inducing plant resistance to several biotic and abiotic stresses (*Danielsson, 2008; Hidangmayum and Dwivedi, 2018; Gangwar and Singh, 2018*).

Bacillus and *Trichoderma* strains are able to improve plant growth and nutrient uptake, thorough phytohormone production, bioconversion of plant debris, or solubilisation of different mineral compounds (*Idriss et al., 2002, 2007; Wahyudi et al., 2011; Wu et al., 2005*).

The purpose of the present study was to characterise several plant beneficial stains for their biocontrol capacity and plant growth promotion. The novelty of our study is the implementation of a model *in vitro* plant assay were small plantlets (not only *Arabidopsis* but also *Trifolium repens*) can be studied when grown in Petri plates for up to 2-3 weeks.

MATERIAL AND METHOD

Eight plant beneficial microorganisms (bacteria and fungi) were analysed for their *in vitro* antifungal activity against: *Fusarium oxysporum*, *Rhizoctonia solani* and *Sclerotium bataticola.* Four of these beneficial microorganisms are *Bacillus amyloliquefaciens* strains (BIR, BPA, OS17 and BW), and the other four are

Trichoderma spp. strains (Tk14, Tk20, T27 and T36). The microorganisms were provided from three microbial collections. From the Research-Development Institute for Plant Protection we used *Bacillus amyloliquefaciens* OS17, and from the National Institute for Research & Development in Chemistry and Petrochemistry, we used *Trichoderma* spp. T27 and T36 strains. The other plant beneficial and phytopathogenic strains were from the microbial collection of the Faculty of Biotechnology (UASVM Bucharest). Bacterial strains were routinely grown on Luria-Bertani Agar Miller (LB), and the fungal strains on Potato Dextrose Agar (PDA).These strains were selected due to their capacity to solubilise silicon (Si) from different different biological and mineral substrates, like horsetail plants, wheat straw, diatomite, silica gel and talc (data not shown). Although Si is considered a non-essential element for plants, it has been demonstrated that available Si has a positive influence on plants growth. Therefore, silicic acid uptake positively influence plants growth, mechanical strength, and resistance to several biotic and abiotic unfavorable conditions (*Detmann et al., 2012, 2013; Ghareeb et al., 2011; Luyckx et al., 2017*).

To analyse direct interactions among strains we used the dual culture technique. The pathogenic fungi (plugs of 5mm diameter) were inoculated on PDA in the centre of 90 mm Petri plates, and bacterial biomass was streaked from the edge of the plate to the fungal inoculum, at 2 mm distance from the mycelia plug. Direct interactions among *Trichoderma* spp. and phytopathogens was analysed in 50mm Petri plates, were both fungi, calibrated as 3 mm mycelia plugs, were placed diametrically opposed in the same PDA plates. Control plates were also prepared, in order to compare the pathogenic growth in optimal culture conditions.

The antifungal activity of *Bacillus* spp. and *Trichoderma* spp. strains was periodically evaluated during 14 days of incubation. Biocontrol efficacy (E%) was determined by the following equation (*Lahlali and Hijri, 2010*):

$$E(\%) = (CR-TR)/CR * 100 \qquad (1)$$

where CR is the measured radius of the fungal growth in control plates, and TR is the fungal radius in the test plates. Clear inhibition zones were also measured, and the fungal edge was microscopically analysed.The antagonistic activity of *Trichoderma* spp. strains was also evaluated using the following equation of *Răuț et al (2012*):

$$X = \frac{I_A}{I_B} \times \frac{E_B}{E_A} \qquad (2)$$

where: *X* represents the level of the antagonistic activity, *I* is the mycelia radius of the inner part of the fungal growth, *E* is the mycelia radius of the external part of the fungal growth, *A* represents the pathogenic growth and *B* the beneficial fungi (*Trichoderma* spp.).

Hyperparasitic potential of *Trichoderma* spp. strains over *Fusarium oxysporum*, *Rhizoctonia solani* and *Sclerotium bataticola* was also determined.

Plant stimulation effect was also evaluated on white clover (*Trifolium repens* L.) selected as model plant for *in vitro* studies. Seeds were kindly provided by PhD Vasilica Stan (UASVM Bucharest). Seeding material was surface disinfected for 30 seconds with 70% ethanol and with 4% sodium hypochlorite for 15 minutes, and rinsed five times with sterile distilled water. Seeds were than maintained to germinate for 5 days at room temperature in humid chamber. Germinated clover seeds were placed on Hoagland-Agar in sterile Petri plates. We used a modified version of the *in vitro* assay for *Arabidopsis*-*Trichoderma* interactions as described by Sáenz-Mata and Jiménez-Bremont (2012). A number of 20 seeds were linear placed in each plate of 12cm x12 cm. Three experimental variants were used: one with bacterial treatment were *Bacillus amyloliquefaciens* BIR strain was used, a fungal treatment with *Trichoderma*sp. T27 strain, and a control variant with no treatment. The inoculum was applied at 3 cm distance from the germinated seeds, by streaking the microbial biomass on the agar substrate.

In order to evaluate plant stimulation effects of the microbial treatments, two weeks old plants were biometrically analysed. Roots length was measured and plant fresh and dry weight was determined.

RESULTS

The antifungal activity of tested bacterial strains was biometrically evaluated. The fungal growth obtained in the control plates was compared with the one obtained in the presence of inhibitory bacteria. Clear zones, between microbial strains, were considered an antagonistic effect, and were also measured (Table 1).

Table 1

Antagonistic activity of *Bacillus* spp. strains

Bacterial strain	*Fusariumoxysporum*	*Rhizoctoniasolani*	*Sclerotiumbataticola*
	Clear zones of fungal growth inhibition (cm)		
BIR	0.3	0.1	0.2
BPA	0.5	0	0.18
BW	0.35	0.15	0.3
OS17	0.4	0.1	0.3

Regarding the antagonistic activity, *in vitro,* the studied bacterial strains revealed larger clear zones against *Fusarium oxysporum*. Among *Bacillus amyloliquefaciens* strains, BPA and OS17 maintained the most wide clear area around the pathogen. This could be due tosome metabolic compounds with antifungal activity or the production of some lithic enzymes released in the culture medium. Most likely, these metabolites were diffused into the growth substrate and therefore were perceived by the fungus, which has limited its growth. The clear inhibition zones were maintained for at least 14 days during the observations.

Biocontrol efficacy against *Fusarium oxysporum* was evaluated, *in vitro*, as 64.7% to 70.6% (Figure 1).

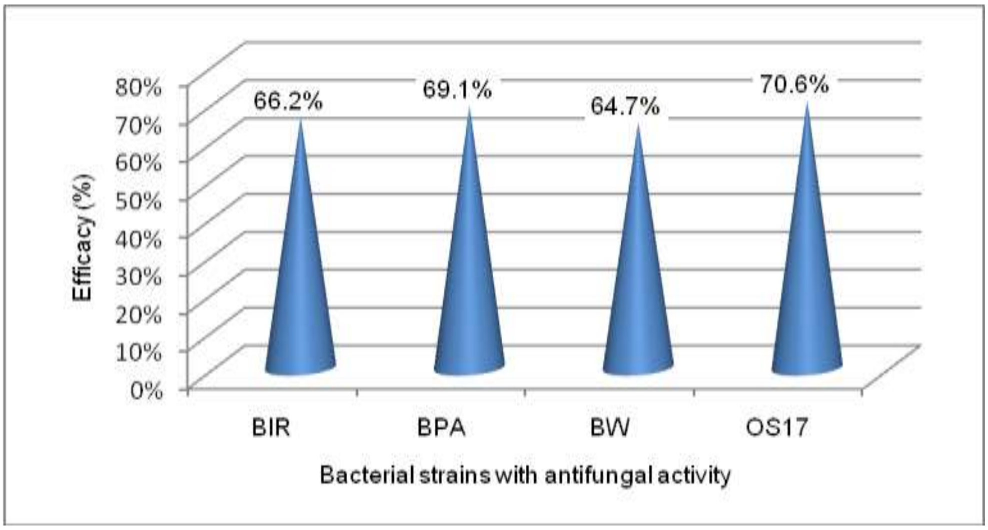


Fig. 1 - In vitro biological control of Fusarium oxysporum using beneficial bacteria

The best bacterial strain with antifungal activity was *Bacillus amyloliquefaciens* OS17, which expressed 70.6% biocontrol efficacy. The following biocontrol bacteria was BPA, revealing 69.1% efficacy, *in vitro*. It has been noticed that *F.oxysporum* modified its growth from white mycelia, as in the control plates, to purple-red at the colony hedge, near the clear inhibition zone induced by the biocontrol bacteria (Figure 2).

Fig. 2 - In vitro antagonistic activity of Bacillus amyloliquefaciens against Fusarium oxysporum

The microscopic analysis of the inhibited mycelial growth of *F.oxysporum* revealed some ulceration of the fungal cells or lysed cells, from which the cytoplasmic content was lost (Figure 3). Similar results were also mentioned in other several studies (*Boiu-Sicuia et al., 2017; Giorgio et al., 2015*).

Fig. 3 - Ulcerations and lysed cells in *Fusarium oxysporum* mycelia in the proximity of the antagonistic *Bacillus amyloliquefaciens* OS17 strain

In vitro antagonism against *Rhizoctonia solani* showed an inhibitory activity of 61.25% to 63.75% when using the selected *B.amyloliquefaciens* strains (Figure 4). Best antagonistic results against were obtained OS17 and BIR strains (63.75%). However, BW strain induced the widest clear zone.

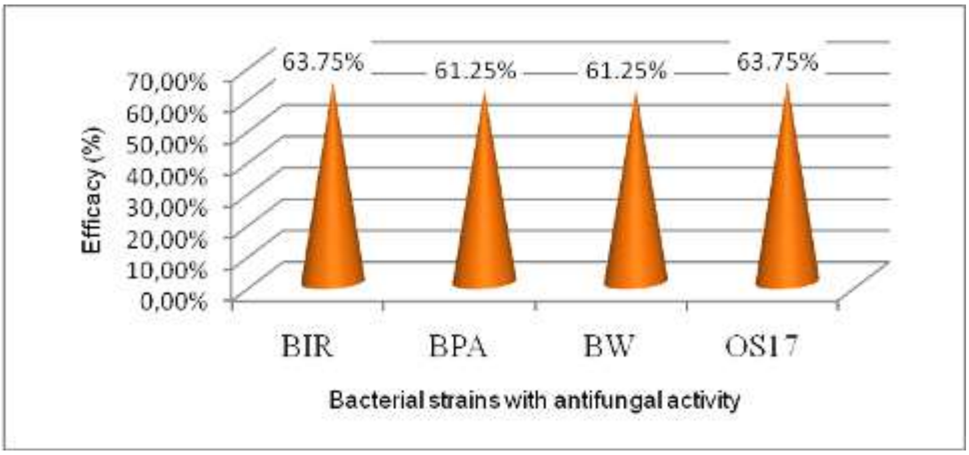


Fig. 4 - In vitro biological control of Rhizoctonia solani using beneficial bacteria

In vitro biocontrol efficacy against *Sclerotium bataticola* was evaluated, as 65% to 71.25%. *B.amyloliquefaciens* OS17 strain showed best inhibitory activity against the fungal growth (Figure 5).

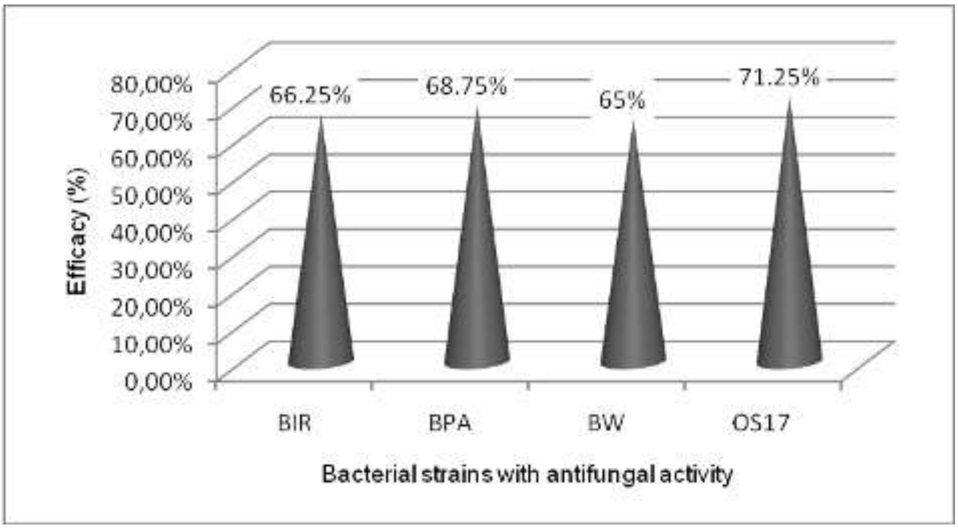


Fig. 5 - In vitro biological control of Sclerotium bataticola using beneficial bacteria

The microscopic analysis of the inhibited mycelia growth of *S.bataticola* revealed fungal cells perforation and leaks of cytoplasmic content, most probably due to lytic character of the biocontrol bacteria (Figure 6).

Fig. 6 - Lysed cells in the *Sclerotium bataticola* mycelia in the proximity of biocontrol *Bacillus amyloliquefaciens* strains

A wide spectrum of antagonistic activity was also revealed by the *Trichoderma* spp. strains. Their antagonistic level was determined based on two algorithms. The first protocol, proposed by Răuț et al. (2012), revealed a higher antagonistic level for those stains having X values closer to 0 (Table 2).

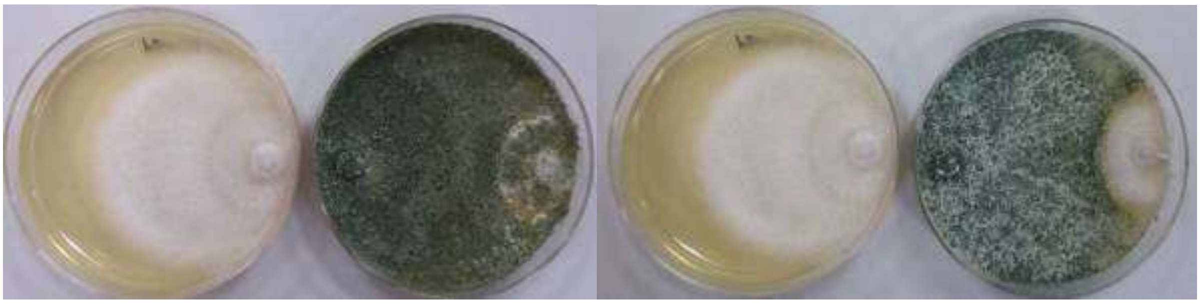
Table 2

Antagonistic level of *Trichoderma* spp. strains

Biocontrol strain	***Fusariumoxysporum***	***Rhizoctoniasolani***	***Sclerotiumbataticola***
	Antagonism level (X values)		
Tk 14	0.23	0.69	0.44
Tk 20	0.19	0.41	0.53
T27	0.15	0.51	0.46
T36	0.35	0.45	0.57

The second protocol used to evaluate the antagonistic activity of the *Trichoderma* spp strains revealed the biocontrol efficacy of the tested strains.

Results showed that *Trichoderma* spp. inhibited *Fusarium oxysporum* growth, with a biocontrol efficacy of 78.8% (T27) to 80% (Tk14, Tk20, and T36) after 7 days of co-cultivation. Moreover, *Trichoderma* spp. Tk14, T27 and T36 strains revealed their hyperparasitic potential against *F.oxysporum*, colonizing the pathogenic growth (Figure 7).



F.oxy **Tk14 vs *F.oxy*** ***F.oxy*** **Tk20 vs *F.oxy***

F.oxy **T27 vs *F.oxy*** ***F.oxy*** **T36 vs *F.oxy***

Fig. 7 -Trichoderma spp. Tk14, T27 and T36 hyperparasitism on Fusariumoxysporum

A lower antagonistic activity was detected against *Rhizoctonia solani*, were *Trichoderma* spp. strains expressed a biocontrol efficacy of 59.9% to 73.6% (Figure 8).

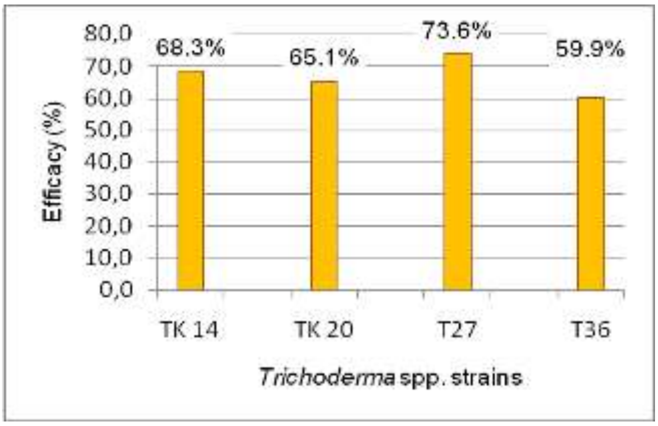
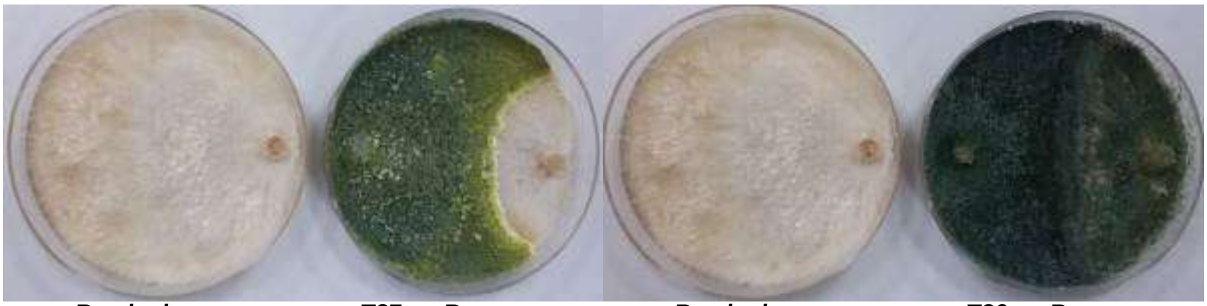


Fig. 8 - Biocontrol efficacy of *Trichoderma* spp. strains against *Rhizoctonia solani*
(after 7 days of co-cultivation)

Analyzing the fungal growth, of the dual cultures, it was noticed that *Trichoderma* spp. Tk20, and T36 strains present a higher hyperparasitic activity against *R. solani*, completely colonizing the pathogenic growth in the first 7 days of co-cultivation (Figure 9). The other two biocontrol strains (Tk14 and T27) revealed a lower hyperparasitic activity against this soil-borne phytopathogenic fungi.

R.solani **Tk14 vs *R.s.*** ***R.solani*** **Tk20 vs *R.s.***



R.solani **T27 vs *R.s.*** ***R.solani*** **T36 vs *R.s.***

Fig. 9 - Trichoderma spp. hyperparasitism on Rhizoctonia solani

Microbial interaction with *Sclerotum bataticola* revealed a biocontrol efficacy of 72.1% (T36) to 86.1% (T27), after the first 7 days of co-cultivation (Figure 10).

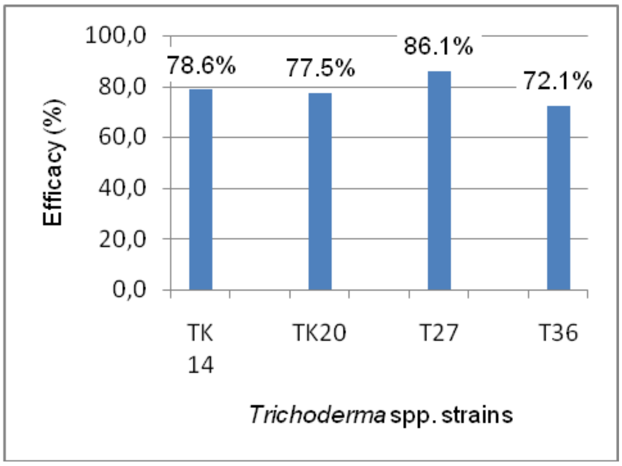


Fig. 10 - Biocontrol efficacy of *Trichoderma* spp. strains against *Sclerotium bataticola*
(after 7 days of co-cultivation)

All four *Trichoderma* spp. strains were able to colonize *S.bataticola* growth within the 7 days of co-cultivation revealing a high hyperparasitic activity against this pathogenic fungi (Figure 11).

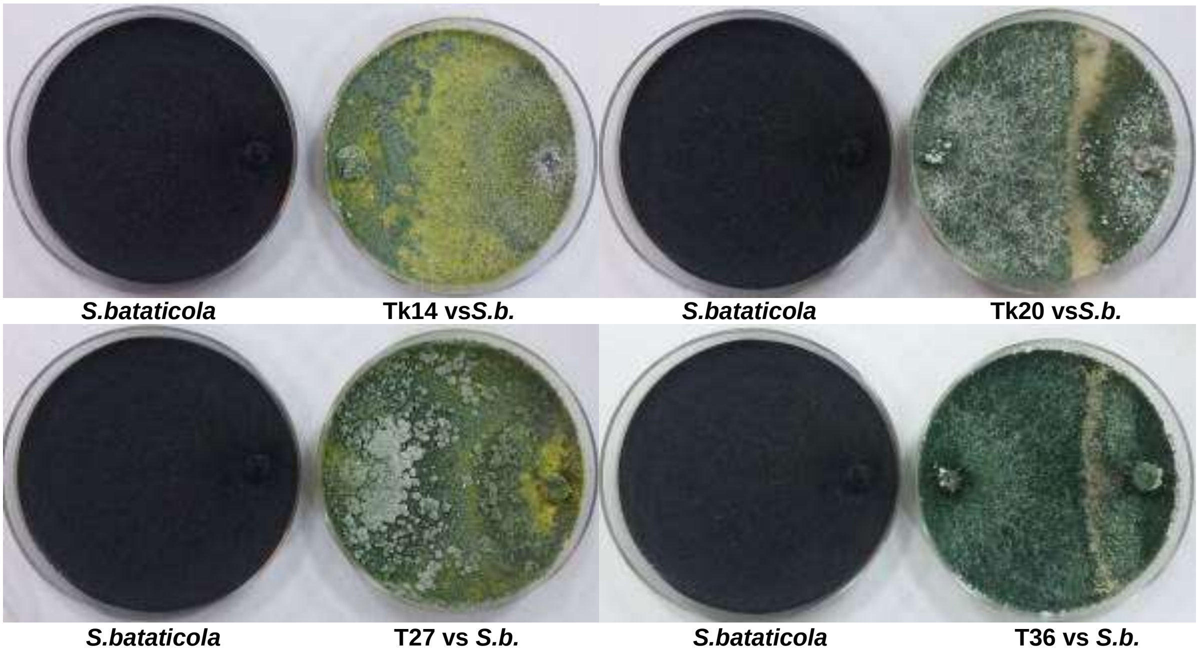


Fig. 11 - Trichoderma spp. hyperparasitism on Sclerotium bataticola

Direct microbial interactions through dual culture technique revealed that all eight biocontrol strains (bacteria and fungi) presented antifungal activity against the soil-borne phytopatogens *F. oxysporum*, *R.solani* and *S. bataticola*. Based on these results, two of these plant-beneficial strains (*Bacillus* sp. BIR and *Trichoderma* sp. T27) were used as inoculants in order to evaluate *in vitro* their potential to stimulate the growth of white clover (*Trifolium repens* L.).

Biometric determination of roots length revealed slight differences among the treated variants (table 3). After the first week of cultivation a growth incensement of 24.2% (BIR) to 35.2% (T27) was registered, compared to the control. Differences among treatments were reduced after the second week of cultivations, and the microbial treated plants revealed a growth improvement of 13.9% to 16.3% compared to the untreated control.

Table 3

White clover root growth

Experimental variant	**Untreated control**	***Bacillus* sp. BIR inoculation**	***Trichoderma*sp. T27 inoculation**
Cultivation time	Average of root length (cm)		
7 days	1.28	1.59	1.73
14 days	2.09	2.43	2.38

However visible differences were noticed among the inoculated clover and the untreated plants (Figure 12) especially in the first seven days of cultivation.

Fig. 12 - White clover plants after 7 days of growth on Hoagland agar substrate

After two weeks of cultivation white clover plants revealed a growth improvement when inoculated with plant beneficial microorganisms (Figure 13). Among the experimental variants, best results were obtained when *Trichoderma* sp. T27 strain was used as inoculant (Table 4).

Table 4

Plant growth promotion of white clover

Experimental variant	**Untreated control**	***Bacillus* sp. BIR inoculation**	***Trichoderma*sp. T27 inoculation**
	Plant weight (mg)		
Fresh weight	0.844	1.088	1.129
Dry weight	0.399	0.450	0.557

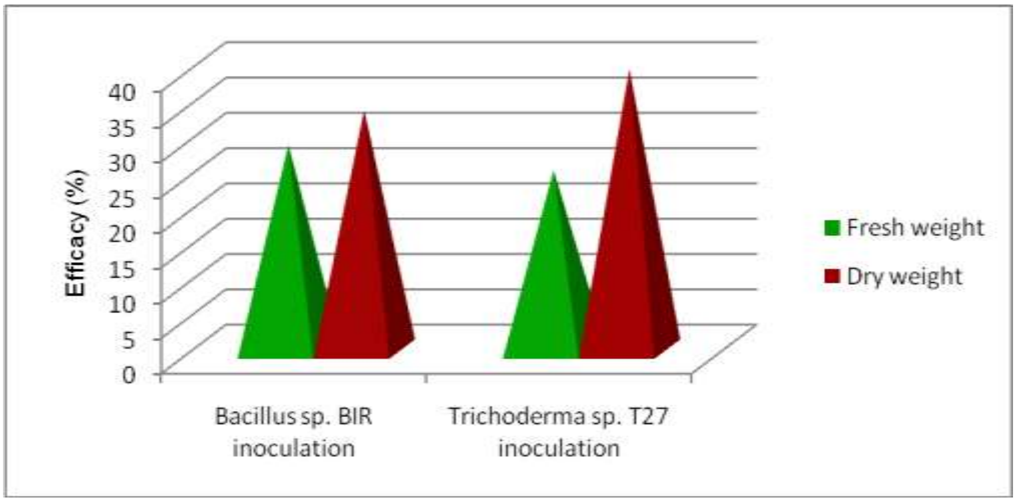


Fig. 13 - Plant stimulation effects of some beneficial microorganisms inoculated on white clover (*Trifolium repens* L.)

White clover inoculation with plant beneficial microorganisms showed an increased growth compared with untreated plants, thus revealing plant stimulation effects of both tested microorganisms, *Bacillus* sp. BIR and *Trichoderma* sp. T27 strains.

CONCLUSIONS

Selected microbial strains of *Bacillus* (BIR, BPA, OS17, BW) and *Trichoderma* (Tk14, Tk20, T27, T36) genera express a moderate to high biocontrol activity against important soil-borne phytopatogens, such as *Fusarium oxysporum*, *Rhizoctonia solani* and *Sclerotium bataticola*. Severe alteration of the pathogenic fungal growth was generated by the biocontrol microorganisms. Direct interaction of plant beneficial microorganisms and fungal pathogens revealed hyperparasitism and fungal cell lysis.

Increased roots length and plant biomass were also registered in white clover inoculated with *Bacillus amyloliquefaciens* BIR and *Trichoderma* sp. T27 strains.

The present study describe a novel *in vitro* assay were small plantlets (e.g. *Arabidopsis, Trifolium repens*) can be studied for 2-3 weeks in Petri plates for growth promotion or biocontrol studies.

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TEST METHOD FOR ASSESING THE BIOLOGICAL STABILITY OF FUNGAL ENTOMOPATHOGENIC BIOINSECTICIDES
/
PROCEDEU DE EVALUARE A STABILITĂȚII BIOLOGICE A FORMULĂRILOR FUNGICE ENTOMOPATOGENE

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Keywords: *Beauveria bassiana, mycoinsecticides, stability*

ABSTRACT

Stability during storage is a limiting factor for the commercial development of Beauveria bassiana mycoinsecticides. The paper presents results of experimental research aimed at developing methods of assessing the stability of entomopathogenic mycoinsecticides: method of assessing the stability of fungal formulations viability, as well as methods of assessing the virulence stability of fungal formulations, by bioassay on Leptinotarsa decemlineata, under laboratory and field conditions. The method for obtaining B. bassiana oily formulations is also described.

REZUMAT

Stabilitatea pe parcursul perioadei de depozitare reprezintă un factor care limitează dezvoltarea comercială a entomopatogenului Beauveria bassiana ca micoinsecticid. În lucrare sunt prezentate rezultatele unor cercetări experimentale care vizează elaborarea unor metode de testare a stabilității micoinsecticidelor entomopatogene: metoda de evaluare a stabilității viabilității formulărilor fungice, precum și metode de evaluare a stabilității virulenței formulărilor fungice, prin biotestare, în condiții de laborator și câmp, pe Leptinotarsa decemlineata. De asemenea este prezentată metoda de obținere a formulărilor uleioase de B. bassiana.

INTRODUCTION

Entomopathogenic fungi are considered sustainable alternatives to chemical insecticides; of these, *Beauveria bassiana* (Bals.) Vuill. is one of the most studied species of entomopathogenic fungi due to cosmopolitan distribution and potential for biological control of insects of agricultural and forest interest, host specificity with a very low risk of attacking non-target organisms. The commercial use of entomopathogenic fungi is linked to technologies which can ensure cost-effective production of biopesticides, simplicity to handle, stability during storage, suitability to mixture and application and repetitively efficacy in controlling the target pest (*Mwamburi, 2016*). *B. bassiana* mycoinsecticides may be applied with conventional equipment used for application of chemical insecticides as powders, emulsions, dusts, granules, pellets; some of them could be adapted as baits or traps, or added into soil (*Feng et al., 1994*). A critical component in helping *B. bassiana* to become a trustworthy plant protection product is the development of fungal formulations that can provide the stability of the biological properties responsible for insecticidal activity as long as possible. Stability during storage is a limiting factor in the commercial development of *B. bassiana* mycoinsecticides.

Rodrigues et al. (2012) have published results on the stability during storage of *Metarhizium anisopliae* (Metschnikoff) Sorokin and *B. bassiana* encapsulated formulations; the paper presents a method to evaluate the effect on vegetative growth, sporulation and viability of sodium alginate, maltodextrin, hemicellulose, dimethyl sulfoxide solvents.

Mascarin et al. (2016) have tested the stability of dried *B. bassiana* blastospore preparations, by measuring blastospore viability after drying and storage and by assessing insecticidal efficacy against the silver leaf whitefly, *Bemisia tabaci* (Gennadius). The tolerance to dehydration-rehydration, the effect of vacuum packaging and temperature, the effect of active packaging on blastospore shelf life are studied.

A protocol for assessing the stability of granulated formulations of *B. bassiana* is also described by *Mwamburi (2016).* The number of colony-forming units is determined after serial dilutions of solid substrates (with barley, rice, wheat bran, clay, kaolin, peat) colonized by *B. bassiana* are plated onto malt extract agar and yeast tryptone agar. Finding that, in submerged culture, entomopathogenic fungi can produce microsclerotia, has led to studies on storage stability of granular formulations containing such overwintering structures (*Behle and Jackson, 2014, Villamizar et al., 2018*).

Methods for assessing the stability of conidia in oily formulations are frequent (*Liu, 2012*), but also have limitations for mycoinsecticide quality control evaluations, especially for oily formulations of *B. bassiana.* The research presented in this paper was aimed to develop methods of assessing the stability of oily formulation of a Romanian *B. bassiana* strain.

MATERIAL AND METHOD

B. bassiana oil-in-water formulation was prepared by mixing oil, which represented the oil phase, with the spore suspension which represented the aqueous phase.

1.For the aqueous phase, the experimental fungal culture was obtained by cultivating on PDA, for 14 days at 24 ± 2^{0}C, a strain of *B. bassiana* (BbIt) isolated from *Ips typographus* L. and belonging to the RDIPP Bucharest collection of entomopathogenic microorganisms (*Dinu et al., 2012a*). The monosporal cultures conserved on peptone-dextrose-agar medium at 4°C were used in the experiments. Two weeks later, the spores from 2 Petri dishes were harvested in glass tubes, using 0.01% Tween 80 and 10 ml. The mixture from the glass tubes was mixed for 15 min using a vortex mixer and afterward it was dispensed into 20 Eppendorf tubes (1 ml per tube). The Eppendorf tubes were centrifuged for 15 minutes at 3500 rpm (subsequently, the liquid from each tube was removed and sterile water added for decanting the spores and removing the emulsifier). The procedure of washing the conidia was repeated 3 times. The washed conidia formed the conidial sterilized distilled water stock (approximately 300µl) which was mixed with 9.7 ml sterilized distilled water. Successive dilutions were made and a concentration of $4x10^8$ conidia/ml was obtained for using as aqueous phase.

2.For the oil phase, five types of cold pressed oils, free of carbohydrates and proteins, have been selected: olive oil, soybean oil, rapeseed oil, sesame seed oil, grape seed oil (Figure 1a). Oils were sterilized by tyndallization method (in a water bath at 90^{0}C for one hour, three days in a row).

Five oil-in-water formulations were prepared with sterilized olive oil, soybean oil, rapeseed oil, sesame seed oil and grape seed oil at a concentration of 1% as follows: 1% sterilized oil, 1% Na_2CO_3, 1% Triton X-100, 0,5% sterilized sunflower oil (as antifoaming agent) and 96.5% of the aqueous phase. In order to get a stable formulation,all these components were homogenized together at room temperature for 120 min using a Kühner mini-shaker at 160 rpm.

Fig. 1 - (a) Cold pressed oils (b) Vegetative growth

RESULTS

In order to evaluate the stability of viability, it was assessed the *germination* and *vegetative growth* (Figure 1b) and *conidiation* at a 1-month interval.

For the *germination assessment*, 50 µl of the *B. bassiana* oil-in-water formulation at $4x10^8$ conidia/ml was used for inoculation PDA plates by spread plate method (three replicates/plates for each formulation). For the control, a sample of aqueous phase was used. The plates were incubated at 24 ± 2^{0}C. After 24h, a drop (~1 ml) of lactophenol with methylene blue (40% glycerol, 20% phenol, 20% lactic acid, 0.05% methyl blue and water) was transferred onto each plate in order to inhibit the germination (Figure 2).

Fig. 2 - Lactophenol with methylene blue for inhibiting the germination

For each plate, 200 conidia were counted and the percentage of germinated/un-germinated was calculated. The conidia were considered germinated when the length of germination tube exceeded 1-1.5 times their length. The data were used to calculate the percentage of germination inhibition by the formula:

$$\boxed{\text{germination (\%)} = (G\%mt - G\%var) / G\%mt \times 100}$$

where: **G% mt** represents the germination percentage for the control and **G% var** represents the germination percentage in the sample with oil formulation.

For the *vegetative growth* and *conidiation assessment*, plates were prepared as follows: a 5mm hole was made using a disinfected cork borer in the middle of the PDA plate and inoculated with 50 µl of the oil-in-water formulation. The plates were incubated for 14 days at 24 ± 2^{0}C. Colony diameter was recorded in the 14th day. For assessment of conidiogenesis, a disc of 5mm was cut using a cork borer. Each disc was distributed in glass tubes with 10 ml of sterile distilled water with 0.01% Tween 80 and the content was homogenized using a vortex mixer. Spore counting was made using Bürker haemocytometer.

In order to assess the *virulence stability* of fungal formulations, treatments with *B. bassiana* oil-in-water formulation were made on *Leptinotarsa decemlineata* Say, under laboratory and field conditions, one month after the preparation of bioinsecticidal formulations.

Procedure for evaluating the stability of virulence stability under laboratory conditions

1. Adults of *L. decemlineata* are collected directly from a potato crop, where plant protection treatments have not been applied. The Colorado beetles are kept in insect cages in natural conditions of temperature and normal photoperiod, on potted potato plants. (Figure 3).

Fig. 3 - Insect cages with potted potato plants (*L. decemlineata* adults on host plant)

2. For laboratory rearing of *L. decemlineata*, potato leaves with clusters of eggs are collected daily from insect cages (Figure 4). After hatching, 15 larvae are placed in plastic boxes and grown under laboratory conditions on potato leaves (Figure 5).

Fig. 4 - Egg cluster of the Colorado potato beetle, *L. decemlineata*

3. When the larvae enter the prepupal stage and stop feeding (Figure 5), they are placed in plastic containers filled with soil, which are checked daily for the emergence of adults. Mature larvae burrow 2-5 cm into the soil, and after about two days begin to pupate. The mean development time of Colorado potato beetle pupae is about 5.8 days (*Capinera, 2001*).

Fig. 5 - Mature larvae of *L. decemlineata* (prepupal stage)

4.Treated samples are sprayed with *B. bassiana* oil-in-water formulations; control samples are sprayed with 0.01% Tween 80. For assessment of conidial viability at the time of application of the treatments, a drop of *B. bassiana* oil in water formulation are applied simultaneously on plates with PDA (Figure 6).

Fig. 6 - Assessment of conidial viability at the time of application of the treatments

5. Each beetle is placed individually in a laboratory insect box after treatment, with wet filter paper and potato leaves and maintained at 25 °C, 16: 8 light-dark cycle for 12 days. At 24-hour intervals, leaves are replaced with new ones and observations on the survival of beetles are made. The dead beetles are placed in "wet rooms" (100% humidity) and monitored for the symptoms of mycosis (post-mortem sporulation). The mortality date and the date of the first symptoms of mycosis are recorded.

6. The insecticidal activity is calculated according to this formula:

Mortality (%) = [1 - A in T after treatment/ A in M after treatment/] x 100]

where: A = number of *L. decemlineata* individuals, T = treatment , M = control

Procedure for evaluating the stability of virulence stability under field conditions

1. An experimental plot is chosen in a crop naturally infested with *L. decemlineata* larvae and where no phytosanitary treatments have been applied.
2. Prior to treatment, surveys are carried out and distribution and degree of infestation is assessed.
3. Treatments corresponding to a dose of 3 x 10^{13} conidia / ha is applied (adjust the dose of oil-in-water formulation). The number of larvae are recorded in the treated and control plots, 5-7 days after treatment.
4. The insecticidal activity is calculated according to this formula:

Mortality (%) = [1 - L in M before the treatment x L in T after treatment
/ L in M after treatment x L in T before the treatment] x 100

where: L= number of *L. decemlineata* individuals, T = treatment, M = control

Fig. 7 - Testing the biological activity of fungal formulations in field conditions (test insect: *L. decemlineata* larvae, host plant: *Solanum tuberosum*)

CONCLUSIONS

These methods for assessing the biological stability of fungal entomopathogenic bioinsecticides have proven to work very well in laboratory and field conditions, as we design them. More than five combinations of methods were evaluated and the presented ones were the most suitable for the tested *B. bassiana* strain, for our laboratory and field conditions. The results confirm findings from other experimental designs founded in the literature. The oil-in-water formulation differentially influenced the growth, colony character and sporulation of *B.bassiana* tested strain. As it is already known, when it is cultivated on PDA, BbIt colony has a circular shape, with no elevation and regular margins (*Dinu et al, 2012b*). In this experiment, almost all replicates formed big coremia (Figure 8).

Fig. 8 - Fungal coremia of *B.bassiana* formulated with grape seed oil and grown on PDA

The purpose of these experiments was to develop a working protocol for future experiments on oil formulations. The five oil formulations tested against *L. decemlineata* larvae and adults displayed high mortality values compared to that of unformulated sample. This demonstrates that oil formulations ehhance the adhesion of spores to the insect cuticle and facilitate spore germination. The percentage of germinated conidia was > 95% in all replicates, indicating viability. Also, in all experiments, 94% of conidia formed germ tubes after 18 hours incubation at 25 °C.

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NUTRITIVE AND FORMULATION SUBSTRATE FOR BEAUVERIA BASSIANA (BALS.) VUILL
/
SUBSTRAT NUTRITIV ŞI DE FORMULARE PENTRU BEAUVERIA BASSIANA (BALS.) VUILL

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ABSTRACT

The paper presents a nutritive substrate for the entomopathogenic fungi Beauveria bassiana in order to formulate it as granulated bioinsecticide. According to the experiments, the substrate consists of bean seeds residues resulted from storages infested with pest or as by-product from mass breeding of insects. Certain species of entomopathogenic fungi of B. bassiana are cultivated on it, in order to prepare highly virulent inoculant bio-insecticides against Colorado beetle.

REZUMAT

Lucrarea prezintă un substrat nutritiv pentru ciuperca entomopatogenă Beauveria bassiana, în scopul formulării acesteia ca bioinsecticid granulat. Conform experimentelor, mediul este constituit din reziduuri de semințe de fasole care au rezultat ca subprodus din multiplicarea în masă a unor insecte de depozit. Acest substrat nutritiv este utilizat pentru formularea unui bioinsecticid inoculant pe bază de B. bassiana cu virulență ridicată față de gândacul din Colorado.

INTRODUCTION

Mycopesticide development challenges research with various technical problems. Compared to production of chemical pesticides, obtaining mycoinsecticides is technologically associated with special conditions (*Andersh, 1992*). Growing microorganisms on industrial scale and maintaining the viability of cells with insecticidal activity are essential conditions and decisively influences the acceptance of a microbial plant protection product. Only well-defined, stable, and economically standardised, biologically active formulations can become commercial microbiological products.

The spread (acceptance) of microbiological products depends on the extent to which these conditions are met (*Soper et al., 1981*). In this respect, the successful use of fungal bioinsecticides is conditioned by the quality of the "active substance" (*B.bassiana* spores), which, in order to ensure biological effectiveness, must be virulent, with ecological potential, and also by the functioning of some technologies of cultivation, which ensure large production of spores, under conditions of economic efficiency. Stored product insects feed on the bean beans, destroying completely the cotyledons and the embryo, thus affecting their biological value (germination, growth of future plants). The damages caused are qualitative and quantitative, in the grain stores the attack results in 100% loss if no action is taken. Degraded bean seeds also result from the mass rearing of the bean weevil (*Acanthoscelides obtectus* Say - Coleoptera, Bruchidae) for research purpose.

Beauveria bassiana Bals. Vuill. is a entomopathogenic microorganism whose biological properties (pathogenicity, virulence, genetic stability), biotechnological attributes (productivity, stability in formulations) and ecological attributes (epizootic character, persistence in the environment, tolerance to adverse factors) provides the quality of a biological pest control agent. The advantages of using fungal entomopathogens, mainly related to environmental protection and food safety, have led to the development of commercial-scale production technologies and their application as biological insecticides.

In scientific literature are presented many results regarding the cultivation of *B.bassiana* fungi in submerged batch culture (*Pham et al., 2009*) and on several nutrient substrates: potato paste (*Kral and Neubauer, 1953*); wheat waste mixed with rice husk (*Gouli et al.,1997*); mixture of malt, agar and powder of *Galleria mellonella* larvae (*El-Sufty R. et al*., 1992); rice moistened with coconut water (*Ibrahim and Low,* *1993*); corn extract and sucrose / wheat bran (*Blachere et al., 1973*); rice (*Posada-Florez, 2008*), mixture of sorghum, millet flour and crushed corn (*Karanja et. Al, 2010*); industrial potato residues, sugar cane birch, coffee husk (*Santa et al., 2005*); barley flour (*Jenkins et al. 1998*). A review of relevant studies of *B. bassiana* conidia production on solid-state cultures was presented by Lopez-Perez et al. (2015).

The aim of this study was to formulate a nutritive substrate (bean seeds residues) for the entomopathogenic fungi *B. bassiana* in order to obtain a granulated bioinsecticide.

MATERIAL AND METHOD

Isolation / characterization of B. bassiana strain used for testing the nutritive substrate (bean infested with bean weevils).

The biological material used to isolate a strain of *B. bassiana* was an adult of *Sciara* spp.,the dark-winged fungus gnats (Diptera: Sciaridae), collected from a natural epizootic outbreak. After isolation (using the direct isolation method), the fungal strain (BbSc) was purified and preserved in tubes on peptone-dextrose agar (PDA) at 4°C. Monosporal fungal colonies were analyzed morphologically and pathologically.

The evaluation of pathogenicity of the BbSc strain was done on following insect pests by contamination of the growth substrate with sporulated fungal biomass (BbSc): the wheat weevil *Sitophilus granarius* L., the dark-winged fungus gnats *Oryzaephilus surinamensis* L., the red flour beetle *Tribolium castaneum* Herbst., the yellow mealworm beetle *Tenebrio molitor* L., the Indian meal moth *Plodia interpunctella* Hubner, the greater wax moth or honeycomb moth *Galleria mellonella* L., the bean weevil *Acanthoscelides obtectus* Say. These insects were reared under laboratory controlled conditions, on specific nutrient natural substrates (Figure 1).

Fig. 1 - Test insects reared in RDIPP (Useful Organisms Laboratory)
(a) *Galleria mellonella* in Hydak medium; (b) *Tenebrio molitor* in wheat bran

The mortality induced by the BbSc strain was evaluated using "wet chamber" method. In order to determine the mortality percentage, individuals who showed symptoms of fungal infection within 48-72 hours were counted.

Cultivation of the BbSc fungal strain on autoclaved bean beans

Bean beans resulted from mass rearing of *A.obtectus* under laboratory controlled conditions (Figure 2) were used as a nutrient substrate for growth and sporulation of BbSc strain, in order to assess its influence on the bio-ecological properties of *B. bassiana*.

Fig. 2 - Bean grains damaged by *Acanthoscelides obtectus* used as nutritive substrate for *B. bassiana*
(RDIPP – Useful Organisms Laboratory)

The cultivation was done in autoclavable plastic bags, (300x600 mm), provided with a tube covered with a cotton plug for ventilation and inoculation. For each bag, 200 g of beans were weighed and 200 ml of tap water added. After autoclaving (1.0 atm) at 121°C for 60 minutes, then cooling to 20-30°C, the bags were inoculated, under aseptic conditions, with conidia derived from cultures on PDA. After inoculation, the bags were manually shaken, then placed in a horizontal position and gently pressed until beans were placed in a single layer.

Testing the bio-ecological abilities of fungal biomass

Considering that *B.bassiana* grown on bean beans will be used as a pest control agent against soil pests, the colonized organic substrate has been evaluated in terms of the extent to which the incubation time in the soil influences the biological parameters of the fungal biomass. The test was conducted in experimental field conditions and consisted of the microbiological analysis of the fungal strain introduced into the soil on an organic substrate (depth of 10 cm), in terms of germination, multiplication and distribution in the environment. After 15, 30 and 60 days, respectively, from soil inoculation, soil samples were taken; the microbiological analysis of the soil samples was done 24 hours after sampling, during which time they were stored in plastic bags at 4 °C. The sampling depth was 0 - 5 cm and 5 - 10 cm, respectively, each analyzed sample (S1, S2, S3) being the result of the mixing of 15 sub-samples; of the obtained mixture, mean samples of 10 g were taken for the microbiological laboratory test. The final sample was dried out in open air to stop microbiological activity prior to laboratory analysis; for this, the soil was sprinkled in a 1 cm layer on an aluminum foil.

For the quantitative evaluation of *B.bassiana* conidia isolated from soil, successive dilutions were made from aqueous suspensions of soil (2 g soil / 100 ml sterilized water). One ml of each dilution was plated on a 10 cm diameter Petri dish. Three Petri dishes were used for each dilution. The hematocytometric method was used to determine the number of conidia. The colonies were measured after 72 hours of incubation at 23 °C. To assess the conidial viability, conidial suspensions (10: 1 / plate) were inoculated on agar medium, and incubated at 28 °C. The germination test was done at 24, 48, and 72 hours. The pathological characterization of the fungal strain reisolated from the soil was tested under laboratory conditions by bioassay on the insect test *Plodia interpunctella*. The results were statically interpreted (ANOVA, Biostat Program 2008) and probit method.

RESULTS

It was registered a mortality rate between 25-80% in wet chambers, which confirms the pathogenicity of *B. bassiana*, BbSc strain, on tested insects. The following results, concerning the vegetative growth of BbSc strain on different culture media, were obtained and the results confirmed findings of *Dinu et al (2012)* presented in Table 1 and Figure 3.

Table 1

Colonial morphology of BbSc strain grown on different culture media

Colony morphology (10 days after inoculation)	BbSc strain on culture media		
	Czapek	**Sabouraud**	**PDA**
Shape	circular	circular, gibbous	circular, slightly bulging
Elevation	plat	hemispheric, fluffy mycelia	flat
Margin	filiform	entire	regular
Opacity	translucent	opac	opac
Sporulation	sporulated	sporulated	sporulated in concentric circles

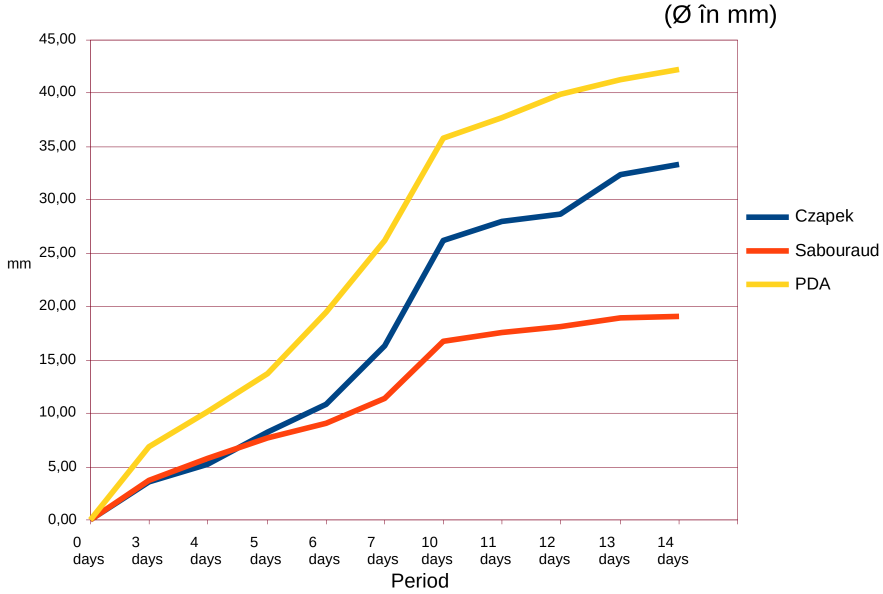

Fig. 3 - Growth dynamics of BbSc strain mycelium on different culture media

Cultivation of the BbSc fungal strain on autoclaved bean beans

After 15 days of incubation at 24 - 26°C, under stationary conditions, each bean bean was completely covered with a white, powdery, spherical fungal mycelium. An average production of fungal biomass of 1.1 x 10^9 conidia / g of nutrient substrate (bean beans) was obtained. The result demonstrates that bean beans represent a nutritious substrate efficiently exploited by *B.bassiana* for fungal sporulation.

Testing the bio-ecological abilities of fungal biomass

The direct examination of the soil from experimental field revealed that the pathogen colonized the soil to different degrees. The percentage of recovered conidia at 5 cm depth, 15 days after treatment, was more than 85%; at a depth of 10 cm, the percentage dropped by about 40%; after 30 days, the conidia recovery rate remained very high (73-81%). After 60 days a decrease of 1.9 times of the conidia in soil was registered. Statistical data processing revealed that the duration of the incubation period in soil induced significant changes of entomopathogenic inoculum recovered from the soil. The results on the evaluation of soil colonization capacity by the fungal biomass developed on beans are presented in Table 2.

Table 2

Evaluation of the soil colonization capacity by the fungal biomass developed on beans

Observation interval (days after application of fungal biomass)	**Soil sample**					
	S1		S2		S3	
	Depth of soil sample (cm)					
	0-5	5-10	0-5	5-10	0-5	5-10
	Number of conidia x 10^{10}/m²					
T0 (Control)	9.23		7.94		11.03	
15	7.85	3.69	6.75	3.18	9.37	4.14
30	7.38	6.92	6.35	5.95	8.93	8.27
60	4.86	4.85	4.18	4.19	5.80	5.81

The results concerning *B.bassiana* spores germination isolated from soil at different time intervals are shown in the Table 3.

Table 3

Results on the germination of *B.bassiana* spores from the soil at different time intervals

Observation interval (days after application of fungal biomass)	Incubation period	Soil sample					
		I		II		III	
		Depth of soil sample (cm)					
		0-5	5-10	0-5	5-10	0-5	5-10
		Conidia germination (%)					
15	24	54.5	56.3	53.6	52.7	55.4	55.4
	48	80	52.7	64.5	60	68.1	63.6
	72	84.5	77.2	75.4	69	78.1	76.9
30	24	53.6	52.7	45.4	45.4	45.4	44.5
	48	72.7	67.2	57.2	53.6	63.6	59
	72	80.9	70	71.8	65.4	74.5	68.1
60	24	38.1	37	37.7	31.8	39	37.2
	48	55.4	51.8	50	46.3	53.6	50
	72	63.6	60	69	57.2	66.3	60.9

The percentage of *germinated conidia* recorded maximum values (71-93%) after 60 hours, regardless of the depth from which samples were taken. Compared to the control variant (incubation under controlled conditions), the greatest decrease in conidial germination capacity was recorded after 60 days of incubation into the soil. Statistical data demonstrate that the duration of the incubation period in the soil induced very significant changes ($p < 0.001$) in the conidial germination capacity.

In order to detect the alteration of morphocultural features, the re-isolated conidia in the experimental field were inoculated on agar medium (PDA); the biological parameter selected for this evaluation was the vegetative multiplication capacity of *B.bassiana*. In sample S1, the average daily growth rate ranged between 0.51 and 0.67 cm in the superficial soil layer (0-5 cm), respectively, between 0.39 and 0.43 cm at a depth of 10 cm. In sample S2, the average daily growth rate of isolated conidia from the analyzed soil profiles (5 and 10 cm) recorded average values of 0.28 cm / 24 h. In sample S3, similar growth rates were recorded. The statistical data reveals that the duration of the incubation period in soil did not cause significant changes ($p > 0.05$) in the vegetative multiplication capacity of *B.bassiana*.

The virulence of fungal biomass after re-isolation from soil (depth of 5 cm) was tested (insect test *A. obtectus*). Taking into account the recorded mortality rates, the following median lethal doses (LD50) expressed as conidia/g growth medium ($x10^5$) were obtained: S1: 1.03> 1.01> 0.50; S2: 2.12>2.07>1.03; S3: 1.89 >1.84 >0.93.

CONCLUSION

Bean beans damaged by stored pests represent a substrate that *B. bassiana* can exploit as nutrient under conditions of stability of the eco-biological parameters responsible for the efficacy of *B.bassiana* bioinsecticides.

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PLANT PROTECTION PRODUCTS WITH LOW ENVIRONMENT IMPACT USED FOR THE PESTS CONTROL IN POTATO CROP
/
UTILIZAREA PRODUSELOR DE PROTECTIE A PLANTELOR CU IMPACT REDUS ASUPRA MEDIULUI IN COMBATEREA AGENTILOR DE DAUNARE DIN CULTURA DE CARTOF

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Keywords: *plant protection products, Cyprinus carpio, Selenastrum capricornutum*

ABSTRACT

Proper use of pesticides is continuously supported in a sustainable and productive agriculture. Ensuring water protection is a priority on the list of public concerns about the environment as it is considered as one of the fundamental elements necessary for the existence of life on our planet.

The paper aims to establish the impact of chemical phytosanitary products on aquatic organisms Cyprinus carpio and Selenastrum capricornutum, species of test organisms recommended by European legislation.The plant protection products tested under laboratory conditions, were the Nuprid 200 SC insecticide, the Sencor 600 SC herbicide and the Consento 450 SC fungicide.

REZUMAT

Utilizarea corectă a pesticidelor este un factor cheie în cadrul unei agriculturi durabile și productive. Protecția apelor reprezintă o prioritate pe lista preocupărilor publice despre mediu și este recunoscută ca unul din elementele de bază necesare existenței vieții pe planetă.

Lucrarea urmărește stabilirea impactului unor produse fitosanitare chimice asupra organismelor acvatice Cyprinus carpio și Selenastrum capricornutum, specii de organisme test recomandate de legislația europeană. Insecticidul Nuprid 200 SC, erbicidul Sencor 600 SC și fungicidul Consento 450 SC, au fost produsele fitosanitare chimice pentru care s-a determinat, în condiții de laborator, impactul asupra peștilor și al creșterii algelor.

INTRODUCTION

Water protection is an essential concern of the European Plant Protection Association (ECPA) and the pesticide industry, materialized by developing projects that support the proper use of pesticides in a sustainable and productive agriculture. Pesticides can reach surface waters in two ways, with two major sources of pollution: point sources mainly represented by pesticide manipulation within agricultural farms and diffuse sources due to rainwater leakage, soil erosion, unfavourable weather conditions or the phenomenon of drift. The contamination of groundwater and surface water is a consequence of the use of pesticides in the agriculture and out of the agriculture. Their significance for human health and the environment largely depends on the quantity applied annually within an area, the toxicological and ecotoxicological properties of the pesticides and the persistence in the environment (*Beitz et all, 1994*).

For a risk assessment of surface and ground water contamination, the occurrence and fate of these chemicals in aquatic environments is to be considered. It requires detailed knowledge of the flow regime and of the geochemical behavior of the pesticides in water and soil with respect to the physical, chemical and microbial processes controlling their persistence and transport in the different aquatic systems (*Matthess G.,1994*). Aquatic ecosystems may be contaminated with PPPs as a result of spray-drift, leaching, runoff, and/or accidental spills, and because aquatic ecosystems contain species related to the target organisms of PPPs, undesirable side effects may occur. Therefore, governmental authorities have set criteria to protect aquatic life from pesticide stress. These criteria, however, often are debated because of the high economic consequences of too strict—and the high ecological consequences of too weak— environmental risk assessment procedures. Consequently, the ecological relevance of estimated risk levels is an important item in recent ecotoxicological research with PPPs (*Brock T. et all, 2006*)

This paper presents the study impact of chemical plant protection products on the *Cyprinus carpio* fish species and *Selenastrum capricornutum*, an algae species, both in laboratory and field conditions.

MATERIAL AND METHOD

During the first part of this study, the toxicity of chemical phytosanitary products to fish, *C. carpio* species and algae, *S. capricornutum*, was determined under laboratory conditions. Testing activities of selected products were conducted on the two aquatic species, species for which plant protection legislation requires the determination of the influence of chemical phytosanitary products. Carp (*C. carpio*) is a species that is part of the list of species recommended for this test, according to Method C1 of Regulation (EC) No. 440/2008. To determine toxicity to fish, a European Guideline (OECD 203, 1984) procedure has been used, a procedure which establishes the methodology for determining acute lethal toxicity of a substance.

The chemical plant protection products tested in order to determine their impact on aquatic species were Nuprid 200 SC, Sencor 600 SC and Consento 450 SC. Chemicals have been tested at concentrations 10 times lower than the recommended dose. They were diluted, considering that the concentration that reaches the surface waters or groundwater is much lower compared to the one given under production conditions.

The fish were purchased from the Nucet Fish Research Development Station where they had controlled growth conditions. They belonged to a single batch, corresponded in terms of health, being approximately the same age and no visible malformations. During the acclimatization period, the fish were fed on a daily basis with standardized feed, with a 24-hour break before testing, with the daily ration administered representing 2% of the weight of the fish batch.

Within the LECO facility, for the maintenance of fish in the laboratory, including for testing is used reconstituted water produced by automated equipment. Reconstituted water is obtained by adding to the deionized water a specific quantity of reagents with an analytical grading recognized in accordance with the requirements of Appendix 1 to Method C1 of Regulation (EC) No. 440/2008.

The acclimatization period was 7 days, the fish were kept in the reconstituted water at a temperature appropriate for the tested species, with a lighting time of 12-16 hours per day; the dissolved oxygen concentration was kept at least 80% of the saturation value in the air and the pH of the water was between: 6.0-8.5. Fish that showed atypical swimming behaviour were isolated from the rest of the lot and were not used for the test. These, as well as surviving fish at the end of the test period were euthanized according to a specific procedure and disposed of in accordance with specific requirements. The fish were exposed to the water-solubilized test substance in a series of concentrations over a period of 96 hours. The mortality was recorded at 24, 48, 72 and 96 hours and the median lethal concentration causing 50% death of the fish group was calculated, if any, being considered dead if the touch of the caudal peduncle produces no reaction, and no breathing movements are visible.

To test substance toxicity to fish, the Static Test method was used in which the test solution was not replaced, so the solutions remained unchanged throughout the test. For the preparation of the test solutions, appropriate quantities of the test substance were solubilized in reconstituted water, fish test aquariums having a capacity of 20 liters.

Algae have been grown using the growing medium according to OECD 201/2006 consisting of:

Stock solution	Nutrients	Stock concentration
Stock solutions no 1 Macronutrients	NH_4Cl	1.5 g/l
	$MgCL_2.6H_2O$	1.2 g/l
	$CaCl_2.2H_2O$	1.8 g/l
	$MgSO_4.7H_2O$	1.5 g/l
	KH_2PO_4	0.16 g/l
Stock solution no 2-iron	$FeCl_3.\ 6H_2O$	64 mg/l
	$Na_2EDTA.\ 2H_2O$	100 mg/l
Stock solutions no 3	H_3BO_3	185 mg/l
	$MnCl_2.\ 4H_2O$	415 mg/l
	$ZnCl_2$	3 mg/l
	$CoCl_2.\ 6H_2O$	1.5 mg/l
	$CuCl_2.\ 2H_2O$	0.01 mg/l
	$Na_2MoO_4.\ 2H_2O$	7 mg/l
Stock solutions no 4	$NaHCO_3$	50 mg/l

To determine the influence of chemical plant protection products on algal growth (*S. capricornutum*), algae growth inhibition test was performed. Unicellular green algae species are best suited for testing, due to their fast growing, so that relatively short trials can determine the possible effects of a chemical over several generations. The test organisms are subjected to various concentrations of the test substance for 72 hours. The system's response consists in reducing the growth of algal culture and is evaluated according to the concentration of the test substance compared to an untreated control. In order to have a complete system response to toxic as much possible, algae-toxic-treated culture is maintained in a nutrient-enhancing environment to ensure adequate growth under continuous illumination conditions.

Growth and inhibition of growth are quantified and recorded by counting the cells at the beginning of the test and then at 24, 48 and 72 hours using Thoma blade. For the test to be valid, the growth factor on the untreated control should be at least 16, after 72 hours.

The growth medium was inoculated with S. capricornutum and incubated under controlled conditions of light and temperature. For each concentration were used three repetitions, including the untreated control. The initial concentration of cells in the test cultures was about 104 /ml.

In order to determine the relationship between concentration and effect, it was used comparing the areas method. To determine the effect of chemically active substances on algae growth, the green algae culture with a cell concentration of about 10 mg / ml was exposed to different concentrations of the test substance. The algae culture, prepared in conical flasks, was treated with the test solution, then maintained under controlled conditions: 24°C and a brightness of approx. 8000 lux.

Fig. 1 - Aspects during laboratory test

Further, the experimental model was carried out in field conditions to determine the toxicity of the products to the same species: C. carpio and S. capricornutum.

The research was conducted under field conditions, crop potato experience being located in Brasov, near the river Tarlung, potato cultivation favorable area. It was intended to place the experience near water in an area characterized by the presence of water shadows (irrigation channels, ponds), thus ensuring that the plant protection products used are leached in these waters.

To determine the influence of phytosanitary treatments on the aquatic organisms studied, the experimental chemical products were applied according to the potato culture maintenance technology, observing the application times, according to the pest development cycle.

To determine the impact of chemical plant protection products applied to the experimental model, water samples were collected at 30 and, respectively, 60 days after the treatment. Samples were collected in 20 liter plastic containers, each 100 liters for the two periods mentioned. Under the ecotoxicology laboratory testing conditions, the water samples were distributed in special vessels, in which the aquatic species, namely juveniles of C. Carpio and S. capricornutum, in concentration of 104/ ml were distributed. Observations have been made on fish behavior and algal growth rate.

Fig. 2 - Potato crop plot; Biological material

RESULTS

The concentrations of the tested products were calculated based on the recommended use dose per hectare, considering that if the potato culture is located less than 10 m away from a water luster, there is the possibility of leaching the product in surface water. Thus, the concentrations used were 10 times lower, and in the case of the Consento 450 SC, 100 times smaller. These concentrations have been established to demonstrate that the products used do not adversely affect aquatic flora and fauna. After implementing both experimental models and testing the toxicity of chemicals for the two aquatic species, *C. carpio and S. capricornutum*, the following results were obtained:

Table 1

Results for impact of plant protection products on fish (*Cyprinus carpio*)

Plant protection product	Tested doses	Observations after:							
		24 h		48 h		72 h		96 h	
		alive	dead	alive	dead	alive	dead	alive	dead
Nuprid 200 SC (imidacloprid 200 g/l)	1 ml/ 10 l water	7	0	7	0	7	0	7	0
Sencor 600 SC (metribuzin 600 g/l)	2 ml/ 10 l water	7	0	7	0	7	0	7	0
Consento 450 SC (propamocarb hydrochloride 375 g/l + fenamidone 75 g/l)	5 ml/ 10 l water	0	7	0	7	0	7	0	7
	50 µl/ 10 l water	7	0	7	0	7	0	7	0
Untreated control	-	7	0	7	0	7	0	7	0

Regarding the toxicity towards *S. capricornutum* algae, the 3 products tested did not show toxicity. After 24, 48 and 72 hours, an increase in the number of cells / ml was determined, the growth factor being between 16 in the treated and 18 in the control variant. Observations on the viability of the tested species were performed at 7 and 21 days and demonstrated that the chemicals tested were at low risk for aquatic organisms. Their impact study on aquatic organisms in field conditions has shown that the aquatic ecosystems close to the potato culture in the Sacele-Brasov area have not been affected in terms of the viability of the two studied species.

CONCLUSIONS

The study shows that phytosanitary chemicals tested for impact on the *C. carpio* and *S. capricornutum* species do not pose a risk to the aquatic environment, with little impact on the tested organisms. Due to the very good selectivity, these plant protection products can be recommended in the potato crop pest control schemes, by applying risk management measures to aquatic organisms, observing distances to surface waters and water shadows, ensuring protecting the environment properly, while getting healthy crops.

In order to protect the aquatic ecosystem, it is recommended to use primarily pesticides that are not classified as dangerous for the aquatic environment, use the most efficient application techniques, and low diversion equipment, the use of mitigation measures to reduce the risk of external pollution caused by spray drift, drainage and leakage. These include the establishment of buffer zones of adequate size to protect aquatic organisms and protection areas for groundwater or surface water sources.

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CLASSIFICATION CRITERIA OF AGRO-FOOD TANKERS
/
CRITERII DE CLASIFICARE A CISTERNELOR PENTRU PRODUSE AGRO-ALIMENTARE

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Keywords: *tanks, classification criteria, agro-food materials*

ABSTRACT

The optimal choice of the constructive characteristics of tanks cisterna for agro-food products continues to expose the need for research on their optimization. The paper is presented an analysis of the stage of the world research on the construction of tankers for agro-food products. Starting with a classification of the tankers in terms of shape, of the dimensions size, of the agro-foods material transported, of the material from which they are made, of the towing and displacement mode, of handling accessories and transportation of agro-food materials, of the interior construction, e.g.

REZUMAT

Alegerea optimă a caracteristicilor constructive ale echipamentelor tip cisternă pentru produsele agro-alimentare presupune, în continuare, necesitatea unor cercetării privind optimizarea acestora. În lucrare este prezentată o analiză a stadiului cercetărilor efectuate pe plan mondial privind construcția recipientelor de tip cisternă pentru produse agro-alimentare.

Punctul de plecare al prezentului studiu îl constituie o clasificare a cisternelor din punct de vedere al formei, al dimensiunilor gabaritice, al materialului agro-alimentar transportat, al materialului din care sunt realizate, al modului de tractare şi deplasare, al accesoriilor de manipulare şi transportare al materialelor agro-alimentare, al construcţiei interioare, etc.

INTRODUCTION

The need to solve impediments caused by the transport, distribution, handling, design, safety and quality of agro-food tankers in a shorter time from manufacturer to consumer has led many researchers to look for their optimal constructive solutions.

So far there are research studies worldwide that show the importance and desire to solve these problems. From the research done by the world's researchers, the nature of the impediments is due the mode of displacement and towing of the tankers, the physical and chemical characteristics of the tank material, the physico-chemical characteristics of the transported agro-food material, the method of unloading / loading the material from the equipment, movement the material inside the tank while displacement (the appearance of the sloshing effect), the action of the forces exerted by the agro-food materials on the walls and equipment supports, external factors (wind, earthquake, insulation, vibrations), internal factors (pressure, temperature).

In this paper is presented the analysis of the stage of the world research of the construction parameters of the tankers. Starting with a classification of the tankers in terms of shape, of the dimensions size, of the agro-foods material transported, of the material from which they are made, of the towing and displacement mode, of handling accessories and transportation of agro-food materials, of the interior construction.

The very high requirement to transport, to distribute in as large a quantity as possible at very good quality over long distances in a short time has motivated many researchers to look for optimal constructive solutions to achieve these types of equipment.

A recent study of *Shimanovsky D., (2016*) shows the constructive evolution and the need to look for optimal solutions to solve the problems encountered in tankers. From this article we can see that transportation of liquids, particularly, of drinking water, milk, wine, has been carried out since ancient times and in the past people used barrels, which were installed vertically or horizontally on horsedrawn vehicles. Industrial development and production specialization led to the need of transportation of fluids for long distances. In this respect, in 1865 the first tank wagons were built in the USA. At the beginning of the XX century special vehicles for the transportation of liquids were developed by Ford, GMC, Garford, etc. Now different types of road tankers and tank wagons are used to transport liquid cargos (*Griff M.I, 2006*; *Kinkaid J., 2010*). For example, in agricultural industry more than 20 types of tank trucks, differed by type of cargo, are used (*Shiva E.P. 2005; Shimanovsky D., 2016*).

In the works on analysis of dynamics and strength of road tankers (*Shimanovsky D., 2016*), the assessment of the static and dynamic properties of a tank vehicle is crucial and it is related to the three motions: longitudinal (driving and braking), lateral (guidance and steering), and vertical (suspension and damping). In the literature on dynamics of vehicles it was pointed out that liquid cargo motion can have both beneficial and negative aspects in terms of driving stability and braking performance but safest maneuver is braking. Thus the studying of tank vehicles dynamics should be started from their motion on curves. The most widely used model in the analysis of road tankers lateral dynamics is the quasi-dynamic model of liquid.

The movement of liquid cargo within a tank when being transported is referred to as "sloshing." Severe effects of sloshing are caused by sudden changes - such as braking and cornering.

The effects of sloshing can be reduced by the fitting of transverse baffles, also known as surge plates.

A study of **„***The International Tank Container Organisation (ITCO)",* (*Rakheja and Kolaei, 2014)* published a newly commissioned Technical Report, focusing on the anti-slosh performance of baffles in tank containers. The study was carried out by professors S Rakheja and A Kolaei, who have published a number of studies on the subject although this is the first that specifically addresses tank containers. Report unveils the key parameters for baffle designs as means for the reduction of liquid sloshing in transport. The surface area of the baffles is studied by the Report, in order to determine the optimum dimension to be effective against sloshing whilst also ensuring maximum aperture for safe entry into the tank for inspection and tests (Figure 1).

Key findings of the report are:

- Baffles provide a reduction in the transient slosh nature of the forces when compared to tanks with no baffles;
- Baffles with between 50-70% cross sectional surface areas of the tank provide similar performance;
- The effect is complex and is dependent on many factors, such as acceleration, product densities, fill levels, baffle area,e.g.;
- ITCO considers this report to be a valuable source of time variable data on longitudinal force and pitch moment which will enable the industry to further work to improve safety;

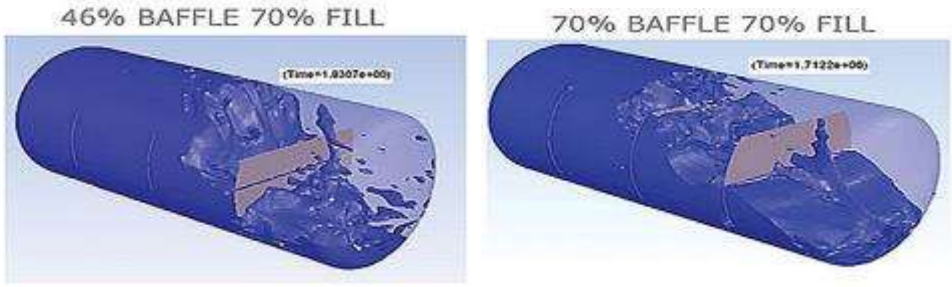

Fig. 1 - Baffles with between 50-70% cross sectional surface areas of the tank provide similar performance

Researcher *Bautista-Jacobo* (2015) presented a comparative numerical study of the effect of using baffles, and its design, on the behavior of sloshing in a partially filled road tanker carrying agro-food products. Navier-Stokes equations and standard k-ε turbulence model are used to simulate fluid movement; the Volume of Fluid (VOF) method is used to track the liquid-gas interface. Velocity distributions, sloshing stabilization times, and contours of turbulent kinetic energy, which are of high importance in choosing the best design of baffles, are shown. The results show sloshing stabilization times of 22 and 21 s for road tankers with cross-shaped (Type I) and X-shaped (Type II) baffles, respectively, finding lower values of turbulent kinetic energy for Type II design, being, therefore, the best design of baffles for damping of sloshing and vehicle control among studied ones (Figure 2).

Assumptions about the System under Study for Fluid Flow Simulations was:

- System under study is three-dimensional;
- Fluid inside tanker consists of two homogeneous phases: liquid and gas;
- Fluid is Newtonian and incompressible;

- Flow is turbulent and is in transient state;
- Fluid is maintained at a constant temperature of 15.5 ºC and remains in thermal equilibrium with the walls of the road tanker and this in turn with the surroundings;
- Road tanker is partially filled (90%) by liquid, at an internal pressure of 12 kg/cm^2.

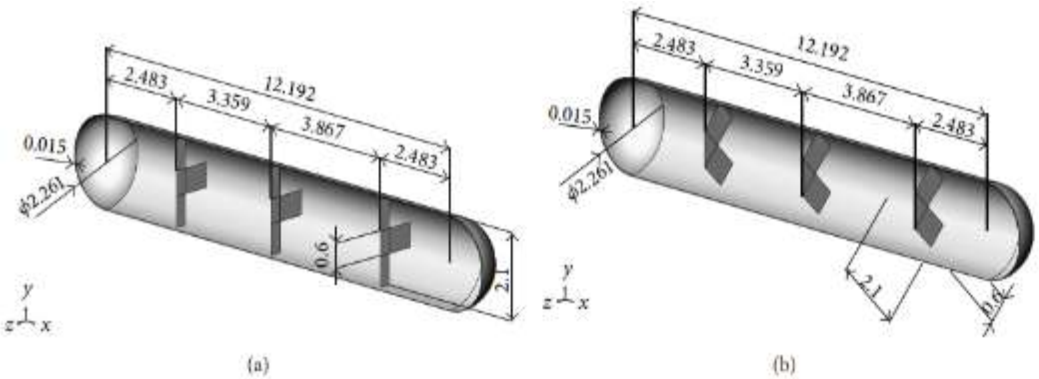

Fig. 2 - Studied circular cross-section road tanker and its dimensions, with
(a) Type I ("+") and (b) Type II ("X") baffles

Following the study demonstrated that times required in the road tankers with baffles for the liquid to come to rest were up to 45% lesser than the time required to reach the same state in the road tanker without baffles, which demonstrates the usefulness of this kind of structures. Among the baffles configurations used nowadays in real road tankers (Types I and II), Type II looks like the best in terms of sloshing attenuation, given the comparatively low values of turbulent kinetic energy and fluid velocity. It is considered that Type II baffles have the best characteristics in terms of vehicle control, due to a less vigorous sloshing that occurs when they are used.

Damaged tanks containing any hazardous material causes environmental polluation. Failure of tank results very destructive hazards on life and property. Seismic study of tanks are essential for strengthening the tankers performance and thereby damages can be reduced. Seismic analysis of tankers are much complicated due the fluid structure interaction of the system. Fluid inside the tank are divided as impulsive and convective liquid mass, and both are induced hydrodynamic pressure on tank wall and base. Seismic energy is tranferred to the fluid from ground due to movement of tanks. Soil structure interaction is another parameter which significantly effect on tankers performance. Interaction of tank with surrounding soil structure will be different, based on soil properties such as elastic properties, cohesion, angle of friction, e.g. Response of elevated tanks and ground supported tanks are different, based on their support conditions provided. Container height, geometry, soil denseness, types of foundation, damping parameters are some of the factors influencing tank response under different types of loadings (*Rupachandra J., 2015; Shilja S., 2017; Ustaoglu et al., 2017*).

George W.Housner (1963) discussed the relation between the motion of the water with respect to the tank and the motion of the whole structure respect to ground. He has considered three basic conditions of tank for the analysis i.e fully filled, empty and partially filled. He said that if water tank is fully filled condition i.e without free board then the sloshing effect of water is neglected and if the tank is empty then there is no sloshing effect. In the above two cases water body in the tank will behave as one-mass structure. But in third case i.e water tank is partially filled, the effect of sloshing should be considered. In the case the water body will behave as two-mass structure. Finally he concluded that the maximum force to which the half-full tank is subjected may be significantly less than half the force to which the full tank is subjected (*Rupachandra J., 2015).*

Structural analysis of a tank-container is a common task in manufacturing industry as it is necessary to keep the design within standards, keep costs down and provide a robust and reliable design. It is also an interesting finite element analysis problem, since it requires the utilization of the shell meshing technology for accurate stress calculation, where a common solid meshing strategy turns out to be harder to implement and impractical regarding the computational cost for matching the accuracy levels of the calculations.

Tanks will be constructed and manufactured in accordance with the provisions of the approved technical regulations so as to the choice of the material and the determination of the thickness of the walls are made according to temperatures of design and operating.

These tank containers are made of corrosion resistant materials with certain physico-chemical properties that do not allow their interaction with the fluids transported to alter their quality.

Tank are constructed from aluminum, carbon steel, stainless steel, or fiberglass-reinforced plastic, depending on the product being transported by the truck.

Food grade tank-container are required to meet stringent safety and sanitation codes before they are certified to transport foods.

Constructive variants of tank classification

Tanks are pressurized containers sealed with one or more compartments, mounted in the same frame of resistance, which can discharge both gravitationally and under pressure, to which service equipment it attached.

A container type tank, in the most general case (Figure 3), consists of the container itself consists of: cover, bonnet, charging connection, drainage connection, vent hole, manometer connection, safety valve connection, level indicator rack, support system.

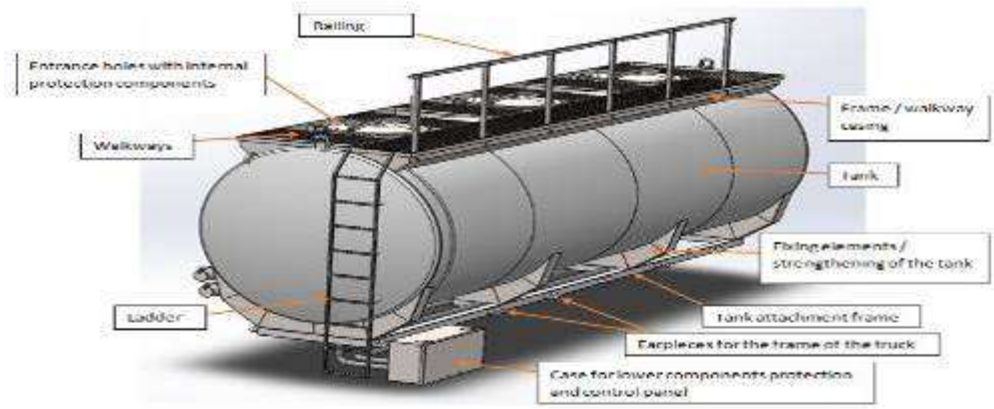

Fig. 3 - Representation of the construction model and the components of the tank

Tanks designed to contain certain hazardous substances (alcohols of different concentrations) must be protected. This may consist of a tank overburden (increased compression pressure) depending on the nature of the hazards posed by the transported (stored) substances or a projection device in accordance with the specific provisions of the ADR standard, paragraph 6.8.4 (*ADR Regulation, Ch. 6.8*). Tanks carrying liquid materials may be isolated or non-insulated, pressurized or unpressurized.

Prototype models of tanks – classification (*ADR Regulation, Ch. 6.8*)

- after towing and displacement mode with tractor head or self-propelled, and depending on the system can be fixed or removable. Fixed tanks are divided into: tank-vehicles, container tank and vehicles – battery.
- after the constructive form of circular section, elispoidal section and rectangular section,
- after gabarit capacity(small,medium and large capacity tanks)
- after nature of the building material: tanks metallic or non-metallic (glass fiber, carbon fiber)
- after nature of the transported material (tanks transporting agro-food liquids, powders and granules
- according to the internal / external constructive shape and the subdivision

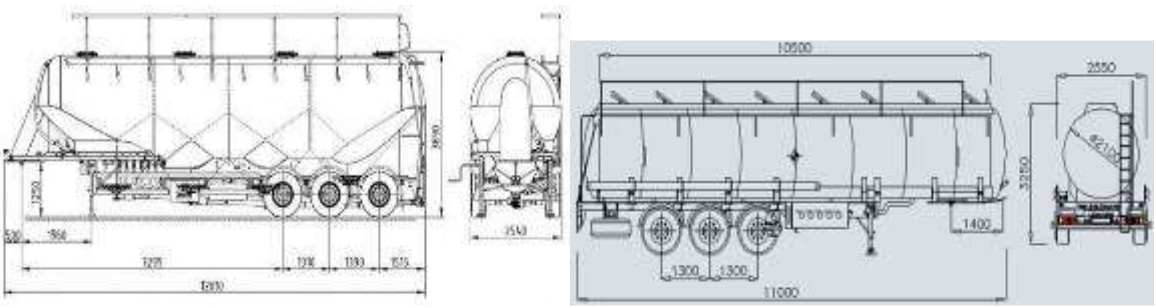

Fig. 4 - Tanks with circular cross-section tanks for liquid, powdered and granular agro-food products

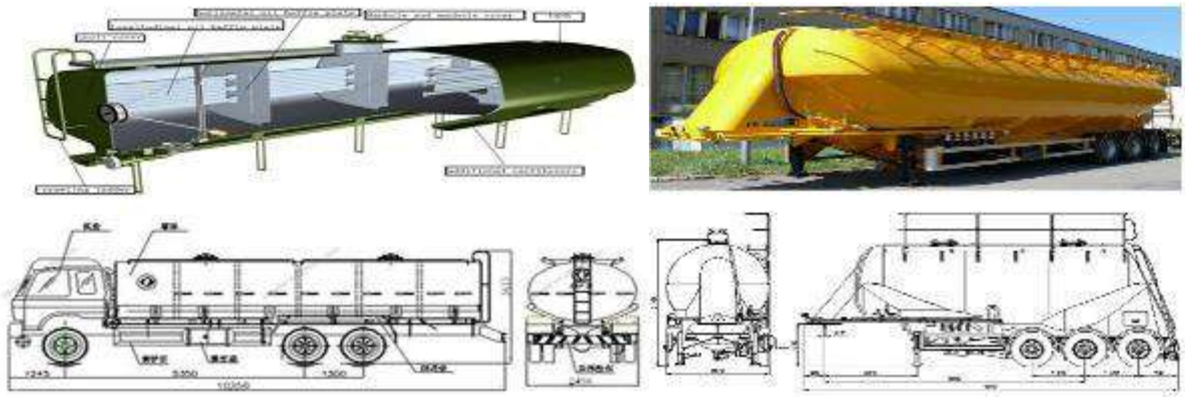

Fig. 5 - Constructive form of a tank prototype transporting materials agro-food
(a) with baffles for liquid materials (b) for pulverulent and bulk granulation materials agro-food less baffles

Fig. 6 – Cross-section for a tank prototype transporting materials agro-food
a) circular cross-section, b) elipsoidal cross-section, rectangular cross-section

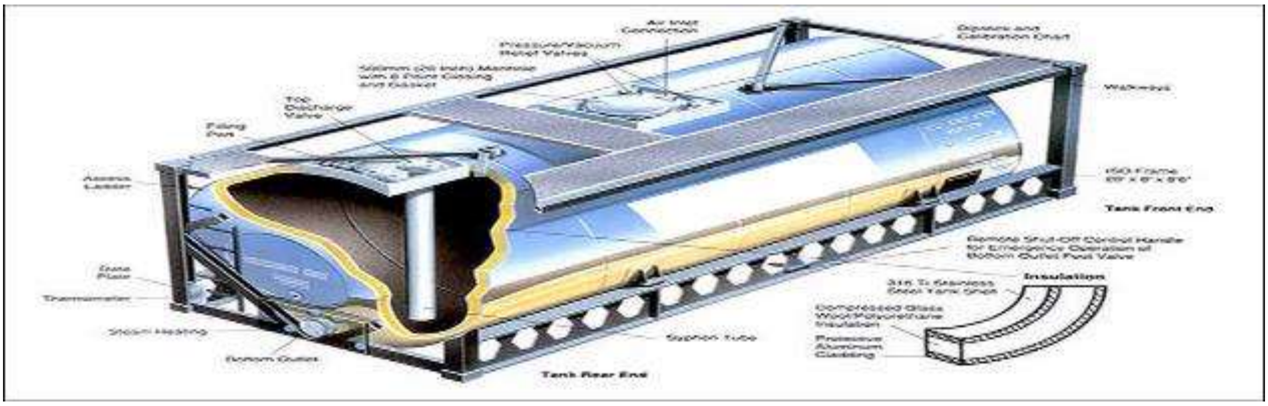

Fig. 7 – Construction details of a tank prototype

CONCLUSIONS

Tankers, attachments, their service and structural equipment must be designed to withstand, without loss of contents (with the exception of gases coming from any degassing ports), static and dynamic loads under normal conditions of carriage, as well as forces minimum required.

Tanks and their means of attachment shall be able to absorb under the maximum permissible load the following forces equal to those exercised by:

- in the sense of movement, twice the total mass (at braking);
- transversely to the direction of travel, once total mass (at start);
- vertically, from the bottom to the top, once the total mass (in the case of an uneven runway);
- vertically from bottom to top, twice the total mass.

Tankers for agro-food products must be made of corrosion-resistant materials with certain physico-chemical properties which do not allow their interaction with the fluids transported to change their quality.

The effectiveness of different baffles designs in controlling the magnitudes of fluid slosh and thus load transfers in the roll as well as pich planes of a partly-filled circular cross-section tank must investigated.

The optimal choice of constructional features of tank equipment for agro-food products further exposes the need for research on optimization.

The optimization methods offer the selection process from the multitude of acceptable solutions of the optimal solution, a solution that satisfies the imposed conditions and leads to the best result.

Optimization methods have become indispensable in making the right decision on the solution to be adopted when designing a product.

ACKNOWLEDGEMENT

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[11] *** ADR Regulation, Chapter 6.8. Requirements for rigging, type equipment, inspections, tests and marking of fixed tanks (tank-vehicles), demountable tanks, tank-containers and mobile tanks whose tanks are made of metallic material.

INFLUENCE OF ROOT TREATMENTS ON PLANT GROWTH OF *SOLANUM LYCOPERSICUM* L.
/
INFLUENTA TRATAMENTELOR LA RADACINA ASUPRA CRESTERII PLANTELOR DE SOLANUM LYCOPERSICUM L.

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***Keywords**: tomatoes, transplantation, accommodation*

ABSTRACT
The tomatoes transplantation without nutrient support from greenhouses to the field implies a period of accommodation due to root lesions and differences dictated by the soil properties compared with germinating bed. Root applied treatments at the transplantation time gave significant results, increasing stem diameter gains around 13 percent when using Origanum vulgare L. essential oil and Beauveria brongniartii based product compared to the untreated control.

REZUMAT
Transplantarea tomatelor fără suport nutritiv din răsadnițe in sere, solare sau in câmp implica o perioada de acomodare ca urmare a leziunilor radiculare si a diferențelor dictate de proprietățile solului comparativ cu patul germinativ. Tratamentele radiculare aplicate in momentul transplantării au dat rezultate semnificative, obținându-se sporuri de creștere a diametrului tulpinii in jurul valorii de 13 de procente in cazul utilizării uleiului esențial de Origanum vulgare L. si a biopreparatului pe baza de Beauveria brongniartii comparativ cu martorul netratat.

INTRODUCTION
Consumption and high productivity of tomatoes (*Solanum Lycopersicum* L.) have pushed this crop from horticultural area to the industrial field. So, form 15-20 tons per hectare under non-irrigated conditions in the past years, now 507 tons per hectare were reached under controlled conditions (*FAOSTAT 2016 Netherlands*). The low yields of field cultivated tomatoes are a consequence of low amount of water in the soil due to the lack of irrigation systems and the low rainfall level in the vegetable basins of southern Romania. Along with these unfavorable abiotic factors, there are also processes of vegetative growth activity stagnation dictated by the transplantation stress and by the existence of soil harmful organisms. The purpose of this study is to identify a research direction regarding the possibility of shortening the adaptation period after transplantation, which can cause increased biosynthesis periods. The hypotheses of this study are related to the plant's response to the modification of nutritional parameters and to the harmful metabolites and organisms found in soil.

Azospirillum brasilense Sp7 (DSM1690) strain was mainly used to improve nitrogen uptake**.** These bacteria colonize plant roots and promote plant growth (PGPR). However, differences regarding plant stimulatory effect of *Azospirillum* sp. were revealed among bacterial strains and plant genotypes (*Bashan and Holguin 1997; Saubidet and Barneix 1998; Romero et al., 2003*). There are also proofs that *Azospirillum* inoculants have plant biocontrol activity (*Gupta et al. 1995; Bashan and de-Bashan 2002a; Romero et al., 2003),* although this feature is secondary and scarcely documented. *Azospirillum brasilense* Sp7 (DSM1690) is a diazotrophic, free-living PGPR, that can improve nutrient uptake and increase plants tolerance to biotic and abiotic stress. Comparative study made by *Lade et al. (2018)* revealed that *A. brasilense* Sp7 strain induces a better seedling emergence and higher vigor in maize compared to tomato.

Cellulomonas cellasea B4.1.4 strain (Romanian native strain isolated from watermelon seeds) was used to increase phosphorus availability from insoluble molecules. This microorganism is a positive, rod shaped bacteria with a high enzymatic potential. Species of *Cellulomonas* bacteria are highly appreciated for their cellulase and xylanase activity, for which are used in the industrial biotechnology (*Mayorga-Reyes et al., 2002; Kheta, 2012*).

Bacillus amyloliquefaciens OS17 strain was used to protect tomatoes against soil pathogens. This bacterial strain is a plant beneficial microorganism used in biological control against plant pathogens or as PGPR (Sicuia et al., 2015). Selected or genetically engineered strains are also used as a source of industrial enzymes and microbial metabolic compounds generally regarded as safe (*Sewalt et al., 2016; Yang et al., 2011*). This bacterial strain was selected due to its large antifungal spectrum against several plant pathogens. This strain revealed complex biocontrol mechanisms, and applied as seed or soil treatment it can induce systemic resistance in tomato. Although the seed treatment is delaying germination, tomato seedlings inoculated with *B. amyloliquefaciens* OS17 strain revealed higher plant vigor compared with the untreated control or other *Bacillus spp.* strains (*Sicuia, 2012*).

Beauveria brongniartii (Sacc. Petch), strain BbgMm1a/09 was used to protect tomatoes against soil pest. It is an entomopathogenic fungus used in biocontrol programs against soil pests. This fungal strain was isolated from natural outbreak.

Essential oil (EO) of *Origanum vulgare* L*.* (Solaris, 9LOT180523) has been used to inhibit oxidation from which may result free radicals as a consequence of chemical reactions around the root wounds produced during transplantation.

MATERIAL AND METHOD

Tomatoes plants, variety Kristinica®, (SCDL Buzau) were planted after the field was plowed in the spring at 30 cm deep followed by disking. The transplantation was carried out using a manual planter with 26 mm diameter of and 20 cm length. The transplanted plants had an average height of 30 centimeters (from the root to the tip) with a pronounced character of unevenness. The experimental model was composed of 28 randomized lots representing six treatments and an untreated control in four repetitions, cumulating a total of 980 plants (Table 1). To highlight the effectiveness of treatments and soil limitations, plant density was doubled to the equivalent of 67857 plants per hectare. Culture prior to the experiment was maize.

Table 1

Treatments performed in planting holes

Control	*Sp7 + B4.1.4.+ OS17*	*Beauveria brongniartii*	*Cellulomonas cellasea* B4.1.4	*Azospirillum brasilense* Sp7 (DSM1690)	*Origanum vulgare* L. essential oil	*Bacillus amyloliquefaciens* OS17
-	10 ml + 10 ml + 10 ml (10^8 cfu/ml)	120 g ($1x10^{13}$ conidia/kg)	10 ml (10^8 cfu/ml)	10 ml (10^8 cfu/ml)	10µL	10 ml (10^8 cfu/ml)
-	liquid bioproduct	solid bioproduct	liquid bioproduct	liquid bioproduct	liquid	liquid bioproduct

Bacterial strains were conditioned in liquid products and stored refrigerated until use. The *Beauveria brongniartii* strain was conditioned as a solid bio formulation on barley substrate. *Origanum vulgare* essential oil was used as such.

To highlight the effects of the treatments, stem diameter was measured at the air/soil interface with the micrometer at 28 and 65 days after transplantation. Statistical calculation and graphs were performed with the GraphPad Prism program. The growth difference between the variants was expressed as a percentage: % growth = ((stem diameter at 65 days * 100) / stem diameter at 28 days) -100.

RESULTS

Average stem diameters at 28 days (Figure 1) from transplantation showed significant differences between the untreated control and the other variants with the exception of the variant where the treatment with the *Bacillus amyloliquefaciens* OS17 based product was performed. The smallest diameter value was recorded for biological treatment with *Cellulomonas cellasea* B4.1.4 (6.83 mm) and the highest for the untreated variant (7.41mm). These values of statistical significance demonstrated the initial observation of the lack of seedlings homogeneity. The growth changes imposed by the treatments are highlighted at the second determination of the stem diameter at 65 days (Fig. 2) from transplantation. The stem diameter values begin to have insignificant differences compared to control, except the treatments with biological products based on *Cellulomonas cellasea* B4.1.4 and *Azospirillum brasilense* Sp7 (DSM1690). The smallest stem diameter was recorded in the variant where *Cellulomonas cellasea* B4.1.4 treatment was performed and the largest in the variant where essential oil of *Origanum vulgare* was used. The variants where

Origanum vulgare essential oil and *Bacillus amyloliquefaciens* OS17 treatments were performed, had a mean diameter greater than the untreated control but statistically insignificant. Using average values of the stems diameters at 28 days as a reference, the percentage of growth recorded at 65 days after transplantation (Figure 3) highlighted that treatments in planting holes based on *Beauveria brongniartii* and essential oil of *Origanum vulgare* have given significant results indicating almost double values compared to the untreated control. The analysis of the coefficient of variation (Fig. 4) shows that the treatment with the *Cellulomonas cellasea* B4.1.4 based biological product had the highest percentage of plant size homogenization.

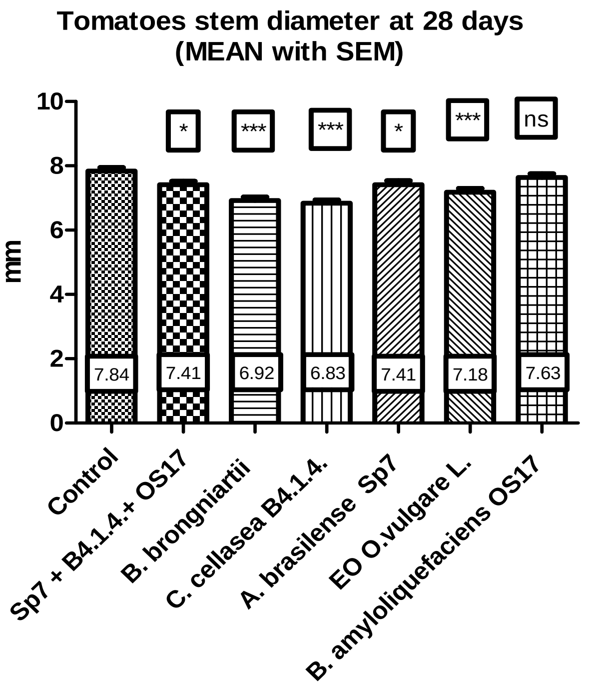

Fig. 1 - **Tomatoes stem diameter at 28 days (MEAN with SEM)**

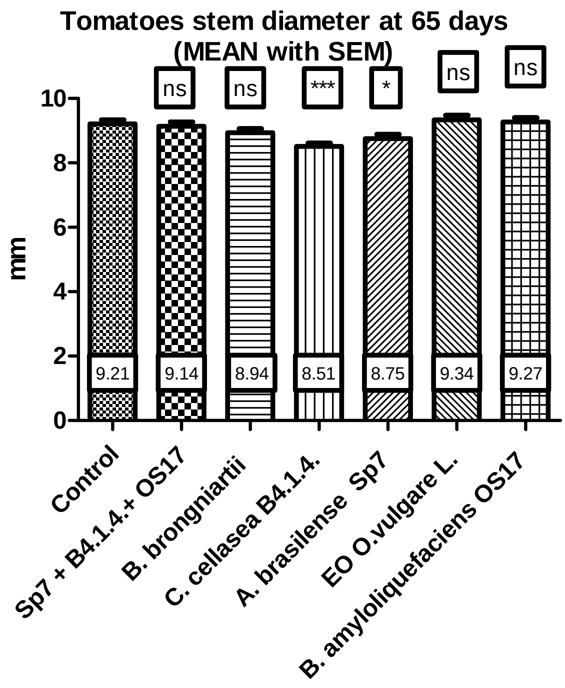

Fig. 2 - **Tomatoes stem diameter at 65 days (MEAN with SEM)**

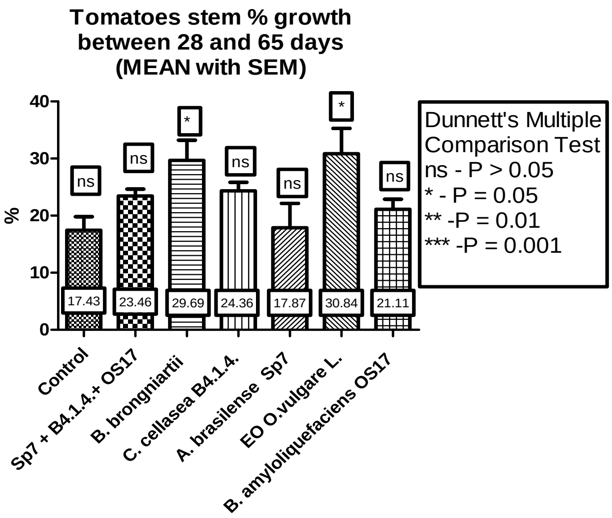

Fig. 3 - **Tomatoes stem % growth between 28 and 65 days (MEAN with SEM)**

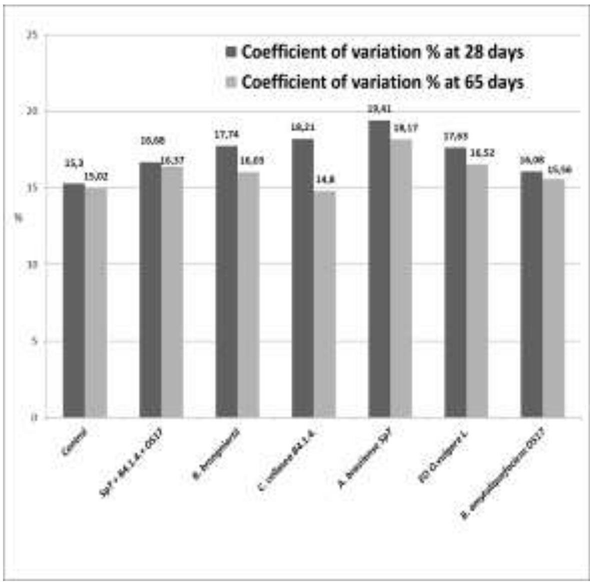

Fig. 4 - **Coefficient of variation of the stem diameter at 28 and 65 days after transplantation**

CONCLUSIONS

The hypothesis regarding the improvement of nitrogen nutrition through the use of the *Azospirillum brasilense* Sp7 (DSM1690) based product has not been confirmed in these preliminary results. The use of

Cellulomonas cellasea B4.1.4 biological treatment to improve phosphorus absorption, although yielding positive results on stem diameter growth and crop homogeneity, has not passed the minimum level of statistical significance. *Beauveria brongniartii's* treatment has achieved significant results on the growth of tomato plants, but due to the high dose use (120 g/plant) this improvement can be attributed to insecticidal properties in addition with nutrient intake, excluding nitrogen and phosphorus. The hypothesis of root protection with *Origanum vulgare* essential oil against oxidizing agents as a result of wounds produced at the time of transplantation has been confirmed.

ACKNOWLEDGEMENT

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EXPERIMENTAL RESEARCH REGARDING ZONAL VARIABLE CROP IRRIGATION
/
CERCETĂRI EXPERIMENTALE PRIVIND IRIGAREA ZONALĂ VARIABILĂ A CULTURILOR AGRICOLE

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Keywords: *agriculture, soil, moisture, irrigation module, maps, water*

ABSTRACT

Irrigation may be considered one of the poles of precision farming. Just as water is a parameter that affects all cultures, it must be approached and well studied. A yield map can show if more water could bring a higher yield or if a particular field is less irrigated. For this purpose, a sprinkler irrigation system was used, with variable zonal irrigation. Variable zone irrigation has the following advantages: maximizing the profitability of the entire area; reducing the effect of flooding and thus protecting the soil and the environment; maximizing water application efficiency and fertilization.

REZUMAT

Irigarea este considerată unul dintre stâlpii agriculturii de precizie. Așa cum apa este un parametru ce afectează toate culturile, acesta trebuie abordat și studiat . O harta a randamentului poate arăta dacă mai multă apă aduce un randament mai mare sau dacă un anumit câmp este mai puțin irigat. În acest scop s-a recurs la sistemul de irigații prin aspersie cu irigare zonală variabilă. Irigarea zonală variabilă are următoarele avantaje: maximizarea profitabilității întregii zone; reducerea efectului de inundare și deci protejarea solului și a mediului; maximizarea eficienței de aplicare a apei și a fertilizării.

INTRODUCTION

Romania has conditions for a large-scale agriculture. Further statistics are presented, which reveal the extent of agriculture in Romania, as well as its availability, demonstrating the necessity and opportunity of efficient water use in agriculture, as well as combating drought.

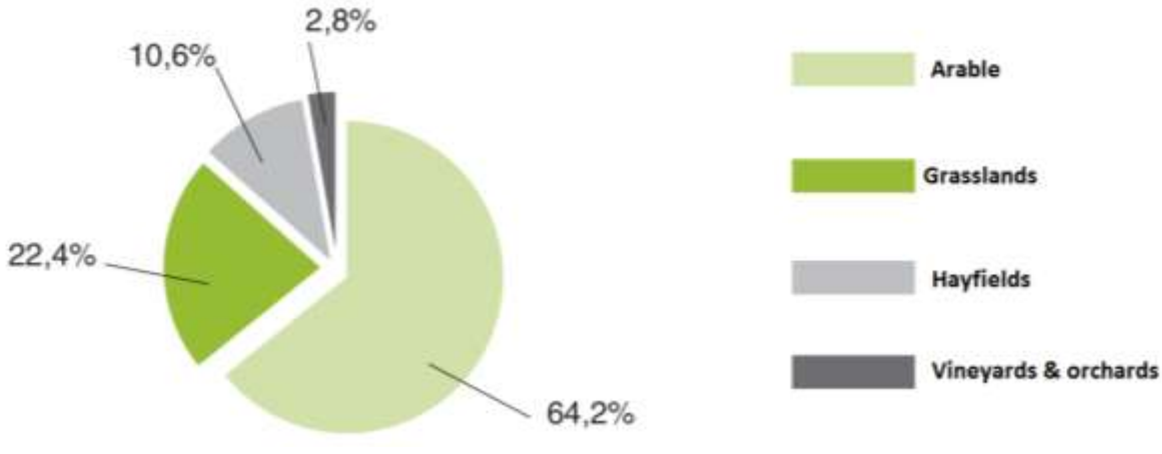

Fig. 1 - Agricultural area by use in 2014 (at the end of the year) [1]

Table 1

Agricultural area irrigated 1) in 2015 [1]

	Irrigated agricultural area (thousands ha)		Structure (%)	
	Total	**of which: private property 2)**	**Total**	**of which: private property 2)**
Total	**173,2**	**168,2**	**100,0**	**100,0**
of which:				
Arable	**172,6**	167,6	99,7	99,6

1) Agricultural area irrigated from the systems administered by the National Land Improvement Agency in 2015.
2) Contains: private property of the state, administrative-territorial units, legal entities and individuals.

MATERIAL AND METHOD

Irrigation module for experimental research

In order to carry out the experimental research, an experimental irrigation module was designed and realized, which is, in fact, an intelligent system of variable zonal irrigation according to the diagram in Fig. 2.

Based on the diagram, an intelligent irrigation system designed for variable area irrigation for agricultural land was designed based on soil moisture determined using satellite information and the water needs of crop development. In practice, there are various types of irrigation systems that use variable rate irrigation based on agro-technical information and field measurements, for example: Valley® Variable Rate Irrigation (VRI).

The disadvantages of these systems are that they are complex, have high prices and do not use satellite information for command and control. The technical problem solved by the proposed solution lies in the development of an intelligent irrigation system adaptable to classical systems that serve different areas with variable irrigation and which can be monitored.

The advantages of implementing the proposed system in agricultural practice on irrigation of land consist of:

- reducing water consumption by 30% and energy consumption by 25%;
- it is relatively simple and can be applied to all types of farms using classic irrigation systems by adapting to the intelligent zonal variable irrigation system [2].

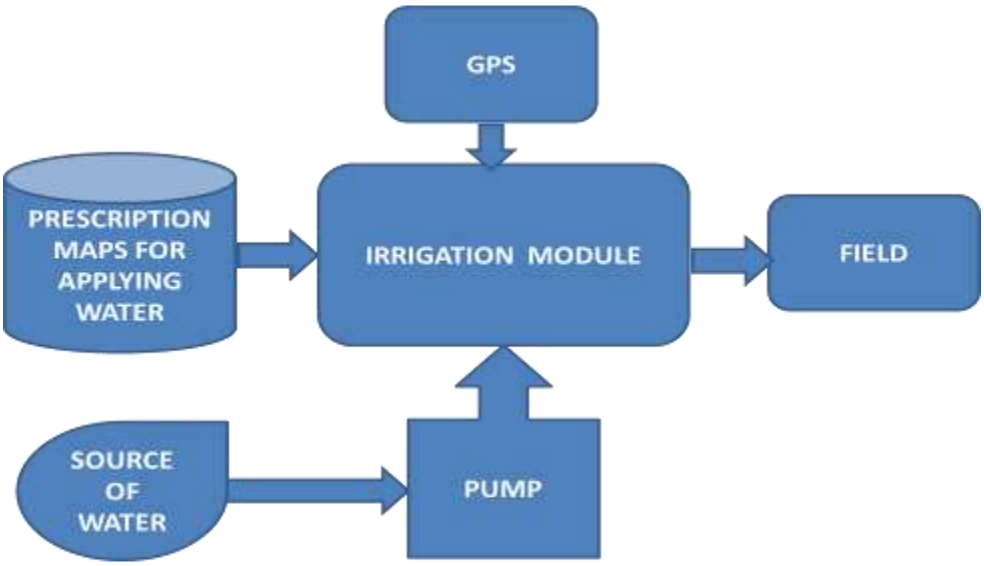

Fig. 2 - Block diagram - Intelligent system of variable zonal

System Command

The system control is carried out by a specialized controller that will be commissioned on the prescription maps for irrigation.

The controller has a variety of advanced water management features, including [3]:

- Zone-based programming, allows independent irrigation programming for different areas (Zones), based on specific water requirements for each area;

- Programs can be set to irrigate on selected days of the week, the seeming or odd days of the calendar, or at custom intervals, allowing for greater flexibility and control of irrigation programs;
- Multiple watering times is allowing to run the same program multiple times on the same day;
- Seasonal adjustment is allowing to quickly adjust the watering time depending on weather or other conditions;
- Manual water feature to allow immediate wetting of all areas or another area at a time.

Controls and indicators of the controller are presented in Figure 3 and, also, the connection cables and WiFi LNK module in Figure 4 and 5:

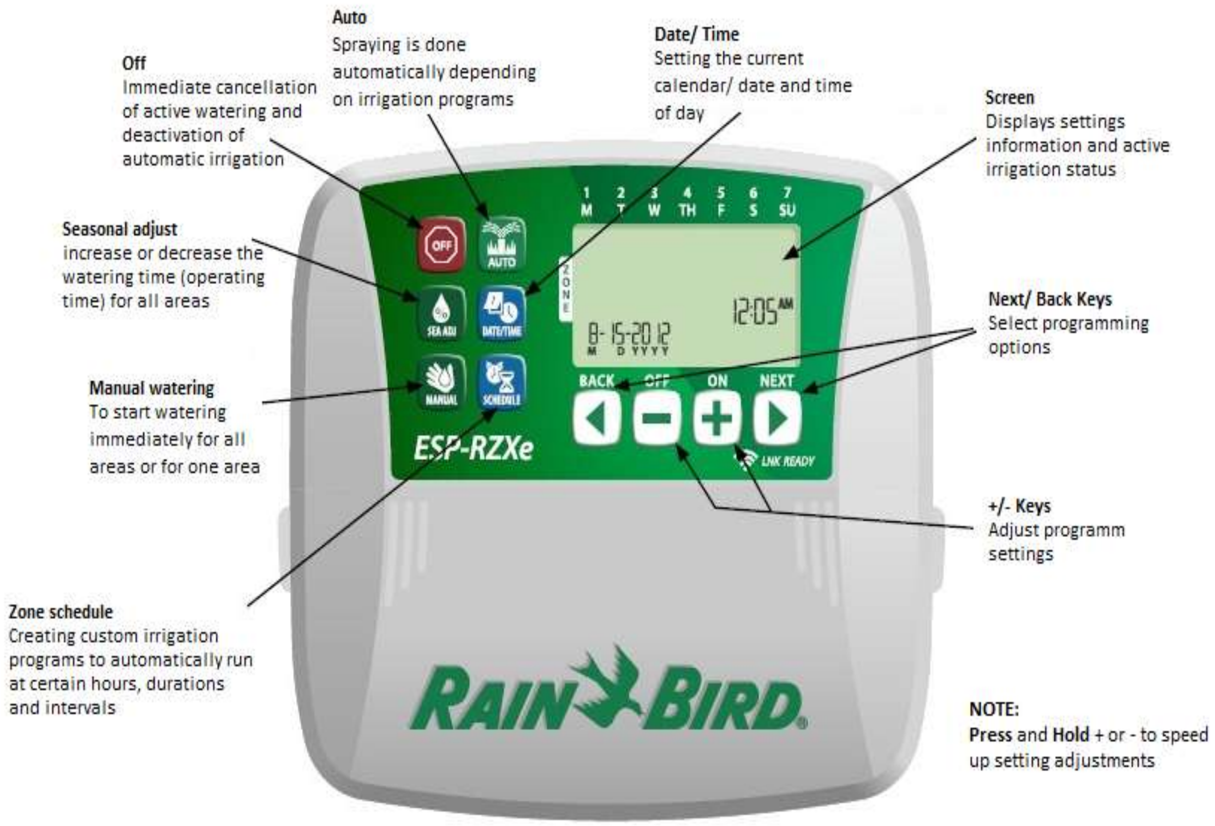

Fig. 3 - Controls and indicators of the controller [3]

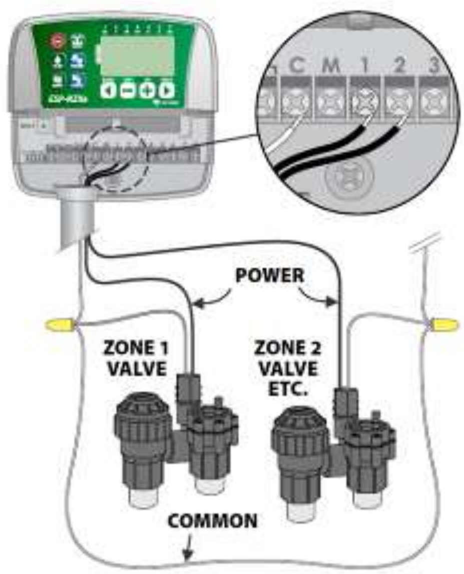

Fig. 4 - Connection cables [4]

Fig. 5 - WiFi LNK Module [3]

WiFi LNK Module

The WiFi LNK module allows remote connection to an ESP-RZXE Rain Bird controller using an Apple iOS or Android compatible smart device. The mobile app allows remote access and configuration of one or more irrigation controllers.

Valve connection is made as follows:

- Connect the power cable from each Zone valve to the corresponding area number on the terminal block of the controller.
- Connect the common thread from each valve to the COMMON terminal (C).

The GPS device

The GPS device that was used to determine the delimitations between the different crops on the field is a GPSMap 64s, shown in Figure 6.

Fig. 6 - GPSMap 64s device during the measurements [5]

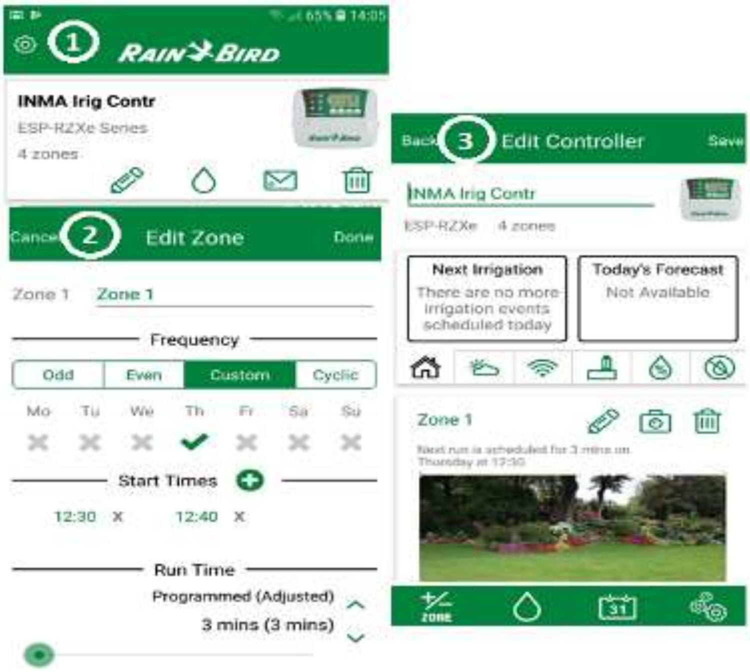

Fig. 7 - Making phone settings for wireless controller activation

It's a robust, portable, full-featured device, GPS, GLONASS and wireless connectivity

- 2.6 inch color display, legible in sunlight
- High sensitivity GPS and GLONASS receiver with quadruple helical antenna
- 3-axis compass with barometric altimeter
- Wireless connectivity via Bluetooth®¹ or ANT + ® technology

The GPSMap 64s is provided with a global map with shaded relief. Additionally, the 64s device is compatible with Garmin Custom Maps, a map format that lets you easily convert printed or electronic maps into downloadable maps for your device.

Wireless distribution of reference points, routes, routes and geocaches to other compatible devices. Just press the send button for the data to be transmitted to another Garmin portable device.

The water requirements have been set and the controller has been programmed using the application installed on an Android mobile phone. In Figure 7 are presented some aspects of its programming.

RESULTS

Experimental research was carried out on one of INMA's experimental land shown in Figure 8.

Fig. 8 - Experimental field delimited using Google Earth [6]

In the experimental field, several cultures were developed. In Figure 9 is represented the sprinkle irrigation system which is controlled wireless. Delimitation of crop plots is shown in Figure 10. Cultures were varied: vegetables, technical plants, medicinal plants including green. These are presented in the legend of Figure 10.

Fig. 9 - Sprinkle irrigation system wireless controlled

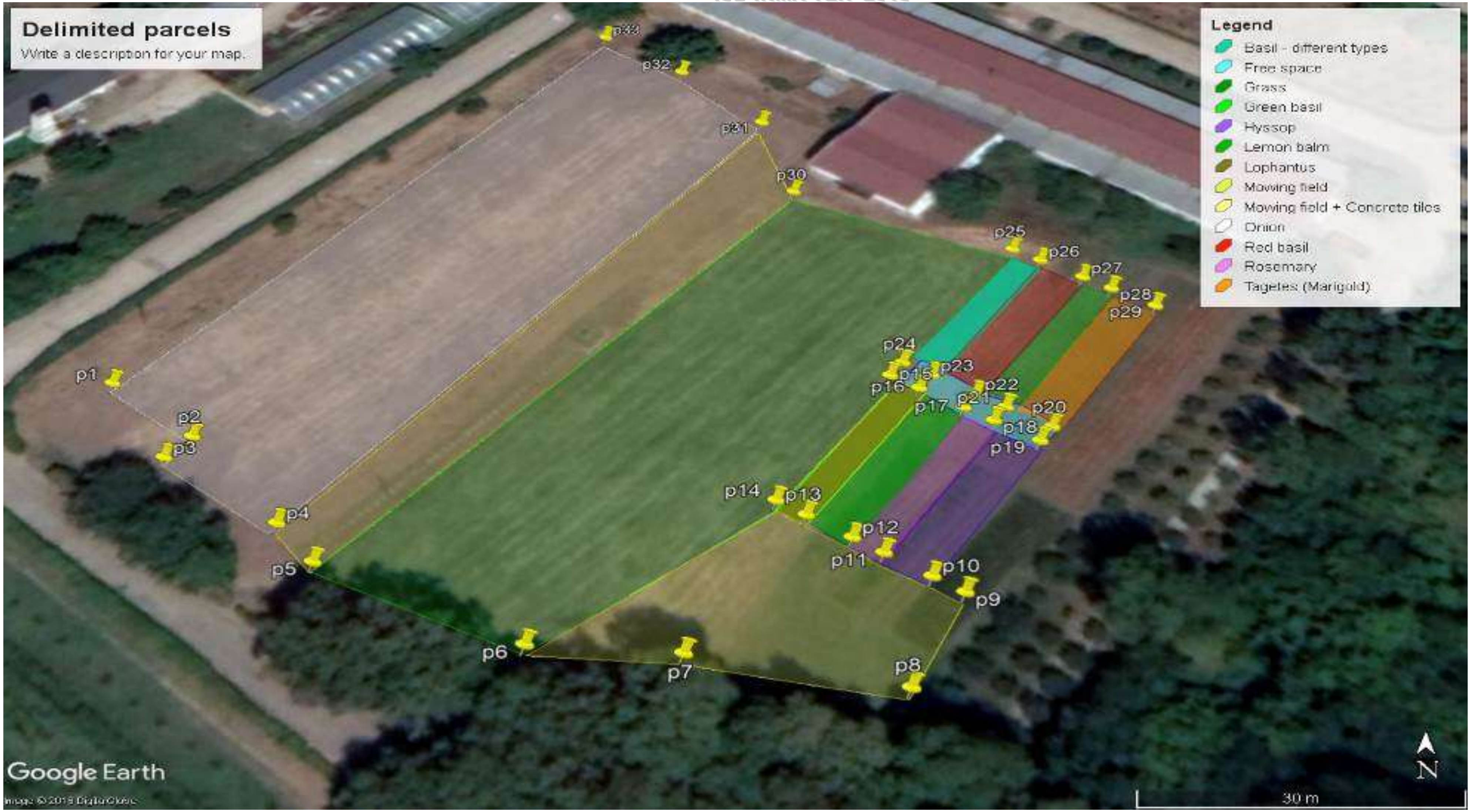

Fig. 10 - Plots delimited by crops planted on the experimental field [7]

Measurement of soil moisture has been determined at various times. For example, Figure 11 shows some moisture distributions at the soil surface on 20th of July 2018, and, the measurements results are found in Table 2.

Table 2

In-situ measurements to determine moisture on the experimental field

ID	X (GPS coordinates)	Y (GPS coordinates)	Theta Probe ML2x
			Soil Moisture [%]- 20.07.2018 (partly cloudy)
0	26,07171597	44,50123148	23.3
1	26,07171739	44,50114146	18.2
2	26,07184317	44,50114248	24.4
3	26,07159305	44,50105042	23.4
4	26,07171882	44,50105145	26
5	26,0718446	44,50105247	22.1
6	26,0714687	44,50095938	22.6
7	26,07159448	44,50096041	26.8
8	26,07172025	44,50096143	27
9	26,07184603	44,50096245	23.7
10	26,0719718	44,50096347	23.6
11	26,07134436	44,50086835	22
12	26,07147013	44,50086937	26.4
13	26,07159591	44,50087039	27.4
14	26,07172168	44,50087141	26.3
15	26,07184746	44,50087244	22.3
16	26,07197323	44,50087346	25.9
17	26,07209901	44,50087448	28.2
18	26,07222478	44,5008755	30.6
19	26,07122001	44,50077731	27.3
20	26,07134578	44,50077833	26.3
21	26,07147156	44,50077935	24.8
22	26,07159733	44,50078038	24.4
23	26,07172311	44,5007814	29.4
24	26,07184888	44,50078242	25.8
25	26,07197466	44,50078344	27.4
26	26,07210043	44,50078447	26.7
27	26,07222621	44,50078549	24.6
28	26,07235198	44,50078651	23.8
29	26,07247776	44,50078753	20.4
30	26,07260353	44,50078855	20.7
31	26,07109566	44,50068627	26.8
32	26,07122144	44,50068729	17.3
33	26,07134721	44,50068832	20.3
34	26,07147299	44,50068934	23.3
35	26,07159876	44,50069036	18.2
36	26,07172454	44,50069138	24.4
37	26,07185031	44,50069241	16.6
38	26,07197609	44,50069343	28.8
39	26,07210186	44,50069445	29.1
40	26,07222764	44,50069547	28.5
41	26,07235341	44,50069649	30.7
42	26,07247919	44,50069751	24.7
43	26,07122287	44,50059728	17.3
44	26,07134864	44,5005983	25.1
45	26,07147442	44,50059932	21.6
46	26,07160019	44,50060035	19.5
47	26,07172597	44,50060137	21.6
48	26,07185174	44,50060239	26.7
49	26,07197751	44,50060341	29.6
50	26,07210329	44,50060443	29.3
51	26,07222906	44,50060546	28.9
52	26,07235484	44,50060648	29.8
53	26,07248061	44,5006075	25.4
54	26,07135007	44,50050829	21.9
55	26,07147585	44,50050931	18.2
56	26,07160162	44,50051033	20.6
57	26,07172739	44,50051135	23.1
58	26,07185317	44,50051238	24.8
59	26,07197894	44,5005134	27.6
60	26,07210472	44,50051442	27.2
61	26,07223049	44,50051544	24.5
62	26,07235627	44,50051646	25.4
63	26,07147727	44,50041929	25
64	26,07160305	44,50042032	23.4
65	26,07172882	44,50042134	20.8
66	26,0718546	44,50042236	26.6
67	26,07198037	44,50042338	28.5
68	26,07210614	44,5004244	24.8
69	26,07223192	44,50042543	17.4
70	26,07173025	44,50033132	21.9
71	26,07185602	44,50033234	25.8
72	26,0719818	44,50033337	24.6
73	26,07210757	44,50033439	25.2

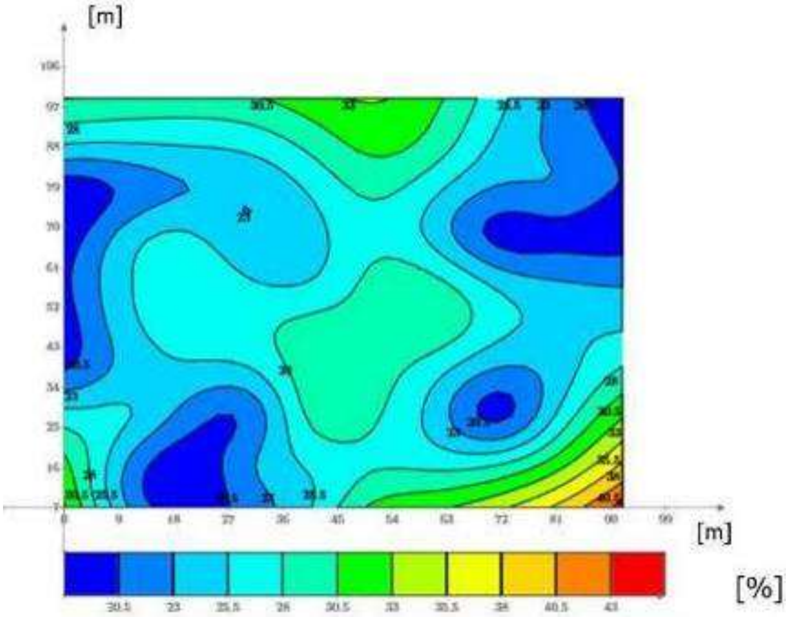

Fig. 11 - Map of moisture percentages on 20.07.2018

CONCLUSIONS

- The system worked well and can be used with ease.
- A limited number of sprinklers were used in just three areas to verify the technology.
- As it was designed, it can be extended to a larger number of sprinklers and areas and can be adapted to sprinkler irrigation systems existing on a farm in any location in Romania.
- The crops developed well and compensated for the lack of precipitation at the beginning of the vegetation period. It was, however, noted during a generous summer of precipitation.

ACKNOWLEDGEMENTS

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EXPERIMENTAL MEASUREMENT OF THE TRACTION FORCE AND FRAME STRAIN OF THE MPM 4 MISCANTHUS PLANTING MACHINE
/
MĂSURAREA EXPERIMENTALĂ A FORȚEI DE TRACȚIUNE ȘI A TORSIUNII CADRULUI LA MAȘINA MPM 4 DE PLANTAT MISCANTHUS

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Keywords: *traction force, frame strain, strain gages*

ABSTRACT
Within this paper will be presented experimental results obtained after testing the Miscanthus planting machine MPM 4 regarding its frame resistance. The assessment was carried out using measurements with strain gages which were applied on the machine's frame in the most stressed points. There were made several tests and the obtained results were averaged so that the final report would contain mean values of stress sustained by the resistance frame during normal use.

REZUMAT
În cadrul acestei lucrări vor fi prezentate rezultatele experimentale obținute după testarea mașinii de plantat Miscanthus MPM 4 în ceea ce privește rezistența la cadru. Evaluarea a fost efectuată cu ajutorul măsurătorilor care au fost aplicate pe cadrul mașinii în punctele cele mai tensionate. Au fost efectuate mai multe teste, iar rezultatele obținute au fost medii astfel încât raportul final să conțină valori medii ale stresului susținute de cadrul de rezistență în timpul utilizării normale.

INTRODUCTION
Miscanthus is a grass which could grow up to 3.5 m tall during a season and the annual yield of dry matter at a hectare could achieve a maximum of 25 t. Its rapid growth, low content of minerals and high biomass yield make from Miscanthus a valuable energetic plant. The CO_2 emission during its burning is equal to the CO_2 quantity used by the plant during vegetation so that the process is neutral as what concerns the greenhouse gases emissions (*Benefits of renewable energy, 2011; Danciu A. et al, 2010*). Miscanthus could be valorised as biomass through transformation in chopped biomass, pellets or briquettes or as a fibre plant, in the cellulosic industry (wrapping material, paper or cardboard), in horticulture (as a decor plant for parks and gardens, support for different crops, beddings etc) or in the constructions industry (insulation plates and products, wind screens etc). (*Voicu E. et at., 2010; Tabil L. et al, 2011; Tumuluru L.S. et al, 2010*) INMA has designed and realized a planting machine, especially for setting up of Miscanthus crops on low value terrains. The resistance frame of the machine has to withstand the weight of the four human operators which sit on top of it and the stress applied by soil through the machines 4 planting sections.

MATERIAL AND METHOD
Miscanthus plating machine MPM4 (Figure 1), realized by INMA Bucharest works in aggregate with 65 HP tractors, on wheels, provided with a three-points linkage mechanism, category II, according to SR ISO 730-1+C1:2000.

The planting section of this machine realize the following operations

- opening the groove in which the planting material – miscanthus rhizomes will be placed, operation done by the section's share;

- introduction of the rhizomes in the groove, one by one, at the right timing, after the human operator place them in the planting tube;

- covering the rhizomes by a pair of spherical discs and soil pressing by a metallic wheel, located at the rear end of the spherical discs.

Fig. 1 - Miscanthus plating machine MPM4

Main technical-functional parameters of the MPM4 Miscanthus planting machine are presented in Table 1.

Table 1

Technical-functional parameters of the MPM4 Miscanthus planting machine

Technical characteristic	Value
Number of planted rows	4
Distance between rows, mm	500…1000
Dimensions, mm - length - width - height	 1520 4200 2780
Working width, m	2.5...4
Planting depth, cm	8...12
Working capacity, ha/h	0,6...0,76
Fuel specific consumption, l/h (l/ha)	4.5..4.8 (7.5...6,6)

Taking into consideration the fact that the MPM4 machine is an experimental model, resistance and functional evaluation had to be done. In order to assess the frame resistance there have been carried out tests in normal operating conditions (with the machine fully loaded and at normal working speeds) in which some critical resistance points were monitored. The monitoring was performed using strain gages which recorded the strain during operation process.

There were applied a number of 14 strain gages on the machine's frame, with a 6 mm grid and a nominal resistance of 350 ohm.

Fig. 2 – Applied strain gages on the frame - aspects

The strain gages were coupled in quarter bridge configuration using a universal system for amplification and data acquisition, QuantumX 1615 type, with 16 input channels. During tests were measured the frame strains and the traction force between the MPM4 machine and the tractor (*Alămoreanu E. et al, 1996; Zaharia R, 1999, Buzdugan Gh., 1980*).

The strains were afterwards transformed in mechanical tension using the simple transform:

$$\sigma = E \cdot \varepsilon \qquad (1)$$

In which σ = mechanical tension;

E = Young modulus

ε = mechanical strain, measured by the strain gage

The tests were carried out within INMA Bucharest testing grounds. There were performed tests on 90 m long experimental terrain. The next figure presents the ASCII file in which were recorded the mechanical strains on the MPM4 frame.

MAS_MISCANTUS rep 23 - Notepad

File Edit Format View Help

0.00000	5.82796	-30.82385	21.59854	-0.29479	0.08573	33.32204
0.02000	5.68765	-30.85948	21.59854	-0.29554	0.08620	33.32201
0.04000	5.65869	-30.95525	21.48273	-0.29770	0.08679	33.32200
0.06000	5.78564	-30.91071	21.36692	-0.29913	0.08719	33.32199
0.08000	5.88364	-30.78599	21.36024	-0.30002	0.08784	33.32200
0.10000	5.98386	-30.72140	21.44264	-0.30052	0.08883	33.32197
0.12000	5.95491	-30.66126	21.44041	-0.30239	0.08969	33.32194
0.14000	5.84577	-30.64568	21.35578	-0.30341	0.09022	33.32191
0.16000	5.80346	-30.70358	21.29565	-0.30522	0.09041	33.32190
0.18000	5.75223	-30.76817	21.25110	-0.30578	0.09077	33.32191
0.20000	5.70324	-30.73253	21.28674	-0.30623	0.09136	33.32191
0.22000	5.74555	-30.70358	21.24665	-0.30666	0.09129	33.32192
0.24000	5.62974	-30.73253	21.28229	-0.30776	0.09165	33.32191
0.26000	5.57852	-30.82607	21.44041	-0.30835	0.09205	33.32188
0.28000	5.63419	-30.75480	21.44487	-0.30895	0.09237	33.32188
0.30000	5.69210	-30.60336	21.29119	-0.30861	0.09240	33.32191
0.32000	5.63865	-30.61449	21.23997	-0.30945	0.09264	33.32189
0.34000	5.56738	-30.72808	21.28229	-0.30966	0.09317	33.32188
0.36000	5.56515	-30.75703	21.29119	-0.31105	0.09372	33.32187
0.38000	5.65201	-30.67017	21.29119	-0.31317	0.09434	33.32183
0.40000	5.74333	-30.57886	21.26892	-0.31441	0.09538	33.32182

Fig. 3 – Data acquisition recording file

Data was afterward processed using a calculus sheet in MATCAD, extracting the statistic information for the realized measurements: mean value, standard deviation, minimum and maximum values.

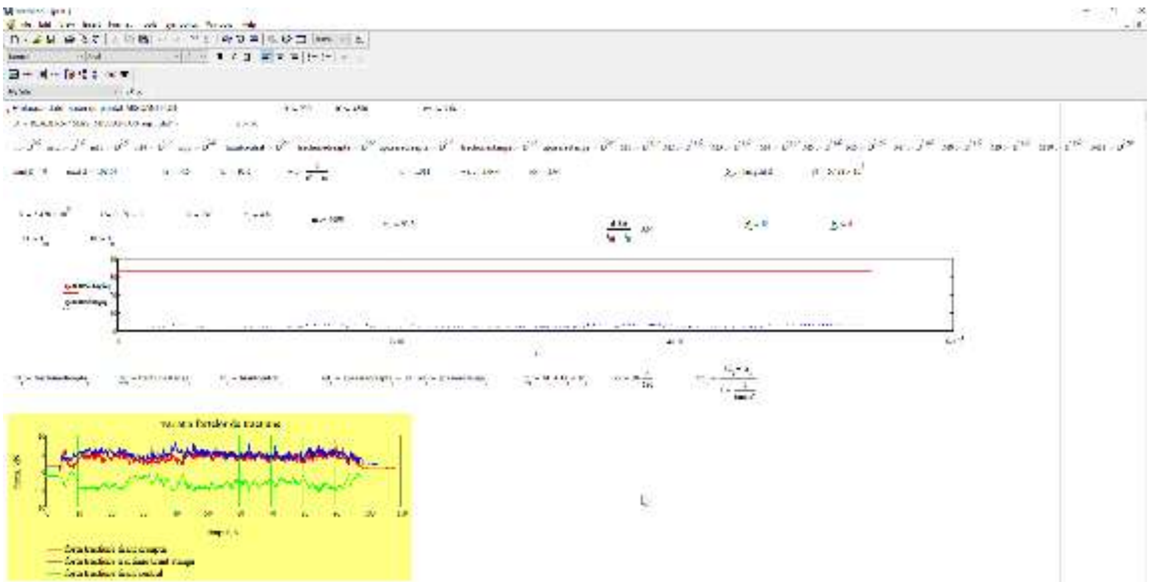

Fig. 4 – Calculus sheet MATCAD

RESULTS

For determination of traction force there were carried out 3 repetitions of the same test after which it was calculated the mean value of the recorded force, at threshold height, for a constant travelling speed of 3 km/h (recommended for the planting process of Miscanthus rhizomes).

Table 2

Traction force

Traction force (kN)	Repetition 1	Repetition 2	Repetition 3	Mean Value
	5.2	5.5	5.6	5.43

In the following figure is presented the traction force evolution during one test. As it can be seen, the evolution is quasi-static which means that the planting process is uniform and doesn't have peaks and valleys which could lead to a premature fatigue of the machine's frame.

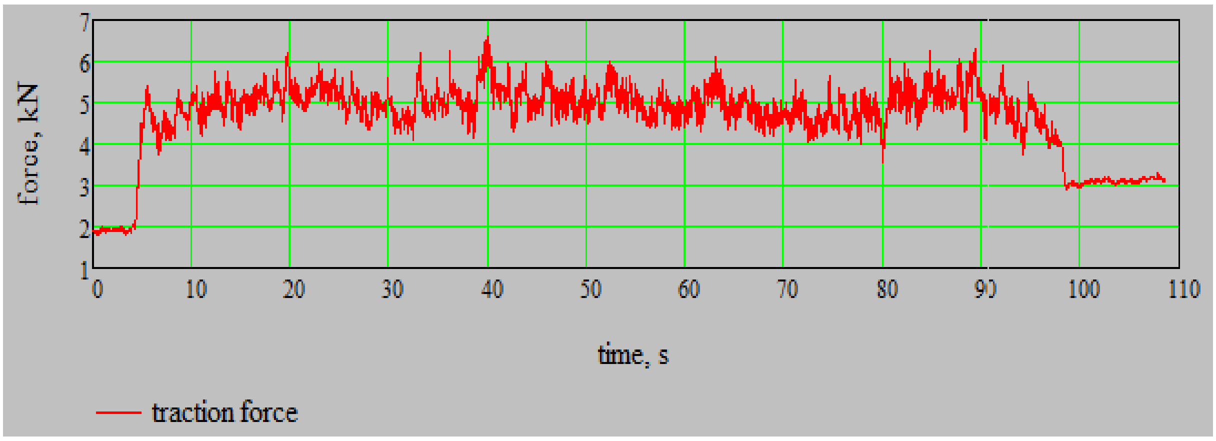

Fig. 5 – Evolution of traction force during tests

During the three repetitions there were recorded also the strains for the 14 strain gages which afterward were transformed in mechanical tensions after multiplication with the Young modulus of $E=2.1*10^{11}$ N/m^2 characteristic to the frame's material.

Table 3

Recorded mechanical tensions

Gage no.	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14
Tension value	MPa	MPa	MPa	MPa	MPa	MPa	MPa	MPa	MPa	MPa	MPa	MPa	MPa	MPa
min	-83	-30	19	-88	30	-28	-39	-1	-147	6,95	-31	3	22	-154
max	-8	3	45	-29	140	-4	15	13	5	26	4	17	124	-24
med	-52	-17	33	-58	86	-17	-7	6	-80	6	-16	10	87	-90
stdev	15,2	6,5	4,5	8,9	13,7	3,7	10	2,2	31	4,1	4,6	4,2	12,4	5,7

As it can be observed, the recorded stresses are both of traction (positive values) and compression (negative values). Within the next diagrams is presented the evolution of the mechanical tensions during tests, highlighting the transitory regimes at the beginning and ending of tests and in the threshold area in which the travelling speed was constant.

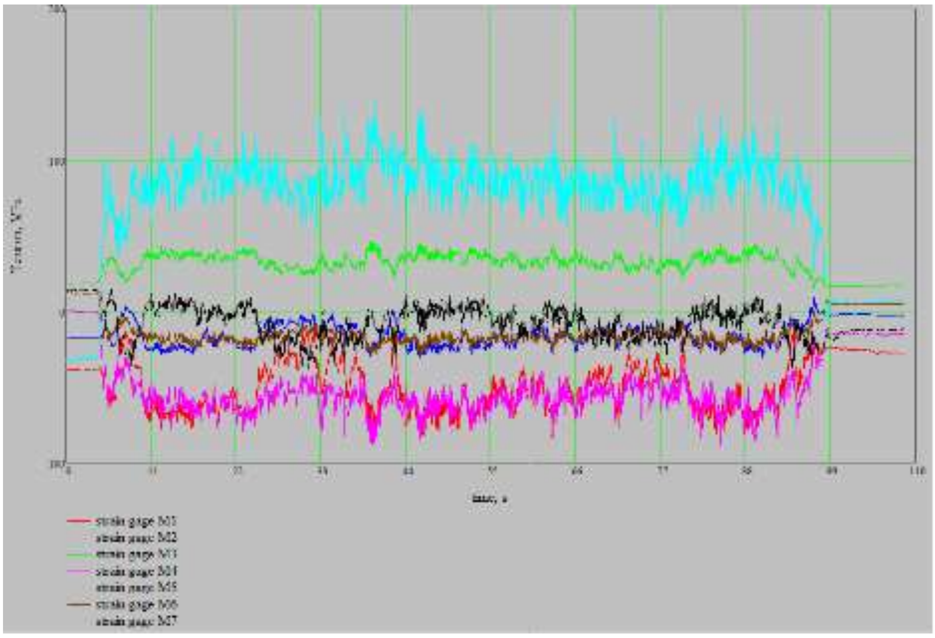

Fig. 6 – Evolution of mechanical tensions recorded by strain gages M1÷M7 during tests

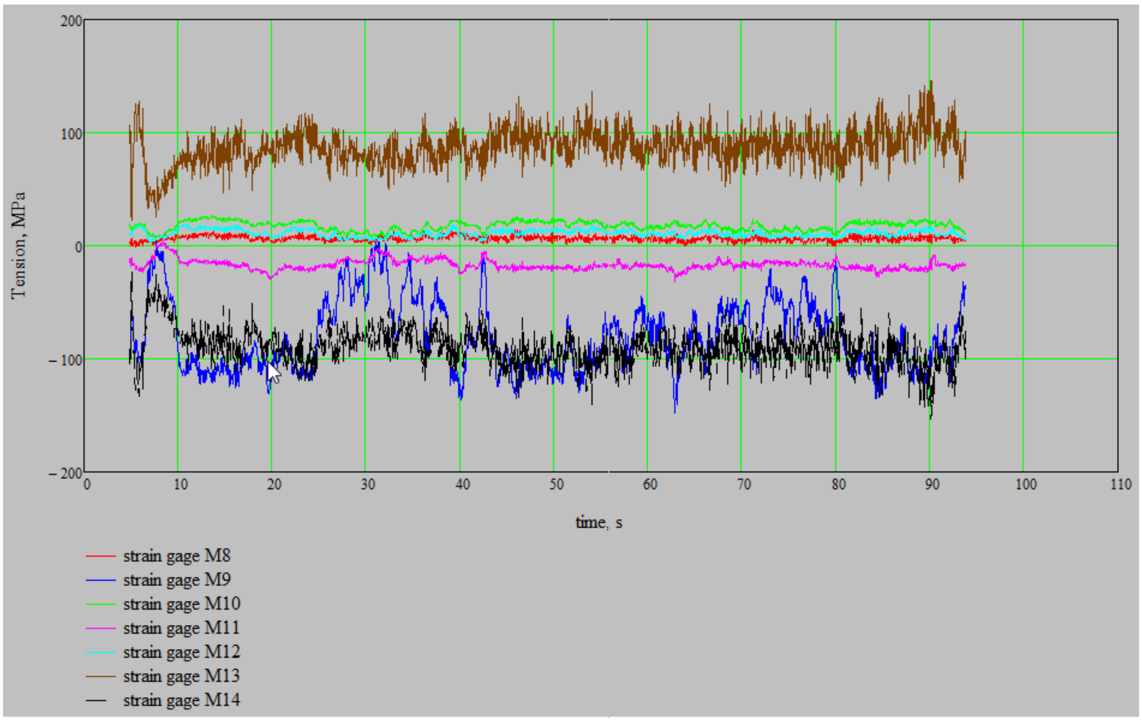

Fig. 7 – Evolution of mechanical tensions recorded by strain gages M8÷M14 during tests

CONCLUSIONS

Miscanthus planting machine MPM4 is an equipment designed for setting up Miscanthus crops, endowed with four working sections mounted on a frame, 70 cm spaced between.

For frame's resistance assessment there were carried out test during which mechanical strain and tensions were recorded. The results of test revealed a mean traction force of 5.43 kN, relatively low comparing with other agricultural works, a force which will not stress out too much the machine's frame. Also the mechanical tensions recorded by the 14 gages does not exceed the fatigue limit of the material from which the frame was built of approximately 220 MPa.

Analysing the mechanical tensions evolution during operation, it's observed that there are no peaks (overloads) of the frame which to have long time effects on its integrity.

The experimental method used for determination of the tension state in the machine's frame is not a destructive method, and can provide in a relatively short period the data regarding the resistance.

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INCREASING THE DEGREE OF UTILIZATION OF TUBULAR CHAIN AND DISK CONVEYORS IN INTERPHASE TRANSPORT
/
CREŞTEREA GRADULUI DE UTILIZARE A TRANSPORTOARELOR TUBULARE CU LANŢ ŞI DISCURI ÎN TRANSPORTUL INTERFAZIC

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Keywords: *tubular conveyor, chain with disks, granular materials, powders, driving station, return station.*

ABSTRACT
Interphase transport represents a basic stage within any technological processing progress irrespective of product type (either mineral or organic). Interphase transport plays an important role in agriculture and food industry. Therefore, studies were performed aiming to find the optimum conveyor able to meet the main requirements imposed by product transported. When it is compulsory to preserve the integrity of materials transported, small working speed equipment and appropriate active parts matchings should be used.. At the same time, it is important to take into consideration the place where the conveyor is used and, therefore, the conveyor should be designed according to space shape. The paper emphasizes that the most appropriate conveyors are the tubular chain conveyors with disks. They can be formed according to respective location requirements by using up to 8 return stations and have small movement speed comparing to other conveyors type. By using the above conveyor, the screw conveyors, band conveyors and bucket elevator can be successfully replaced.

REZUMAT
Transportul interfazic reprezintă o etapă de bază în cadrul oricărui proces tehnologic de procesare a produselor indiferent de natura acestora, minerală sau organică. Transportul interfazic își găsește un loc important în agricultură, industrie alimentară și agricultură. S-au căutat soluții pentru alegerea transportorului optim care sa satisfacă principalele cerințe impuse produsului transportat. Acolo unde este necesar a se respecta integritatea materialelor transportate se impune ca să se folosească echipamente cu viteza de lucru mici și cu adaptări necesare la organele active specifice situației. De asemenea trebuie ținut cont de configurația locului unde se folosește și, în acest scop transportorul trebuie configurat după spațiul unde este folosit. În lucrare se arată că în scopul celor prezentate anterior cel mai bine se pretează a fi utilizate transportoarele tubulare cu lanț cu discuri. Acestea pot fi configurate conform cerinței locului prin folosirea până la 8 stații de întoarcere și au viteze de deplasare foarte mici în comparație cu celelalte tipuri de transportoare. Prin folosirea acestui tip de transportor se înlocuiesc cu succes transportoarele cu șnec, transportoarele cu bandă și elevatoarele cu cupe.

INTRODUCTION
Interphase (operational) transport in any domain where it is performed, is an extremely important activity, being sometimes determinant in establishing the speed of a technological process.Thus, the mechanization of lifting and transport operations is ensured in individual production of small series up to large production, between different machines, implements and installations forming the technological flow, automated lines or flexible processing systems. At the same time, the costs involving handling, external and internal transport, loading, unloading the raw materials, unfinished goods, end products and other by-products resulted after the technological process, determine the increment of products price, without affecting their usage value. Therefore, we must choose the most appropriate technical solutions related to organization and development of transport within the technological manufacturing flow, able to ensure high techical performances at small cost. Within the study of handling and moving the materials in a technological flow, a systemic approach aiming to find the most suitable solutions, will be performed. Thus, it is necessary to analyze the requirements related to the whole current and future handling and transport system, the imposed restrictions, the performances of chosen system and comparison with other similar systems. This analysis will emphasize the connection between the handling and transport requirements

and necessary expenses for actual situation. The operational transport deals with all the mechanisms and machines designed to lift and transport materials, used both within the main technological flow and within other related activities. According to working process they perform, these mechanisms are grouped in two categories:

- lifting mechanisms and machines;
- continuous transport installations.

The lifting machines are designed to vertically move a charge made by a solid body, mostly combined with a horizontal displacement of the entire lifting machine or of one part of it. Thus, the load taken over and lifted from a certain point can be moved down and left in any other point of machine outreach. During operation, the lifting machine supports on a bearer, on a fixed base, a running way or on a ground or floating vehicle. In certain special conditions, certain bodies can be lifted by helicopter, but they do not frame within the lifting machineries. Continuous transport installations aim at achieving a continuous flow of individual tasks or of bulk materials. These installations perform not only the transport, but also the lifting and lowering of materials, but according to their construction, can ensure working angles of 0-90º . As the transport installations are long enough to cover the entire transport distance, the transport vehicles which have not a continuous flow of material do not frame within transport installation category. This can be remedied by using technical equipment or continuous transport installations.

Classification criteria of continuous regime conveyors are presented below:

- In terms of construction, there are:

- Vertical conveyors that transport the material along of a vertical or inclined path of an angle smaller than 20° comparing to vertical, comprising the bucket elevators;
- Inclined conveyors that transport the material along a straight track inclined by 55 and 70° to horizontal, comprising the inclined bucket elevators, screw conveyors;
- Vertical conveyors with swinging buckets that transport the materials between the points situated in the same vertical plan at different levels;
- Horizontal conveyors, that transport the material along a horizontal path or with an angle smaller than 15°, comprising the screw conveyors, the band conveyors, chain conveyors with disks (knots) and Redler conveyors;
- Mixed transport conveyors that ensure the transport of material along a horizontal and vertical plan, comprising the chain and knots conveyors.

- In terms of capacity, conveyors divide in :

- Simple conveyors that comprise: simple elevators, band conveyors, screw conveyors, Redler conveyors, chain and disk (knot) conveyors;
- Double conveyors comprising double elevators and conveyors with chain and disks (knots). Their advantage consists in the fact that they ensure the transport of the same or different materials on each tube.

- According to peripheral speed of traction part, conveyors are:

- rapid (v >1 m/s)
- slow (v <1m/s)

Speed of flexible traction part influences the ratio between gravity force and centrifugal force of unloading process, the following types of unloading resulting: *centrifugal, mixed* (centrifugal and gravitational), exterior *gravitational and interior gravitational.* This type of unloading leads to a smaller or bigger percentage of seed damaging, depending on the impact between seeds and material with which they come into contact. The conveyor should be chosen according to materials that must be transported: for example, for transporting the corn seeds designed to be sown, slow conveyors should be used for not hurting or destroying the embryo.

MATERIAL AND METHOD

The conveyor with tubular chain with disks is a close transport system that comprises a tubular casing (Figure 1) where a chain moves on each of the two links that are in cicular disk. Product caught between two disks is taken over and transported at storing location. The system functioning is completely without any dust.

Tubular conveyors with chain are stationary transport equipment appropriate to bulk materials. Materials to be transported may be grains of 0-10 mm size, that can flow(trickle) and can not be destroyed.

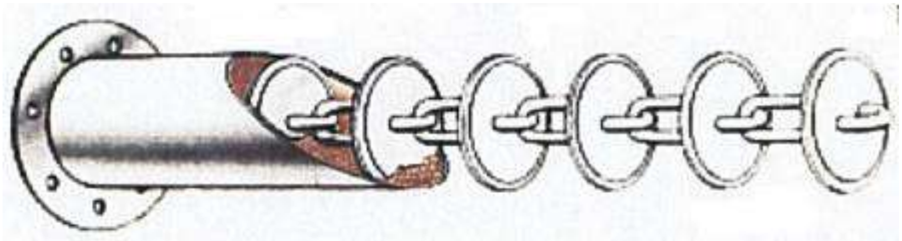

Fig. 1 – Conveyor with tubular chain with disks

Adaptibility of this conveyor for big grain or seed materials must be verified first by an initial test of determining the damaging degree of seeds. According to their damaging degree and utilization field (as sowing seeds or raw matter in human and animal consumption), one can establish if the tubular conveyor may be used or not. There are manufactured tubular conveyors of 60, 90, 115, 160, 200 and 270 mm diameter.

Tubular conveyors with chain generally transport: cereals, corn, rapeseeds, grains, flour, bone flour, tapioca flour, peanut shells, peanut kernel, semolina, broken biscuits, baking powder, cocoa beans, coffee beans, ground coffee, powdered milk, sugar, potato flour, seed powder, coal dust, PVC granules, colouring agents and many other granular materials.

The conveyor is appropriate when the products unloading is done in different storing places, and feeding in one or several locations, performing the relevant arrangements. The conveyor comprises individual elements according to general mechanic system of such a conveyor, namely: driving station,return stations,inputs and outputs, control tube and transport tube system. When seeds transported are designed to sowing, then they should not be damaged, because they would harm the people that finally consume the product. When the external shell is destroyed, the aleurone layer is traumatized, which will disturb the main component of germination process- the fermentation of nutritive substances (transformation of complex compounds, fats, sugar, proteins, necessary to feed the embryo).

Main technical characteristics of a tubular conveyor are the productivity and power necessary to drive. Productivity or transport capacity is expressed in t/h and is calculated by relation:

$$Q_m = 3600\ A\ v\ \rho\ \psi\ [t/h] \tag{1}$$

where:

A represents the tube section surface [m^2];

v – transport speed [m/s];

ρ - material density [t/m^3];

ψ - filling coefficient; $\psi \leq 0{,}8$

Conveyor speed is equal with peripheral speed of star wheel from the driving station and is given by relation:

$$V = \frac{\pi d n}{60}\ [m/s] \tag{2}$$

where:

d represents the pitch diameter of star-shaped wheel;

-n is rotational frequency of star-shaped wheel that equals the frequency of gearmotor outing shaft;

Power necessary to drive is determined starting from classical formula of determination of power, when force and linear speed are known.

$$P = F \cdot v \tag{3}$$

When material is moved away, the following resistance forces appear (Figure 2):

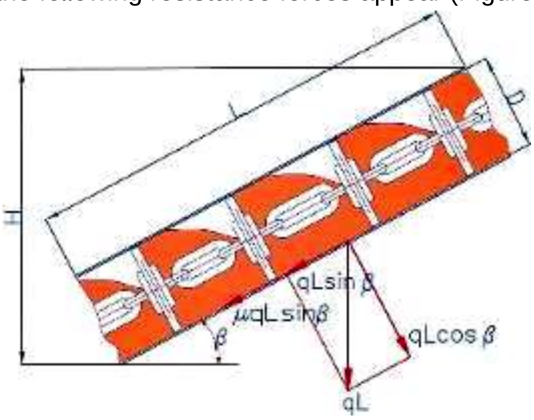

Fig. 2 – Resistance forces appearing at material movement into the tube

-weigh component according to movement direction;
-material friction into the chute;
-resistance opposed by material at displacement;
- material friction against the components of disk chain;
-friction of shafts at return stations;
-transmission friction.
Taking into account the notes in Figure 2, it results:
-weigh component according to movement direction is: $qL\sin\beta = qH$;
- weigh component according to normal movement is $qL\cos\beta$;
-resistance resulted from material friction against the chute is: $\mu qL\sin\beta = \mu qL$;
-resistance due to material mixing into the chute is assessed based on the experimental results, multiplying the displacement resistances by a coefficient k_0, which value depends on the material type.

Axial force necessary to overcome the resistance will be:

$$F_a = k_0 q(\mu L + H)\varepsilon \ \text{[N]} \tag{4}$$

where: μ - coefficient of friction of material with chain components;
q – weigh per linear meter of material to be transported [N / m];
L- length of conveyor charged with product [m];
H – lifting height of material to be transported [m];
k_0 = 1.1-1.2 for light and non-abrasive materials;
k_0 = 1.2-1.6 for heavy and non-abrasive materials;
k_0 = 1.8-2 for heavy and abrasive materials;
ε = coefficient that depends on the conveyor's length without material (ε= 1.1-1.4)

$$q = \frac{Q_m\, g}{3{,}6\, v} \ \text{[N/m]} \tag{5}$$

Replacing in equation 3, it is obtained:

$$P = \frac{(k_0 q(\mu L + H)\varepsilon)\frac{\pi d n}{60}}{1 - 0{,}02\lambda} \tag{6}$$

where: λ is the number of return stations, including the driving station.

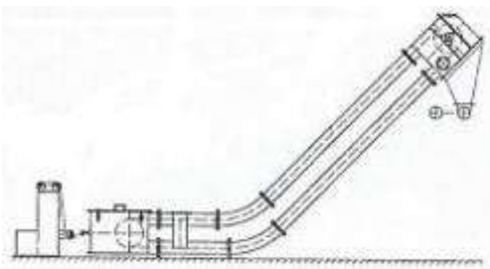
Fig. 3 – Tubular conveyor with 2 return stations

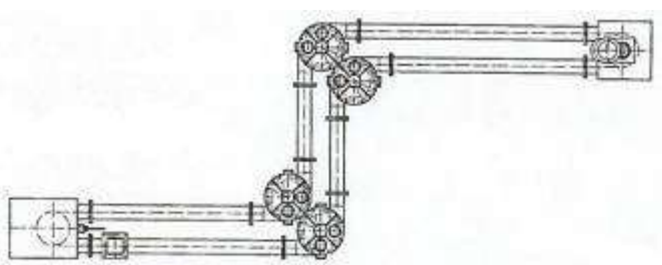
Fig. 4 - Tubular conveyor with 6 return stations

Power may be also expressed according to displacement resistance coefficient *w*, namely:

$$P = \left(\frac{1{,}1\, Q_m\, g}{3600}\right)(Lw + H)\frac{1}{\eta_l}\mathcal{L} \ \text{[kW]} \tag{7}$$

where: w=1.5-1.6 for grains;
w=1.2-1.3 for husks;
w =1.4-1.6 for lightly abrasive materials;
w =1.8-2 for heavy and lightly abrasive materials;
w = 4 for salt.
η_l = bearings yield, η_l = 0.7-0.8.
$\mathcal{L}$ = coefficient depending on number of return stations, including also the driving stations; $\mathcal{L}$=1.1-1.3. Value of 1.1 is specific to a tubular conveyor with 2 stations (see Figures 3 and 4).

Return stations are of two types:

- stations with enclosures made of steel sheets of 2 mm.
  - Vertical return station 90°.
  - Vertical return station with cleaning access 90°.
  - Horizontal return station 90°.
  - Horizontal return station with cleaning access 90°.

- Horizontal return station 180º.
- Horizontal return station 180º with cleaning access
- Return station with variable angle (as special design : 0º-180º).

- Return stations made of cast iron GG 20:
  - Vertical return station 90º.
  - Horizontal return station 90º
  - Horizontal return station 180º;

The guiding devices for the return stations should be installed according to mounting position of return stations. (Figures 5 and 6). They enable an appropriate transport. The guiding devices should be mounted according to transport direction.

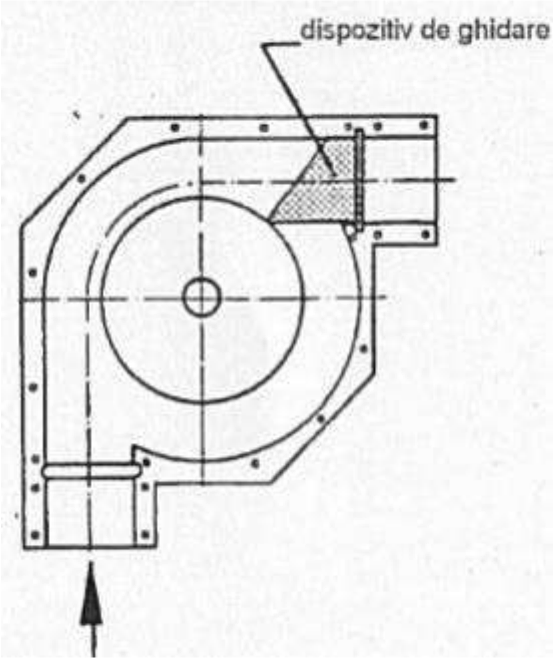

Fig. 5 – Horizontal return station 90º

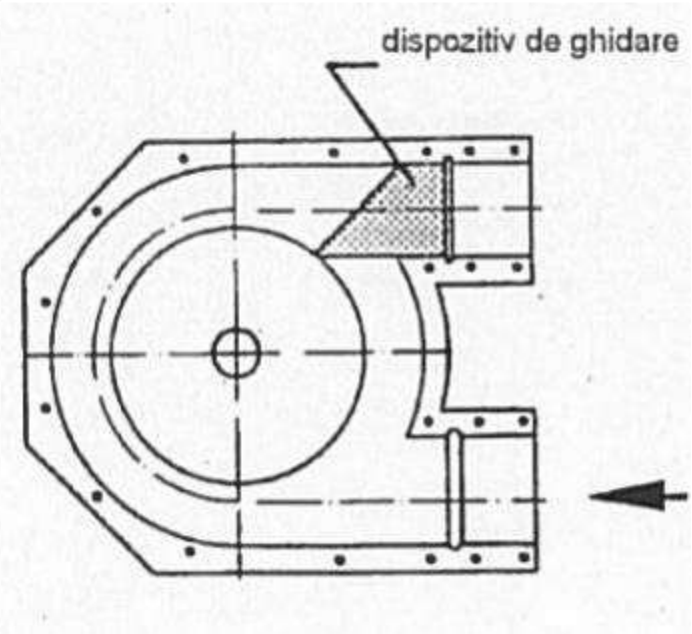

Fig. 6 – Return station 180 - vertical

As for the return stations made of grey cast iron, only 90º station is equipped with a guiding device for a vertical installation. This return station should be installed according to Figure 5.

Conveyor chain has round links made of steel resistant to wear (Figure 7).

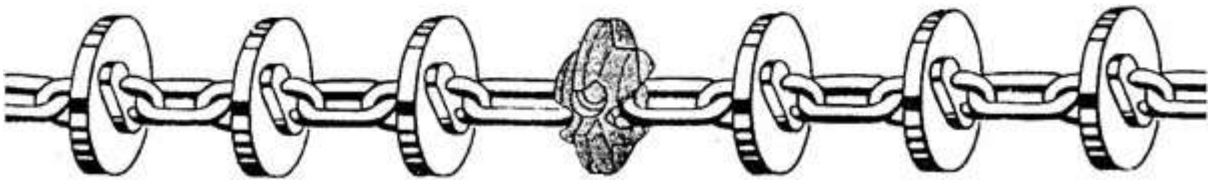

Fig. 7 – Two pieces chain jonction

Non-abrasive plastic disks are put on the chain. When the material to be transported reaches high temperatures, then a conveying chain with bolts on cast iron disks, is used.

The connection with the chain ends is made by a special coupling.

RESULTS

The use of a tubular conveyor with chain makes useless the screw elevators and bucket conveyors, whenever the situation allows it.

Tubular conveyors with chain and disks can be delivered having the chain speed reduced by means of a direct driving system adjustable to respective situation and, respectively by a motor gear with low rotational frequency. If the case is, a stainless steel model with protection against bad weather or for food transport, can be used.

In Figure 8 is shown in detail the manner of driving the disk chain in chain conveyor driving station TTL 60 and in Figure 9 is presented a tube with control window of a tubular chain conveyor TTL 90.

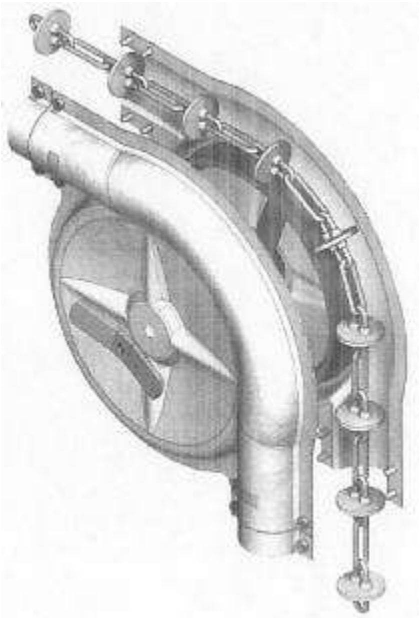

Fig. 8 – Chain driving at TTL 60

Fig. 9 – Tube with control window

An essential advantage when using the tubular conveyor is the possibility of using it in places where other equipment can not be used, because it is designed according to space. (up to 8 return stations);

A tubular conveyor may be successfully used both for vertical and horizontal transport of material with return angles of 90°, 180° and 360°for granular products (including seeds) or powder products without any modifications or adjustments.

Main indexes of tubular conveyors are shown in Table 1.

Table 1

Main indexes of representative tubular conveyors

Tube diameter (mm)	Chain speed (m/s)	Capacity (m^3/h)	Installed power (kW)	Tube diameter (mm)	Chain speed (m/s)	Capacity (m^3/h)	Installed power (kW)
60	0.02	0.122	0.37	160	0.02	0.864	0.55
	0.05	0.305	0.37		0.04	1.728	0.75
	0.09	0.550	0.5		0.07	3.024	1.5
	0.25	1.527	0.75		0.09	3.888	2.2
90	0.02	0.274	0.37		0.15	6.480	2.2
	0.04	0.549	0.5		0.20	8.640	4
	0.09	1.235	0.75		0.25	10.80	4
	0.32	4.392	1.1		0.32	13.824	5.5
115	0.02	0.449	0.37		0.45	19.44	7.5
	0.05	1.121	0.5	200	0.02	1.339	0.55
	0.15	3.365	0.75		0.04	2.678	0.75
	0.24	5.384	1.1		0.07	4.687	1.5
	0.38	8.525	1.5		0.09	6.026	2.2
270	0.10	12.367	4		0.15	10.040	2.2
	0.20	24.734	5.5		0.20	13.392	4
	0.30	37.101	7.5		0.25	16.740	4
	0.35	43.285	11		0.32	21.427	5.5
	0.40	49.468	11		0.45	30.132	7.5

In Table 2 it can be noticed the linear speeds appropriate to seed conveyors, for which they are successfully used.

Because the maximum capacity they cover is of 50 t/h., for bigger capacity it is recommended to use other types of conveyors: screw conveyors, Redler conveyors, band conveyors, bucket elevators.

Tubular chain conveyors length is calculated according to each dimeter necessary and number of return stations shown in Table 2.

Table 2

Maximum length of chain according to tube diameter and number of return stations

Maximum length of chain used according to number of return stations	**Tube diameter [mm]**					
	60	90	115	160	200	270
2 return stations	70 m	70 m	70 m	80 m	80 m	80 m
4 return stations	80 m	80 m	80 m	100 m	120 m	120 m
6 return stations	60 m	60 m	60 m	80 m	80 m	80 m
8 return stations	50 m	50 m	50 m	60 m	60 m	60

One simple return station is shown in Figure 10 and one driving return station is shown in Figure 11.

Fig. 10 – Simple return station. TTL 90

Fig. 11 – Driving return station. TTL 90

The disks are attached on the chain by injection on chain links (at each two links) of plastic material . Plastic material of which the disks are made should not have electrostatic charge. The method of fixing is shown in Figure 12 and driving manner in Figure 13.

Fig. 12 – Chain with disks at TTL 90

Fig. 13 - Manner of driving and changing the direction to return station with driving at TTL 90

The chain ensures the connection with all return stations and acts in each station as an universal joint during the products transport and can return in many directions or plans. The conveyor will be chosen according to appropriate capacity and space shape.

CONCLUSIONS

Tubular chain conveyor can successfully replace the screw conveyors and bucket elevators.

When variable speed of chain frames between 0.02 m/s and 0.47 m/s (see table 1)–the product is very little damaged and equipment performance is increased and its life span is prolonged. Therefore, these conveyors can be used very well to transport seeds for sowing, because the danger for seeds to be damaged is very little.

From Table 1, we deduce that this type of conveyors can be used only for capacities up to 50 t/h. For higher capacity, this conveyor is inappropriate.

Tubular conveyor can be used in places where other equipment is inappropriate, having the advantage of being designed according to respective space (up to 8 return stations). Tubular chain conveyors length is calculated according to tube diameter and number of return stations.

According to Table 2, maximum length of chain with disks belongs to conveyor with 270 mm diameter with 4 return stations.

Tubular conveyor can be successfully used both to transport materials in vertical plan and horizontal plan with returns at 90°, 180° and 360° for granular or powder products without any modification or adjustment.

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QUALITY MANAGEMENT IN A KNOWLEDGE-BASED ECONOMY
/
MANAGEMENTUL CALITATII INTR-O ECONOMIE BAZATA PE CUNOASTERE

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ABSTRACT

The paper presents the evolution of the quality concept and the quality standards, and then two management models are analyzed: the ISO 9000 quality management system and the EFQM excellence model. The key features that make the ISO 9000 series the most widespread model for leading modern businesses are also described. Finally, the main advantages of the quality management systems implementation are mentioned.

REZUMAT

Lucrarea prezintă evoluţia conceptului de calitate si a standardelor privind calitatea, iar apoi sunt analizate două modele de management: sistemul de management al calităţii conform seriei ISO 9000 si modelul de excelenta al EFQM. De asemenea sunt descrise caracteristicile esenţiale care fac din seria de standarde ISO 9000 cel mai răspândit model de conducere a întreprinderilor moderne. In final se menționează principalele avantaje ale implementării sistemelor de management al calităţii.

INTRODUCTION

Quality is a concept that is used in all areas of economic and social life but which has a subjective character and has particular significance for different areas, sectors, services or products.

Being an abstract concept, the word *"quality"* can have many different definitions, such as *"an essential or remarkable sequence of someone or something"* or *"the feature defining the individual nature of a thing"*; these are just a few of the many definitions of this word.

There are many definitions of the term *quality*, formulated by different experts in the field of quality management. Among the most well-known definitions are the following:

- "the extent to which a set of intrinsic characteristics fulfils the requirements" *(ISO 9000:2015)*
- "appropriate to the purpose for which it was created" *(Juran J.M., 1988)*
- "fulfilling the requirements to achieve their satisfaction" *(Deming W.E., 1982)*

For a long time, the main concern in the field of quality has been reduced to controlling product compliance. Initially, the emphasis was on the *findings*, but one can assume that the results of the control were used in one way or another also to prevent the occurrence of inappropriate situations in the future. Quality control aims to determine whether products meet the imposed quality requirements.

It is only in the 20th century that the preventive aspect is proposed as a distinct objective under the name of "quality assurance". Quality assurance aims to prevent the occurrence of non-quality by adopting appropriate measures that give confidence that a product or service will meet the quality requirements. People relied, sometimes excessively, on documenting the activities, applying the principle *"TO DO WHAT IS WRITTEN, TO WRITE WHAT YOU DO"*.

Subsequently, there has been an increase in quality requirements throughout the world. This trend is accompanied by the understanding that *continual improvement of quality* is indispensable to achieve and maintain sustainable *economic performance* and, consequently, *profit*.

Thus, the notion of Quality Management emerged, which represents the modern management system by involving all the personnel in the process of quality achievement and the extension of the notion of quality to the entire activity of an organization, vertically and horizontally.

The next concept used in quality management, Business Excellence, is a complex system of quantitative appreciation of a company's performance, including quality. In this sense, EXCELLENCE MODELS are used, with criteria and sub-criteria that can quantify the overall performance of a company (determinants and results), representing the quantitative expression of the TQM (Total Quality Management) concept implementation in a company *(Cua K.O. et al, 2001; Kiran D.R., 2016)*.

In the following, two management models are presented: the ISO 9000 quality management system and the EFQM excellence model.

MATERIAL AND METHOD

The Quality Management System aims to integrate organizational culture and the internal environment with management involvement to align operational missions and practices to continually improve quality. The system has a high participatory character, starting from the principle that quality culture is an integral part of organizational culture and encourages all staff to be involved in its implementation and monitoring.

An effective quality management approach is achieved when in the organization there is individual commitment to engage in a process of continuous improvement of products and services, within a development-based organizational culture.

The staff and the organization it represents must develop an environment in which *quality is seen as a planned journey to continuous improvement*, which leads them to meet the set goals.

A quality management system can be seen as a complex system of all components of an organization that wants to improve the quality of its products and processes. The quality management system can be defined as the ensemble of the organizational structure, responsibilities, processes and resources needed to implement the principles and lines of action needed to meet the goals set by the organization.

RESULTS

Quality management system according to the ISO 9000 set of standards

The ISO 9000 set of standards promotes the adoption of a *"process-based approach"* in developing, implementing and *improving the effectiveness* of a quality management system that wants to achieve customer satisfaction by meeting their requirements. The Quality Management System approach encourages organizations to analyse customer requirements, define the processes that contribute to achieving an acceptable product / service for the customer and keep these processes under control (*Hoyle D., 2015*).

A quality management system can provide the framework for continuous improvement, increase the probability of raising customer satisfaction and raise the satisfaction of other stakeholders. This system provides confidence to the organization and its customers that it is capable of delivering products and services that consistently fulfil the requirements.

The ISO 9001:2015 standard [9] is used as a reference for self-assessment but also for the certification of quality management systems, becoming the basis for mutual recognition of certificates internationally.

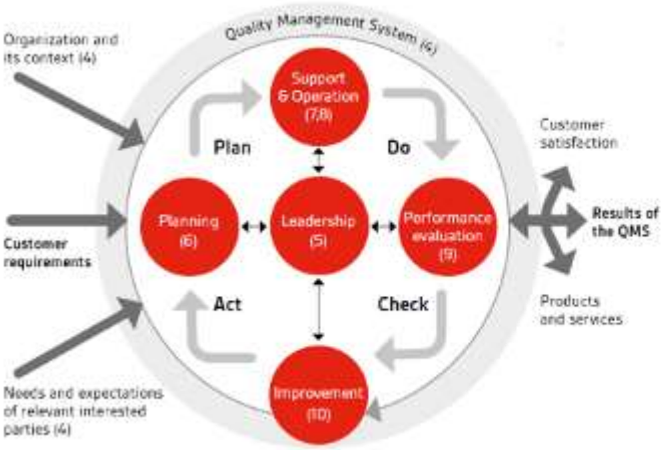

Fig.1 - Process approach ISO 9001:2015 [6]

In the context of ISO 9001:2015, the process-based approach includes the processes required to achieve the product / service and the other processes necessary for effective implementation of the quality management system, such as the internal audit process, management review process, data analysis process, resource management process, etc. All processes can be managed using the PDCA concept.

The "Plan-Do-Check-Act" cycle was first developed in the 1920s by Walter Shewhart and was later popularized by W. Edwards Deming. For this reason, it is known as the "Deming Cycle". In the context of the quality management system, the PDCA is a dynamic cycle that can be deployed in each of the processes of the organization and in the process system as a whole. It is related to planning, implementation, control and continual improvement - both of the product and service delivery process and of the other processes of the QMS.

The philosophy of PDCA is to keep in balance the 4 steps of the cycle, as shown in Figure 2.

Fig. 2 - PDCA Cycle

This cycle applies to both high-level strategic processes such as quality management system planning or management analysis as well as to simple operational activities performed as stages of the realization process of organization's products and services.

The quality management approach described in the ISO 9000 set of standards is presented in the diagram of Figure 3:

Fig. 3 - Diagram of continual improvement of QMS [7,10]

EFQM Excellence model

One of the best-known Total Quality Management (TQM) models is the European Foundation for Quality Management (EFQM) Excellence Model.

The EFQM Excellence Model is a business excellence framework most used in Europe where more than 30,000 businesses use it to improve business performance and development.

The EFQM Excellence Model, a non-prescriptive framework based on 9 criteria, is used to assess the progress of an organization on its way to Excellence, as shown in Figure 4.

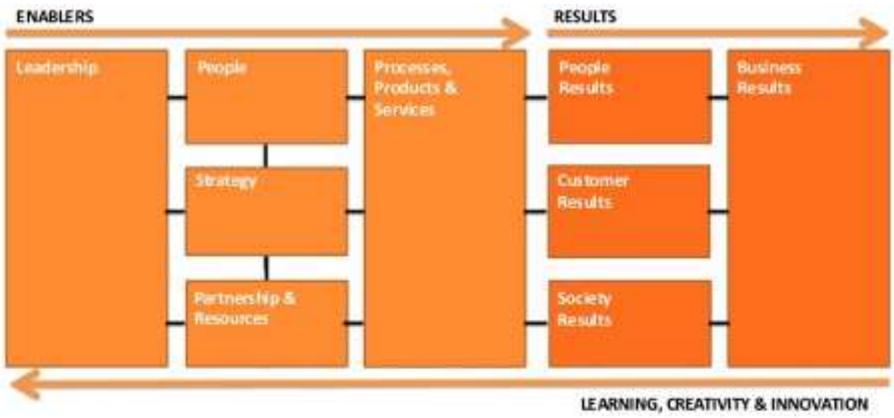

Fig. 4 - Diagram of EFQM Excellence Model [8]

The EFQM Excellence Model is a practical tool used by organizations for several purposes:

- As a self-assessment tool, to measure where the organization is on the road to excellence, helping it identify weaknesses and find solutions;
- As the basis for a vocabulary and a way of thinking about the organization, common to all its functions;
- As a scheme to position different initiatives, avoiding overlapping and identifying weaknesses;
- As a structure for the organization's management system.

The Excellence Model has a number of advantages that have proven to be valuable:

- It addresses all areas of the organization, offering a global approach of the business;
- Describes a self-assessment process according to the nine criteria (non-prescriptive but detailed and yet flexible) of the Model;
- It can be adapted to suit the specific nature of the organization (requirements, size and complexity, the extent to which resources can be committed);
- It contains a set of indicators, both financial and non-financial, that are oriented towards the needs of customers, staff, local community and the organization's own requirements.

The Excellence Model offers Benchmarking opportunities with top organizations, thanks to the common language used by these organizations. The EFQM Excellence Model can be used as a benchmark in self-evaluation, providing valuable information to the organization about its current performance level.
Any organization that uses the Excellence Model and self-evaluation will benefit sooner from the benefits of self-evaluation if it has a culture of continual improvement.

CONCLUSIONS

Implementing any quality management system means introducing in the organization the way you work and think which ensures the success of the system in question. The immediate benefits, especially those in the medium and long term, advocate the implementation of these systems.

A quality system should not be considered a random collection of procedures (which many quality systems are), that is why quality systems, like central heating systems, must be designed. All components must fit, inputs and outputs must be connected, sensors must provide information to processes that cause changes in performance and all elements of the system need to work together for a common purpose: *to continuously improve the relevance, suitability and effectiveness of the quality management system*.

Thus, for quality management to be strategic, organization needs to commit to an ongoing effort to improve the quality of products, services or processes to sustain market competitiveness of its product and service.

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MICROBIOLOGICAL ANALYSIS OF RAW WASTEWATER FROM A DAIRY FARM / *ANALIZA MICROBIOLOGICA A APEI UZATE BRUTA PROVENITA DINTR-O FERMA DE BOVINE*

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ABSTRACT

Due to water scarcity, wastewater reuse is becoming an essential and reliable component of integrated and sustainable water resource management, especially in arid and semi-arid areas. Improper microbiological quality of raw and treated wastewater is a challenge for developing countries, because it limits their agricultural reuse. In order to prevent or reduce the environmental and public health risks, it is essential to regulate the microbiological quality of wastewater used in irrigation of food crops. The paper presents the analysis of the microbiological load of wastewater from a Romanian cow farm.

REZUMAT

Din cauza deficitului de apă proaspătă, reutilizarea apei uzate devine o componentă esențială și fiabilă a gestionării integrate și durabile a resurselor de apă, în special în zonele aride și semi-aride. Calitatea microbiologică necorespunzătoare a apelor uzate brute și epurate reprezintă o provocare pentru țările în curs de dezvoltare, deoarece limitează reutilizarea agricolă a acestora. Pentru a preveni sau reduce riscurile asupra mediului și sănătății publice, este esențial să se reglementeze calitatea microbiologică a apelor uzate utilizate în irigarea culturilor alimentare. Lucrarea prezintă analiza încărcării microbiologice a apei uzate provenită dintr-o fermă de vaci din România.

INTRODUCTION

Communities around the world are facing challenges related to water supply due to increased water demand, drought, resource depletion and groundwater contamination, as well as the dependence on single sources of supply.

It is estimated that more than 40% of the world's population will face water stress or scarcity within the next few decades, with significant impact on socio-economic, water and food security (*Beccera-Castro et al, 2015*). The causes of water scarcity are a combination of several problems: inefficient water distribution networks, lack of emergency plant to face decreasing rainfall and basic infrastructure, poor wastewater treatment, environmental resource degradation, and climate change (*Urbano et al., 2017*). 40% of the total land area is dry and includes climate zones classified as arid, semi-arid and dry sub-humid (*FAO, 2008*).

Wastewater recovery, recycling and reuse addresses these challenges by solving water resource issues and by new sources of supply with high quality water. The future potential for recovery of effluents is enormous. The composition of wastewaters depends on their origin but in general, major contaminants found include organic compounds, xenobiotics, metals, suspended soils, nutrients (mainly nitrogen and phosphorus) and pathogenic microorganisms (*Bitton, 2005*).

The agricultural sector is the largest user of freshwater worldwide, with about 70% of the total water usage (*Elgallal et al, 2016*). Agricultural reuse of wastewater for irrigation has been considered a valuable and reliable alternative, alleviating the pressure on freshwater resources in arid and semi-arid regions (*Farhadkhani et al, 2018*). The reuse of treated wastewater, in particular for irrigation, is an increasingly common practice, encouraged by governments and official entities worldwide.

Irrigation with wastewater reduces the utilization of natural water resources, reduces chemical fertilizer usage, protects the aquatic ecosystems from contamination and improve crop yield due to nutrient delivery.
Approximately 10% of the total global irrigated land area receives untreated or partially treated wastewater, encompassing 20 million hectares (10% of all irrigated land) in 50 countries (*Winpenny et al, 2013*) and the European continent reuses 963 Mm^3/year of untreated wastewater (*Bixio and Wintgens, 2006*).

It has also been reported that over 200 million farmers in 44 countries recover over 15 million m^3 of treated wastewater / day for irrigation purposes (*Ungureanu et al, 2018*).

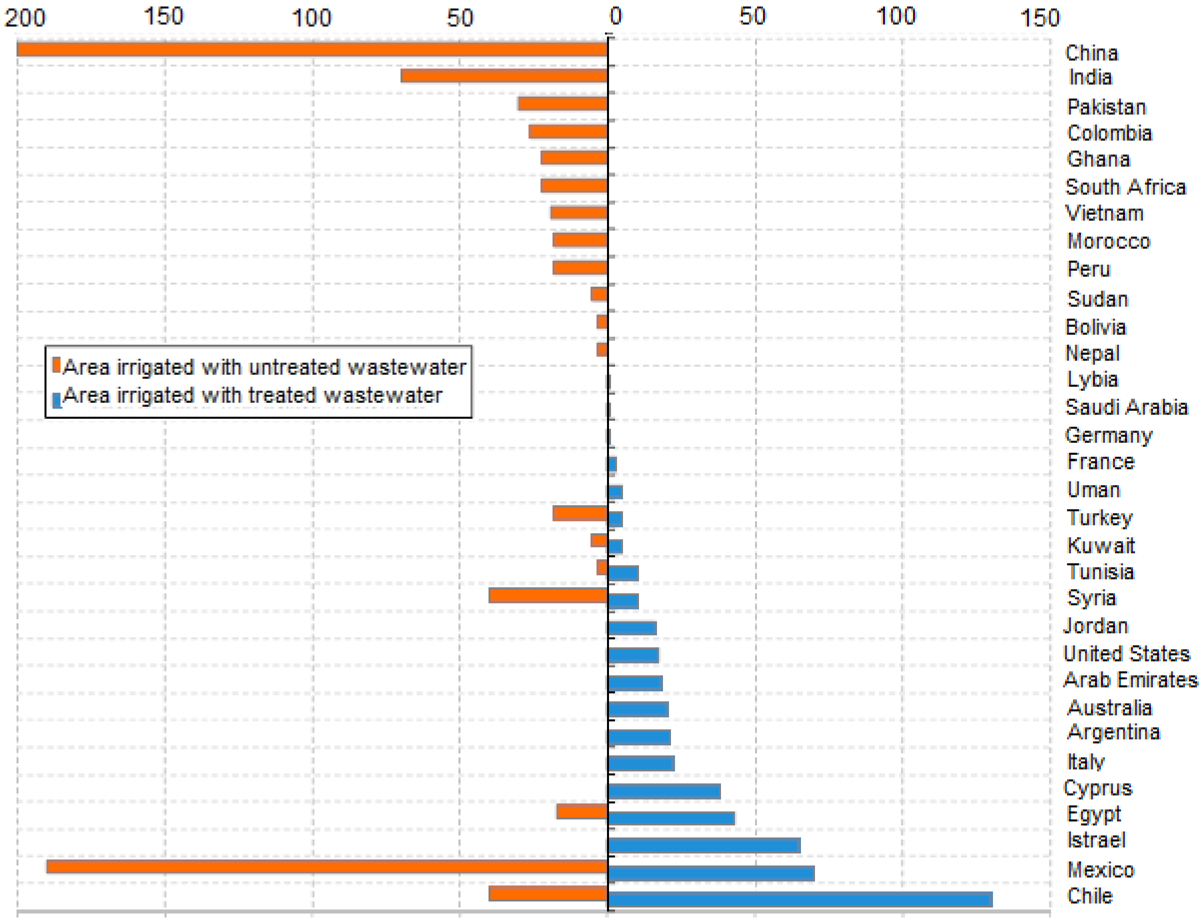

Fig. 1 – Areas of wastewater reuse in agriculture by country, data refers to thousand hectares (*Jaramillo and Restrepo, 2017*)

Romania's accession to the European Union requires compliance with European requirements, and the reuse of wastewater effluents is in line with Objective 6 of the European Union's Sustainable Development Strategy. In Romania, reuse of irrigated water is not largely practiced (there is a low demand for the global use of treated wastewater), and different wastewater treatment methods for reuse are only addressed at the experimental level.

Although the Romanian legislation does not prohibit the use of irrigated waste water, the relatively low number of users connected to the irrigation system does not stimulate investment in new waste water treatment technologies in order to use them as irrigation water. However, in the long term, the interest in reuse of irrigated water could increase, as Romanian agriculture continues to be dependent on climatic factors (*Ungureanu et al, 2018*).

Nevertheless, various studies have pointed out that the pathogens contained in wastewater pose a serious threat to human health and increase the risk for bacterial, parasitic and viral infections in consumers of wastewater irrigated crops, estimating the risk of infection based on the microbial concentration of reused wastewater (*Moazeni et al, 2017; Elgallal et al, 2016*). Human and animal pathogens, phytopathogens and antibiotic resistant bacteria and their genes are important biological contaminants that can be transported by wastewater and/or be enriched in soil.

Many pathogens are able of survival in the environment (e.g., water, soil, crops) long enough to allow transmission to humans (*Campos C., 2008*). Wastewater and agricultural soil have quite different characteristics, but both are inhabited by a wide diversity of bacteria (Figure 2).

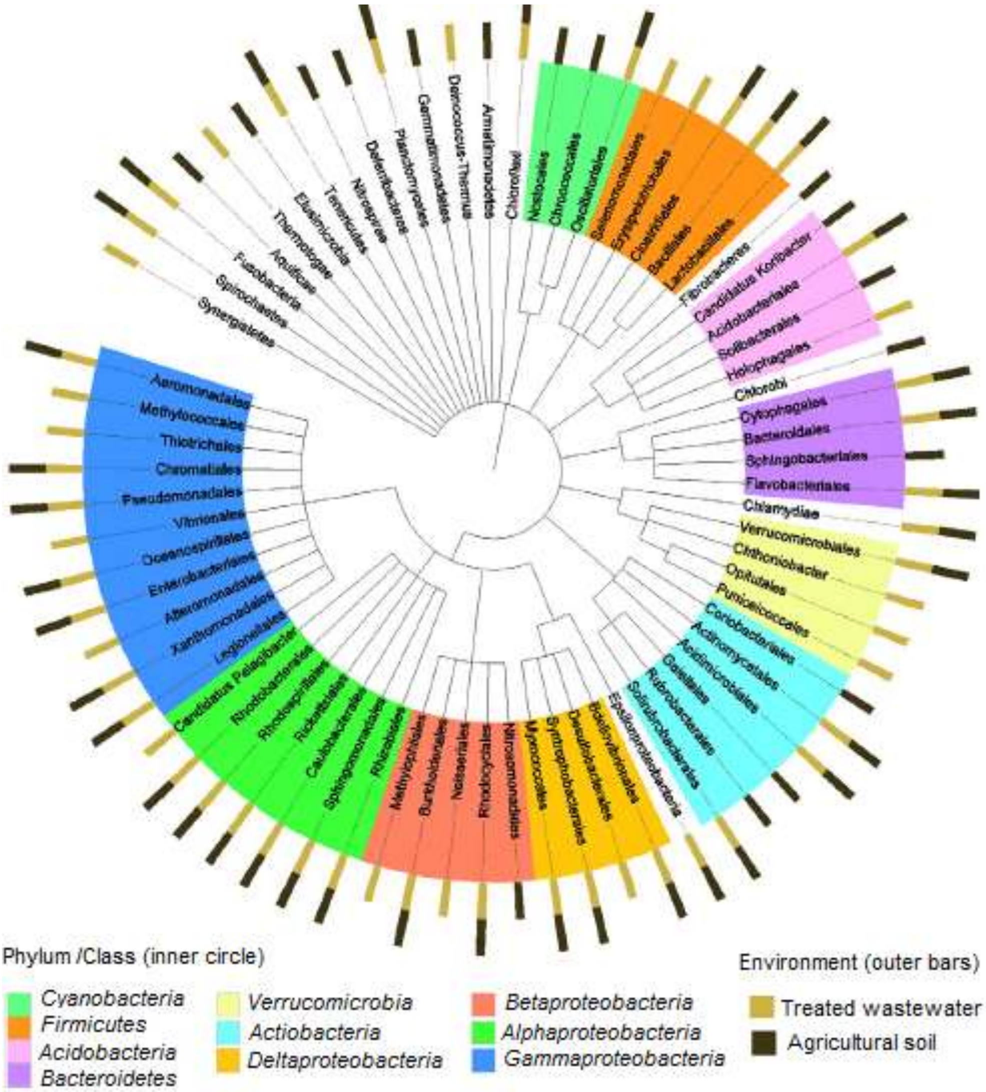

Fig. 2 - Dendrogram representation of the bacterial diversity observed in treated wastewater and agricultural soil (*Letunic and Bork, 2011*)

Inadequate microbial quality of treated wastewater is a challenge for developing countries, and limits agricultural reuse of wastewater (*Farhadkhani et al, 2018*). The primary exposure routes to microbial pathogens associated with the reuse of wastewater in agriculture arise from (*WHO Guidelines, 2005*):

• Human contact with the wastewater (or with contaminated crops) before, during or after irrigation (farmers, vendors, local communities);

• Consumption of wastewater irrigated products;

• Consumption of animals or animal products that have been contaminated by exposure to wastewater.

The required level of wastewater treatment prior to application can be reduced by the restrictions imposed by each type of crop and irrigation systems so as to minimize the risk to health. The most suitable treatment method that can be applied to wastewater prior to its use as irrigation water in agriculture is the method that can produce an effluent that meets the microbiological and chemical quality standards, with minimum operating and maintenance requirements. Adoption of a lower level of treatment is desirable especially in developing countries, both because of the cost and the difficulty of operating reliably the complex wastewater treatment systems.

Advanced treatment of wastewater can significantly reduce the concentrations of the specific pathogens in the wastewater and thus the risk of disease transmission. However, treated wastewater still contains high loads of bacteria. Most of these are of environmental origin and a non-negligible fraction (up to10^3 colony forming units per mL) is derived from human and animal guts (*Varela and Manaia, 2013*).

The World Health Organization gives the main starting points for setting water quality standards, including microbiological standards. However, these guidelines are not international standards and they are meant to be adapted to local social, economic and environmental factors (*Campos C., 2008*).

The Food and Agriculture Organization of the United Nations (FAO) has also developed several guidelines relevant to the use of wastewater in agriculture. These guidelines related the degree of restriction of water use to salinity, infiltration and toxicity parameters of specific ions (*Jaramillo and Restrepo, 2017*).

A summary of the main microbiological parameters considered in different guidelines and policies is given in Table 1. Several countries (e.g. the USA, Spain, Jordan) establish different threshold values in function of the type of irrigated crops. For raw-consumed food crops the recommended values are generally stricter than for other crops that will be further processed (processed food) or used as pasture or energy crops (*Beccera-Castro et al, 2015*).

Table 1

Guidelines on wastewater reuse for irrigation in different countries (*Beccera-Castro et al, 2015*)

Country or organism	Irrigation category	Total coliforms [CFU/100 mL]	Faecal coliform [CFU/100 mL]	*E. coli* [CFU/100 mL]	Nematode eggs (no/L)
US-EPA	Unrestricted		Absent		
	Restricted		2×10^2		
WHO	Unrestricted			10^3	≤1
	Restricted			-	≤1
California	No determination		2×10^2		
Italy	No determination				
France	Unrestricted		4	10^2	
	Restricted		2 - 3	2.5×10^2	
Spain	Unrestricted			10^4 - 10^5	
	Restricted			10^2	0.1
Portugal	Unrestricted		10^2	10^3 – 10^4	0.1
	Restricted		$2 \times (10^2 - 10^4)$		
Australia	Unrestricted	10			
	Restricted	10^2 - 10^4		10^2 - 10^4	
Israel	No determination		10		
Tunisia	No determination				≤1
Jordan	Unrestricted			10^2	<1
	Restricted			10^3 – no determination	<1
Kuweit	No determination	4×10^2	20		<1
Oman	Unrestricted		$2 \cdot 10^2$		<1
	Restricted		10^3		<1
Saudi Arabia	Unrestricted	2.2			1
	Restricted	10^3			1
China	Unrestricted		2×10^4		
	Restricted		4×10^4		
Mexico	Unrestricted		240		
	Restricted		10^3		

MATERIAL AND METHOD

Wastewater samples were taken from a Romanian cow farm with a total of 570 animals, of which 370 mature cows and 200 calves. Within the farm, coarse organic residues consisting of fodder residues, paddock litter and cow manure are collected and stored on the composting platform.

Fig. 3 - Paddock of the cow farm

Fig. 4 - Composting platform

Regarding the wastewater, no preliminary or primary treatment in applied. Wastewater from the farm is directly collected in a lagoon next to the composting platform. These wastewaters are a mixture of wastewater from paddock washing, liquid manure mixed with solid trapped residues, wastewater from the farm's milk processing plant and meteoric waters.

The lagoon is provided with a mechanical system that has the role of homogenizing the wastewater when it is taken in basin cleaner machine to be used as a fertilizer on the farmland near the paddocks. During sampling, wastewater collected in the lagoon was continuously homogenized.

Fig. 5 - Lagoon from which the wastewater samples were taken

Fig. 6 - Sampling of wastewater

Wastewater samples were stored at 4 °C until the analysis, which were made within 24 hours from sampling. Culture medium (Figure 7) were prepared to determine the microbiological load of the wastewater samples taken from the lagoon. The following microbiological indicators were considered:

- total number of mesophilic aerobic germs - on the Plate Count Agar medium with the following composition (g/L): peptone 5.0; glucose 1.0; yeast extract 2.5; agar 15.
- number of yeasts and molds - on the Potato Dextrose Agar medium, with the following composition: potato infusion 4g/L, glucose 20 g/L, 15 g/L agar, supplemented with 0.1 g/L chloramphenicol.
- number of coliform bacteria - on EMB (Eosin Methylene Blue Agar) medium with the following composition: peptone 10 g/L, lactose 10 g/L, dipotassium phosphate 2 g/L, eosin 0.4 g/L, methylene blue 0.65 g/L, 15 g/L agar.
- *Escherichia coli* - on the TBX selective medium, with the following composition: 20 g/L peptone, 1.5 g/L bile salts, 0.075 g/L X-β-D-glucuronide, 15 g/L agar (chromogenic medium).
- Bacteria of the genus *Staphylococcus* - on the Chapman Agar medium.
- *Enterococcus* - on the Ethyl Violet Azide Agar medium.

Culture medium were weighed and prepared in 500 mL Erlenmeyer flasks and sterilized in the autoclave at 121 °C for 15 minutes (Figure 8).

Fig. 7 - Culture medium used in the analyses

Petri dishes and graduated pipettes, as well as metal instrumentation and other glassware were sterilized in the oven at 180 °C for 60 minutes and the let to cool until use.

Fig. 8 - Autoclave for the sterilization of culture medium

Wastewater samples, considered to have highly microbial load (considering their origin), were diluted in sterile physiological serum, by performing series of decimal dilutions, in sterile tubes each containing 9 mL of liquid. For each analysis, three successive dilutions were made, so that the number of colonies in the Petri dishes ranges between 10 and 300 (for the measurement uncertainty to be minimal).

All analyzes were performed in a sterile microbiological hood. Prior to being poured into Petri dishes, the culture medium were cooled in a water bath at 45 °C. In each Petri dish was introduced one milliliter of the wastewater sample to be analyzed or its dilutions, the melted and cooled culture medium was poured, then homogenized by circular movements and then it was let to solidify.

Fig. 9 - Inoculation of Petri dishes

The innoculated Petri dishes were thermostated at the specific growth temperatures for each microorganism, and the counts of the grown colonies were performed after 48-72 hours of incubation. The number of colonies was multiplied by the dilution factor and the result of the determinations was expressed in CFU/mL (colony forming units/mL sample).

RESULTS

1. The total number of mesophilic aerobic germs was determined by counting the colonies grown in Petri dishes on Plate Count Agar medium. In the Petri dishes was pipetted one milliliter of 3 successive dilutions prepared from the initial sample and the cultures were thermostated at temperatures of 20 and 37 ºC for 2 and 3 days. The number of colonies was calculated by multiplying the number of colonies grown in the Petri dish multiplied by the dilution factor. Petri dishes in which the number of colonies ranged from 10 to 300 colonies were considered.
2. The number of yeasts and molds was determined in Petri dishes on Potato Dextrose Agar medium, supplemented with 0.1 g/L chloramphenicol, taking into account the dilution factor. Readings were made after 5 days of thermostation at 25 ºC.
3. The number of coliform bacteria was determined on the EMB (Eosin Methylene Blue Agar) medium at 37 ºC.
4. *Escherichia coli* was determined on the TBX selective medium (chromogenic medium). *E. coli* bacteria absorb the chromogenic substrate 5-bromo-4-chloro-3-indolyl-β-D-glucuronides. The ß-glucuronidase enzyme cleaves the substrate into 5-bromo-4-chloro-3-indolyl and β-D-glucuronide. Colonies of *E. coli* appear colored in blue-green.
5. Bacteria *Staphylococcus* were determined in Petri dishes on the Chapman Agar medium at 37 °C.
6. *Enterococcus* was determined onthe Ethyl Violet Azide Agar medium at 37 °C.

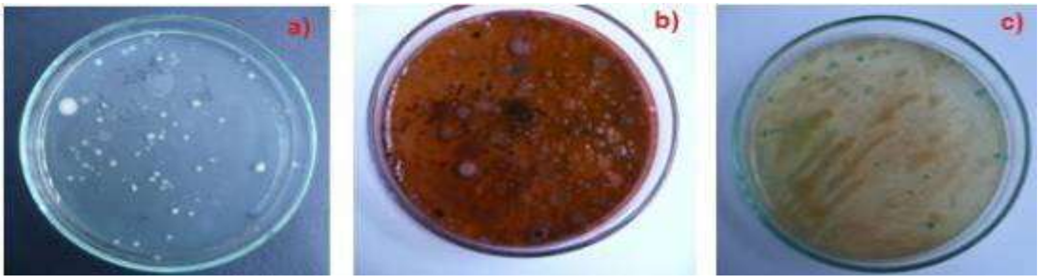

Fig. 10 – Determination of : total number of germs at 37 ºC (a), coliform bacteria (b) and *E. coli* (c)

Table 3

Microbiological load of wastewater samples

Characteristic	Analysis method	M. U.	Determined value
Total number of germs - at 22 °C - at 37 °C	SR EN ISO 6222 : 2004	CFU/mL	15×10^4 47×10^4
Coliform bacteria	Count on dishes on EMB (Eosin Methylene Blue) agar medium	CFU/mL	28×10^3
E. coli	Count on dishes on chromogenic medium TBX	CFU/mL	5×10^2
Yeasts and molds	SR ISO 21527	CFU/mL	4×10^2
Staphylococcus	Count on dishes on Chapman medium	CFU/mL	8×10^2
Enterococcus	Count on dishes on Ethyl Violet Azide Agar medium	CFU/mL	3×10^2

Directive 91/271 / EEC on Urban Wastewater Treatment has been fully transposed into Romanian legislation by GD no. 188/2002 for the approval of the norms regarding the discharge conditions of the waters in the aquatic environment, modified and supplemented by GD no. 352/2005. It should be noted that this GD regulates only the physical and chemical indicators of wastewater quality, without mentioning any limits imposed on microbiological indicators.

CONCLUSIONS

For a sustainable and safe wastewater reuse, parameters affecting the environment safety and human health should be included in the quality standards.

The risks posed for human health cannot be accurately estimated at the moment, but they cannot be ignored. However, the microbial pathogens contained in the wastewater (bacteria, viruses, protozoa, and nematodes) can be removed by physical and biochemical treatment processes.

Affordable technological solutions with minimal environmental impacts must be developed in order to assure wastewater treatment processes compatible with sustainable uses.

ACKNOWLEDGEMENT

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RESEARCHES ON THE MECHANIZED PLANTING OF AGROFORESTRY CURTAINS ON SANDY SOILS IN THE OLTENIA PLAIN
/
CERCETĂRI PRIVIND PLANTAREA MECANIZATĂ A PERDELELOR AGROFORESTIERE PE SOLURILE NISIPOASE DIN CÂMPIA OLTENIEI

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Keywords: *planting, agroforestry protection curtains, sandy soils*

ABSTRACT
The paper presents the experimental researches conducted at INMA Bucharest on sandy soil from Oltenia plain, situated in the south-west of the Romanian plain, in the purpose of determining the quality working indices of a new machine destined for the technology for establishing agroforestry protection curtains. The results presented generate solutions valid at any scale, from households smaller than one hectare, to large farms, with the necessary adjustments, because they offer data necessary for implementing a sustainable land management, with beneficial effects on agroforestry plantations for the crops, the stability and natural balance, for biodiversity.

REZUMAT
Lucrarea prezintă cercetările experimentale efectuate de INMA București pe solurile nisipoase din Câmpia Olteniei, situată în sud- vestul Câmpiei Române, în scopul determinării indicilor calitativi de lucru ai unei mașini noi destinată tehnologiei de înființare a perdelelor agroforestiere. Rezultatele prezentate generează soluții valide la orice scară, de la gospodării mai mici de un hectar și microferme până la ferme mari, cu ajustările de rigoare, deoarece oferă date necesare în implementarea managementului durabil al terenurilor, care are efecte benefice asupra plantaţiilor agro-forestiere pentru culturi, stabilitatea şi echilibrul natural, pentru biodiversitate.

INTRODUCTION
Oltenia plain is one of the most important agricultural regions in Romania and one of the most sensitive in terms of extreme meteorological phenomena, namely draught, due to its localization in the south-west part of the country, combined with natural and socio-economical conditions. It is situated in the south-west part of Romania, between the Danube river (south and west), river Olt (east) and the Getic piedmont (north) covering the Romanian plain, also known and the Lower Danube plain (*Dumitrascu et al, 2018*).

Starting with the year 1989, the uncontrolled and abusive exploitation has affected forestry areas situated in Dabuleni plain, allowing the extension of the sand dune and causing ecological disruptions (*Calciu et al, 2017*).

Several techniques were proposed for attenuating these disruptions. Agroforestry curtains, representing the common growing of crops and trees, is such an attenuation technique (*Pavlidis et al, 2018*).

In accordance with the provisions of Article 4, paragraph 2 of the Law no. 289/2002 on forest protection curtains, the realization of the National system of forest protection curtains is declared to be of public utility and, according to Article 3 paragraph (1), forest protection curtains constitute a good of national interest. In the realization of the National System of Expropriator Protection Curtains, the Romanian State, through the National Direction of Forests - Romsilva, the land owners will be compensated according to the legal provisions, after a preliminary evaluation of the buildings, conducted by authorized evaluators. The technical coordinator of this process is the central public authority responsible for forestry. Depending on their role, the forest protection curtains are of the following types (Article 2 of Law No. 289/2002, republished): for the protection of agricultural lands against harmful climatic factors and for the improvement of the climatic conditions in the defended perimeter; anti-erosion, soil protection subject to erosion phenomena; for the protection of communication and transport ways, especially against snow; for the protection of dikes and shores against currents, floods, ice and others; for the protection of localities and various economic and social objectives (*Law No. 289/2002, republished*).

Within innovative technologies, it is imperative to implement the research results with protective effects for agricultural crops, stability and biological balance regarding the planting of agroforestry curtains (*Malschi*

D. et al, 2009). In Romania, this protection method through forest curtains was initiated starting with 1861 and was developed in years with great calamities, excessive draughts, dust storms (1890, 1935, 1946), materializing until 1961 in planting over 6000 ha of forest curtains, and within 1970-1975 with another 1700 ha on the sandy soils in south Oltenia (*Popescu E., 1993*). In Romania, the agricultural area that needs to be protected by forest curtains is about 11 million ha, which represents 2/3 of the agricultural area of the country, and this area is in two climatic zones: I. Warm - dry and II. Moderately thermal – sub-humid, and from an administrative point of view it belongs to 5 development regions: 1. North-East, 2. South-East, 3. South - Muntenia, 4 + 8. South - West Oltenia + Bucharest - Ilfov and 6. North - West. The area of agroforestry curtains required to protect agricultural land and crops from extreme climatic phenomena varies between 433 and 650 thousand ha at national level and between 80-150 thousand ha per development region (*http://agriculturadurabila.ro*).

At European level, the European Agroforestry Federation - EURAF (Federation of Farmers Using Agricultural Technologies with Agroforestry Curtains) aims to implement the agroforestry system in 50% of European farms until 2020, as a sustainable use of land, including the role that agroforestry has to play in fighting climate change (*http://www.eurafagroforestry.eu*). Forest curtains always contain a multitude of species, with different sizes, the most common being acacia, honey locust, poplar, ash, elm, oak, maple, lime, cherry plum, wild cherry, forest apple, forest hair, mahaleb, elderberry, hawthorn, dog rose, thistle, silver berry (*http://permacultura-romania.com*).

Regarding mechanized planting, nowadays internationally, cutting-edge planting equipment are far less automated than machines operating in the last decades. Following the abandonment of highly automated machinery, the development of planting equipment followed the simple and easy to operate mechanization principles (*Rummukainen, A. et al, 2002*). In Romania, studies and researches were conducted regarding the working process of machines destined for establishing forest curtains, which involved the mechanization of two operations, one for opening the gutter by a ploughshare with special geometric shape and the second for planting the forest seedling conducted by the planting device (*Popescu I. and Popescu S.C., 2000*).

The authors have proposed to conduct a series of experiments on sandy soils in the Dăbuleni Plain, located in the southwest of the Romanian Plain, in order to determine the quality indices of a new machine designed for the technology of establishing agroforestry curtains, to make it possible to identify the optimum solution in the implementation of sustainable land management with agroforest plantations by farmers in the area.

MATERIAL AND METHOD

The experimental researches conducted by INMA Bucharest on sandy in the Oltenia plain, situated in the south-west of Romanian plain, in the purpose of determining the quality indices were carried out using the functional model of equipment for establishing agricultural curtains (Fig. 1), destined to operate in aggregate with 80-120 HP tractors on wheels for the mechanization of the work of planting seedlings of forestry trees in the view of establishing agroforestry curtains in the purpose of fighting draught phenomena.

Fig. 1 – Functional model of equipment for establishing agroforestry curtains

The functional model has in its componence the following subasemblies: frame, ploughshare, planting mechanism, compaction system, parking foot, operator seat, RealView™ video guidance system with Matrix 570GS agricultural GPS for the next pass and supports for the seedlings.

The demands of modern agriculture are related to high yield and efficiency. Reducing costs, working time and ensuring control over agricultural activities in their entirety are essential factors of profitability and competitivity, both internally and externally. In this purpose, the guidance system for the next pass of the functional model for the equipment for establishing agroforestry curtains is of the video type with agricultural GPS.

The main technical characteristics for the functional model of equipment for establishing agroforestry curtains is presented in Table 1.

Table 1

Main technical characteristics

Characteristic	Value
Type	Carried behind the tractor
Ploughshare type	prismatic shape construction with sharp angle
Gutter type	trapezoidal
Number of planting stations	1
Planting mechanism	disc type with arms and tweezers for gripping small seedlings (50…70 cm)
Guidance system for the next pass	RealView™ video guidance with Matrix 570GS agricultural GPS from the tractor's cabin
Distance between two seedlings (on a row), cm	75, 100, 150
Gutter depth, cm	30
Movement speed during operation, km/h	1
Overall dimensions, mm - length - width - height	 2400 2600 1555
Weight, kg	840

The species planted was *Honey locust* which is a tree similar to black locust, with spiny branches, small green flowers and pod fruits, grown for protection curtains (*https://ro.wikipedia.org*).

The quality working indices determined were:

- *the average force of extracting seedlings* F_m after planting, calculated using relation (1), based on measuring the force of extracting seedlings after planting F_i (i=1, 2, 3, 4, 5), in N, that was measured using the dynamometer t;

$$F_m = \frac{\sum_{i=1}^{n} F_i}{n},\ cm \tag{1}$$

- *standard deviation S*, calculated using relation (2):

$$S = \sqrt{\frac{\sum_{i=1}^{n}(F_m - F_i)^2}{n-1}},\ cm \tag{2}$$

- *variation coefficient* c_v*,* calculated using relation (3):

$$c_v = \frac{S}{F_m} \times 100,\ \% \tag{3}$$

For measuring soil moisture, TDR modified method also called Amplitude Domain Reflectometry (ADR) was used, with the help of the HH2 portable moisture analyser and the Theta Probe.

RESULTS

In Table 2 are presented the results per experimental years regarding the average force of extracting seedlings after planting, and Table 3 present the moisture at planting depth per experimental years.

Table 2

Average force of extracting seedlings after planting

	Year 1(2016)	Year 2(2017)	Year 3(2018)
Average force of extracting seedlings after planting F_m, N	3.1	5.1	5.4
Standard deviation S, N	2.39	1.75	1.80
Variation coefficient c_v, %	7.67	5.59	5.72

Table 3

Moisture at planting depth

	Year 1(2016)	Year 2(2017)	Year 3(2018)
Moisture at a planting depth of 25 cm, %	5.2	5.6	7.3

Figure 2 graphically presents the average force of extracting seedlings after planting and the moisture at planting depth for the experimental years.

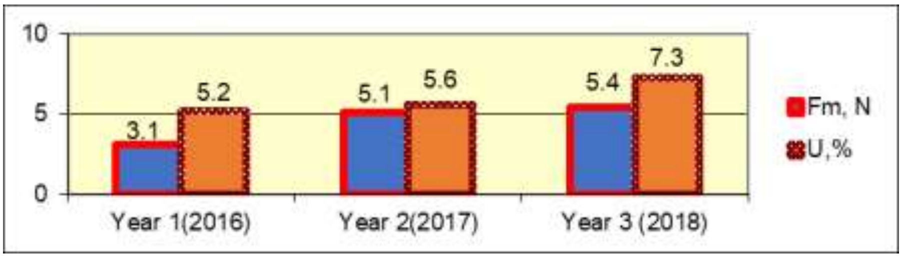

Fig. 2 – Graphical representation of the average force of extracting seedlings after planting and of the moisture at planting depth for the experimental years

By analysing the graph in Figure 2, is noticed that in year three of experiments, the average force of extracting seedling after planting has grown along with moisture growth at planting depth.

CONCLUSIONS

Experimental researches for determining quality working indices allowed the technical validation of solutions addressed at the conceptual validation of components for the experimental model of technical equipment for establishing agroforestry curtains;

The experimental results allow to elaborate a useful recommendation for farmers applying the technology for establishing agroforestry curtains for improving the growing environment of agricultural crops.

ACKNOWLEDGEMENT

Results presented were obtained with the support of Ministry of Agriculture and Rural Development through the ADER Program, contract 16.3.1/16.10.2015, "*Researches on influence of applying new conservative systems and technologies of agricultural mechanized works for fighting against draught effects, preserving soil fertility and quantitatively and qualitatively increasing the yield of main species of plants cultivated".*

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FIELD TESTING OF COMPACTION CHARACTERISTICS FOR FARM TRACTOR UNIVERSAL 445
/
TESTAREA ÎN CÂMP A CARACTERISTICILOR DE COMPACTARE PENTRU TRACTORUL AGRICOL UNIVERSAL 445

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Keywords: *soil, tractor, compaction, pressure, contact area*

ABSTRACT

In the past few decades, size and weight of agricultural machinery have increased significantly, and as a consequence, the severity and depth to which the stress is transmitted into agricultural soil have increased. The objective of experimental determinations was to study the influence of some factors characteristics to compaction: tire inflation pressure, wheel load and contact pressure on the contact area between tire and soil, as well as 2D and 3D mapping of pressure distribution in the footprint. The front tire of the U445 Romanian agricultural tractor was tested at five tire inflation pressures: 100, 150, 200, 250 and 300 kPa, obtaining contact areas between 0.0252 – 0.0349 m² and contact pressures between 98 - 136 kPa.

REZUMAT

În ultimele decenii, mărimea și greutatea mașinilor agricole au crescut în mod semnificativ și, în consecință, au crescut severitatea și adâncimea la care se propagă tensiunile în solul agricol. Obiectivul determinărilor experimentale îl constituie studiul influenței unor factori caracteristici ai compactării, precum: presiunea din pneu, încărcarea pe roată și presiunea de contact asupra ariei de contact dintre pneu și sol, precum și obținerea hărților 2D și 3D ale distribuției presiunilor în pata de contact. S-a testat pneul față al tractorului agricol romanesc U445, la cinci presiuni în pneu: 100, 150, 200, 250 și 300 kPa, obținându-se suprafete de contact între 0.0252 – 0.0349 m² si presiuni de contact intre 98 - 136 kPa.

INTRODUCTION

Worldwide, soil compaction has become a concern and is recognized as one of the major problems in modern agriculture associated with soil degradation. Soil compaction is an increase of soil wet density, and it occurs mostly when a vehicle operates on soil with increased soil moisture or due to improperly dimensioned running gear of heavy field machinery, though loaded and inflated according to manufacturers' technical instructions (*Grecenko and Prikner, 2014*).

Soil compaction under the wheels of agricultural field vehicles such as tractors is of special concern (*de Lima et al, 2018*), because of demand for mechanization, hence increased field traffic under predominantly all-weather operations. In European agriculture, tractor weight increased from 3 tons (in 1940) to 7 tons (in 1998) respectively 20 tons (at present). Although with the increasing adoption of precision agriculture that can confine traffic, modern tractors are heavier and available power and their load carrying/pulling capacity is greater, hence, current field machines have potential to cause much more site disturbance and damaged (*Mohsenimanesh and Ward, 2010*).

On contact with the soil, the tire of agricultural machinery leaves a footprint whose shape and size depend on several categories of factors: the type of soil and its physical characteristics, the type of tire (rigidity, tread pattern), tire inflation pressure, wheel load. The contact area is the part of the tire that comes into contact with the soil and is calculated as the ratio between the wheel load and the tire inflation pressure. Static contact area is the contact area between the tire and a rigid or deformable surface when the tire is statically loaded without movement (*Wulfsohn D., 2009*). The contact area between has a major influence on the distribution of stress in the soil. The increase in the contact area does not necessarily lead to the decrease of the stress in the soil, but to the limitation of the distribution of the large stresses in the depth, respectively to their extension in horizons close to soil surface. The problem of deep distribution of large stress can be solved by adopting double-drive wheels for which the contact area doubles.

Tire inflation pressure is, along with soil moisture, one of the most important factors influencing soil compaction (*Batey T., 2009*) because it influences the contact area and the contact pressure at the soil-tire interface for a given wheel load (*Xia K., 2011*). The contact pressure at the soil-tire interface is a good indicator of the potential for compaction of agricultural soils. In order to reduce the contact pressure and therefore to reduce the artificial compaction, it is recommended to use machines and agricultural equipment fitted with tracks or tires higher than the standard ones and with low tire inflation pressures (radial tires) (*Ziyaee and Roshani, 2012*). As the vertical contact pressure is distributed over the contact area unevenly, the vertical resultant reaction force tends to shift toward the leading edge (*El-Sayegh et al, 2018*). One of the approaches to reduce the risk of soil compaction is to reduce tire pressure on soil either by decreasing axle load and/or increasing the contact area of wheels on the soil (*Kenarsari et al, 2017*).

Studying tire-soil interaction in agricultural soil is also important because vertical deformation of soil (as a deformable material) is sometimes larger than the tire deflection (*Farhadi et al, 2018*). Soil-tire interaction, however, is complex and difficult to quantify. Understanding the stresses at the soil–tire interface would provide insight into the current state of tire traction development, data for soil–tire interface discrete and finite-element models, and information for future tire designs (*Roth and Darr, 2011*).

MATERIAL AND METHOD

Experimental research was carried out at the National Research - Development Institute for Machines and Installations Designed to Agriculture and Food Industry – INMA Bucharest. On an agricultural field cultivated with red basil, it was tested the pressure distribution under the left front wheel of the Universal 445 tractor (Fig. 1), which is a small agricultural tractor equipped with a 33 kW engine. The front axle tires are Danubiana Superfront Tractor, size 6.00-16, profile F-2.

Fig. 1 – Universal 445 Romanian tractor

The weight of the Universal 445, determined by the electronic weighing platform type RW-10PRF, was 2041 kg, of which 700 kg were distributed on the front axle (350 kg or 3.43 kN on each front wheel) and 1341 kg on the rear axle (670.5 kg or 6.57 kN on each rear wheel). The pressure at the interface between the agricultural soil ad the front wheel of the tractor and the sizes of contact area were established by interpolating between the two elements a Tekscan Industrial Sensing sensor for measuring the pressure distribution (sensor size: 600 x 500 mm). After calibration, the pressure sensor was coupled to the VersaTek Handle electronic data acquisition system (Fig. 2) and to a laptop.

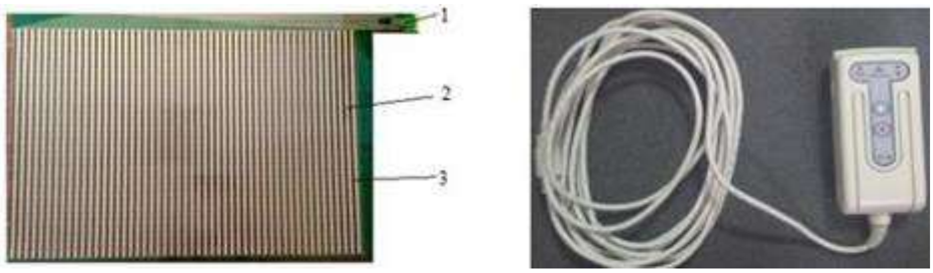


Fig. 2 - Tekscan pressure sensor and VersaTek Handle data acquisition system

1 – connection to the data acquisition system; 2 – sensitive elements; 3 – connecting threads between sensitive elements

Data acquisition was done in the I-Scan software, which displays the 2D and 3D pressure distribution in the contact area, as well as the values and variations in time of some parameters such as contact area, contact pressure, maximum pressure, force on the soil, etc.

During the experiments, tire inflation ppressure values were varied five times and measured with the aid of the compressor and the pressure gauge: 100 kPa, 150 kPa, 200 kPa, 250 kPa and 300 kPa.

Fig. 3 – Variation of tire inflation pressure

Figure 4 shows the under-wheel placing of the mesh-type pressure sensor and the profile of the front tire of the U445 tractor at the minimum tested tire inflation pressure of 100 kPa.

Fig. 4 - Front tire at minimum inflation pressure (100 kPa)

RESULTS

The experimental data for both the input and output parameters monitored and analyzed are presented in Table 1.

Table 1

Compaction characteristics under the front wheel of U445 tractor

Wheel load Q [kN]	Tire inflation pressure p_i [kPa]	Size of contact area A [m^2]	Contact pressure p_c [kPa]	Footprint length l_c [m]	Footprint width l_w [m]
3.43	100	0.0349	98	0.241	0.179
	150	0.0314	109	0.214	0.170
	200	0.0298	115	0.246	0.161
	250	0.0290	118	0.223	0.165
	300	0.0252	136	0.212	0.162

As it can be seen from Table 1, by varying the tire inflation pressure from 100 kPa to 300 kPa, contact areas ranging from 0.0252 - 0.0349 m^2 were obtained, with the corresponding contact pressures being between 98 kPa and 136 kPa.

Studies in the literature have shown that the agricultural soil is compacted if the contact pressure exceeds 85 kPa. Considering that, it can be said that in all tested situations, compaction would mainly affect the arable layer of soil, but its negative effects can usually be alleviated by moldboard or chisel plowing. However, repeated passes of the tractor on the same traffic lanes would intensify the effects of compaction, and stresses could affect the subsoil. Subsoil compaction persists for longer periods and the compacted layers are difficult cu alleviate, resulting in increased fuel consumption and reduced crop yields.

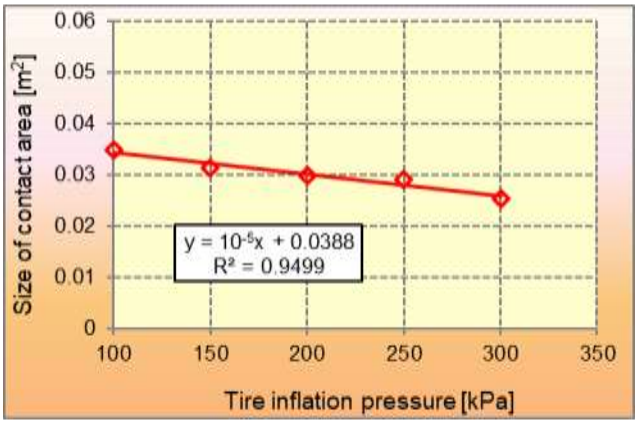


Fig. 6 - Influence of tire inflation pressure on the contact area of the U445 tractor

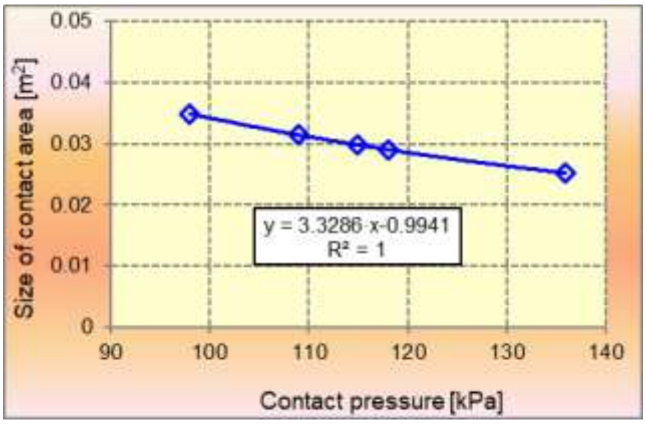


Fig. 7 - Influence of contact pressure on the contact area of the U445 tractor

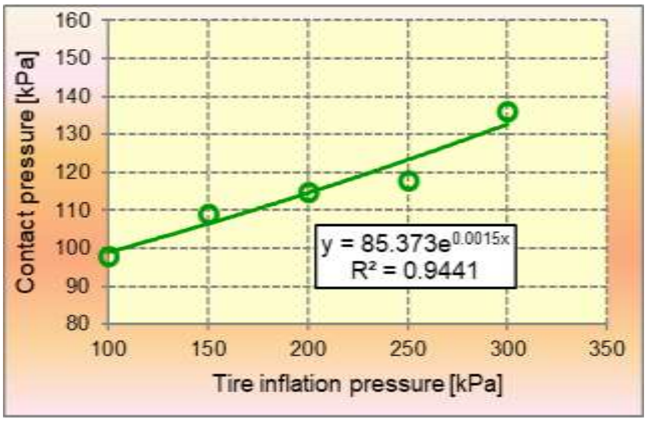
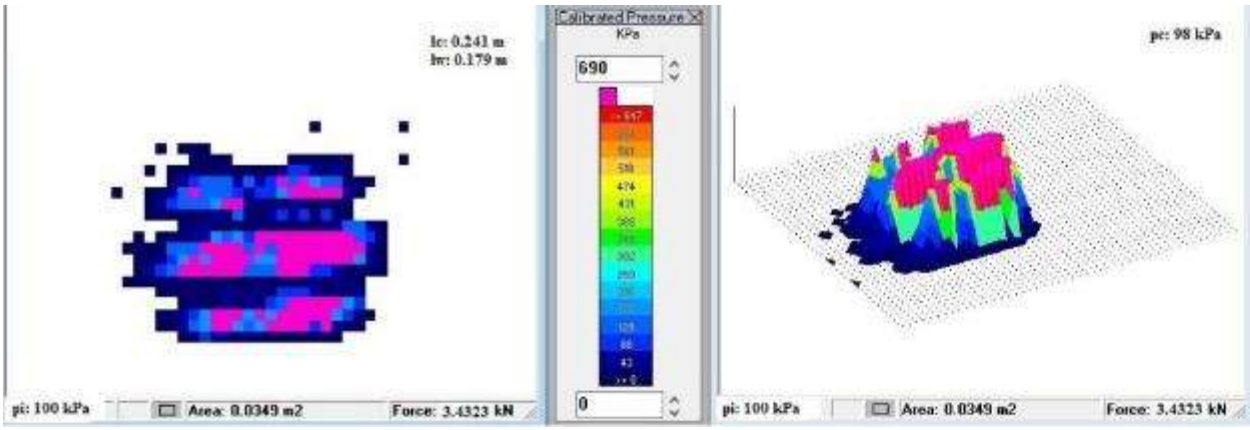


Fig. 8 - Influence of tire inflation pressure on the contact pressure of the U445 tractor

With the I-Scan software were recorded the 2-D and 3-D distribution maps of contact pressures at the tire-soil interface. It should be noted that the value of the contact pressure indicated by the data acquisition software represents an average of the pressure recorded on each sensitive element of the Tekscan Industrial Sensing Pressure Sensor which was in contact with the tire of the Universal 445 tractor during testing.

Thus, for the front wheel of the U445 tractor (wheel load Q = 3.43 kN), were obtained the pressure distributions in the contact area shown in Figure 9.



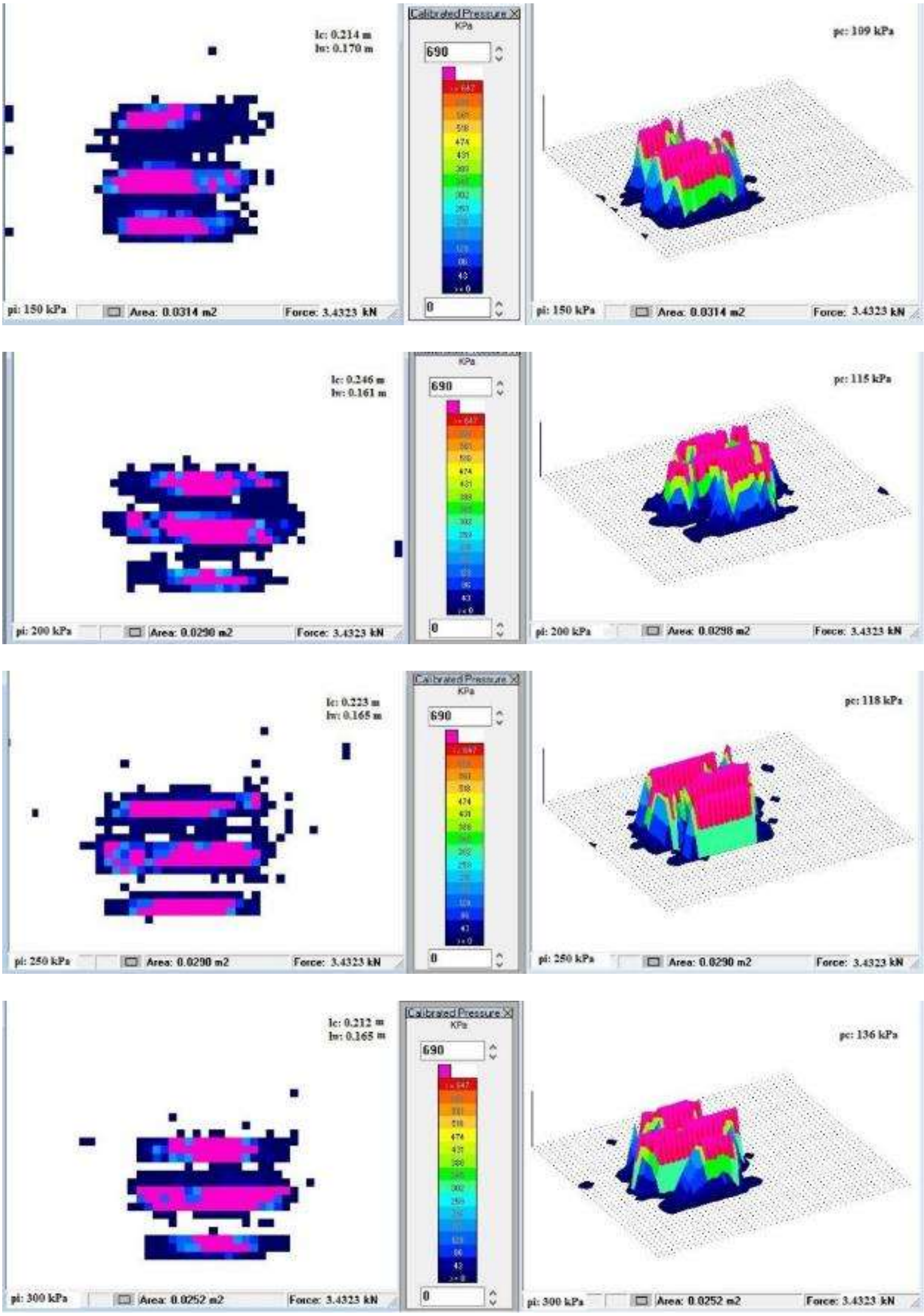


Fig. 9 – Maps of pressure distribution in the contact area, at 3.43 kN wheel load and tire inflation pressures between 100 – 300 kPa

As can be seen from Figure 9, the shape and size of the tire-soil contact have changed in the tested conditions. Under the influence of tire pressure and wheel load, the tire deforms both longitudinally and transversally and the contact area tends to have a rectangular shape with rounded corners (more or less) and less towards an elliptical shape.

CONCLUSIONS

The shape and size of the tire-soil contact contour changed with tire inflation pressure which in turn affects the soil-tire interface pressures across the surface of the tire. The benefits of low inflation pressure of farm tractor tires may include decreased soil-tire interface pressures, increased tire performance, and decreased soil compaction and a smoother ride.

Compaction in the plow layer is largely related to contact pressure of the tire on the soil. Compaction below the plow layer is related to total wheel load. Considering that the agricultural soil is compacted if the contact pressure exceeds 85 kPa, it can be said that in all tested situations, compaction would mainly affect the upper soil layer, but its negative effects can usually be alleviated by moldboard or chisel plowing.

Proper tractor and machine set up and operation can minimize the effect of compaction, but improved management of agricultural works is the best solution for addressing compaction.

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COMPARATIVE STUDY REGARDING ADVANCED WASTEWATER TREATMENT USING ELECTROCHEMICAL OXIDATION AND PHOTOCATALYSIS METHODS
/
STUDIU COMPARATIV PRIVIND EPURAREA AVANSATĂ A APELOR UZATE PRIN ELECTROOXIDARE ŞI FOTOCATALIZĂ

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Keywords: *electrooxidation, photocatalysis, dairy wastewater, COD removal*

ABSTRACT

Wastewater treatment technologies are designed to ensure the removal of pollutants that are partially removed by conventional treatment methods. In the last period, a special attention has been accorded to electrochemical methods due to the advantages presented: safety in operation, possibility of the process automation, environmental protection and modular structure. These methods are based, mainly, on electrochemical generation of some free radical species with high oxidation potential, such as hydroxyl radicals. Hydroxyl radicals (•OH) is a strong oxidant, that can destroy most organic and organometallic contaminants until their complete mineralization into CO_2, water and inorganic ions. In the present paper are presented the most used electrochemical advanced oxidation processes in wastewater treatment, namely electrochemical oxidation and photocatalysis.

REZUMAT

Tehnologiile pentru epurarea avansată a apelor uzate sunt destinate să asigure îndepărtarea poluanţilor parţial eliminaţi prin metodele de epurare convenţionale. În ultima perioadă, o atenţie deosebită a fost acordată metodelor electrochimice datorită avantajelor prezentate: siguranţă în exploatare, posibilitatea automatizării procesului, protecţia mediului înconjurător, structura modulară. Aceste metode se bazează, în principal, pe generarea electrochimică a unor specii de radicali liberi cu un înalt potenţial de oxidare, cum sunt radicalii hidroxil. Radicalul hidroxil (•OH) este un oxidant puternic, care poate să distrugă majoritatea contaminanților organici și organometalici până la mineralizarea lor completă în CO_2, apă și ioni anorganici. În lucrare sunt prezentate cele mai utilizate procese de oxidare avansată electrochimică în epurarea apelor uzate: electrooxidarea și fotocataliza.

INTRODUCTION

Lately, the removal of pollutants from water has become a major issue for the sustainable development of industrial processes, which must comply with regulations to ensure clean environments *(Feng et al, 2016)*. To remove toxic organic pollutants from wastewater, treatment methods based on a powerful oxidant, namely hydroxyl radicals (•OH), are developed during last decades. These methods are commonly called “advanced oxidation processes” and are based, mainly, on electrochemical generation of some free radical species with high oxidation potential, such as hydroxyl radicals. Hydroxyl radicals (•OH) is known as a strong oxidant, that can destroy most organic and organometallic contaminants until their complete mineralization into CO_2, water and inorganic ions (*Oturan M.A., 2014; Sires et al., 2014*).

Advanced oxidation processes are widely used for the removal of pollutants that are partially removed by conventional methods from industrial and municipal wastewater, such as: biodegradable organic compounds, suspended solids, colloidal substances, phosphorus and nitrogen compounds, heavy metals (*Segneanu et al., 2013*).

The electrochemical methods (electrooxidation, electrocoagulation, Fenton processes, electroflotation, photocatalysis) are promising alternatives for organics degradation because of their environmental compatibility, versatility, simplicity and easy possibility of automation (*Segneanu et al., 2013; Radjenovic and Sedlak, 2015*). On the other hand, these methods present some disadvantages which include the high cost of the used electrodes and the electricity supply, low conductivity of many wastewaters requiring the addition of electrolytes, as well as shortening the life of electrodes due to the deposition of organic material on their surface (*Oturan M.A., 2014)*.

Among these techniques, electrochemical oxidation and photocatalytic processes have proved to have high efficiency with advantages such as high energy efficiency, process automation and safety because it operates with limited use of chemicals.

In this paper, we reviewed the electrochemistry approaches for removal of pollutants in wastewaters, such as electrochemical oxidation and photocatalytic processes.

MATERIAL AND METHOD

Agro-industries, especially dairy industry, generate large amounts of wastewater, which are difficult to treat because of their pollution loading. The main organic pollutants contained in this type of wastewaters are carbohydrates, proteins and fats from milk. Lately, electrochemical methods are increasingly being used for the treatment of wastewater containing organic pollutants (*Chakchouk et al., 2017*).

Electrochemical oxidation or electro-oxidation is the most popular electrochemical procedure for removing organic pollutants from wastewaters *(Martinez-Huitle and Brillas, 2009).* The electrochemical oxidation performance is strongly influenced by the type of electrode material used. Many types of anodes are suitable for the generation of hydroxyl radicals (OH) by electrooxidation, such as: dimensionally stable anodes, lead oxide (PbO_2) and boron doped diamond electrodes (BDD). Recently, electrochemical oxidation with a boron-doped diamond electrode is one of the most promising technologies in the treatment of water containing organic pollutants (*Gengec E., 2017*). The electrooxidation process can be carried out in an electrochemical cell, as it can be seen in Figure 1 *(Mouli et al., 2004).*

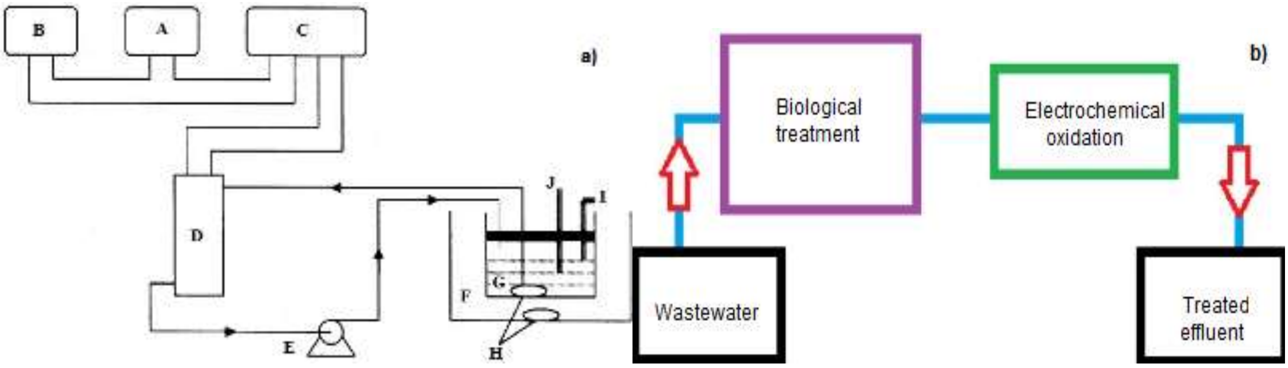


Fig. 1a - Pilot plant scheme with electrooxidation treatment *(Mouli et al, 2004)*; **b – Integrated treatment** *(Garcia-Segura et al, 2018)*

A – power supply; B – digital ammeter; C – power integrator; D – electrocatalysis reactor; E – circulated pump; F – water bath; G – reservoir; H – magnetic stirrer; I – to biological process; J – sampling port

Another advanced oxidation method used in wastewater treatment is photocatalysis. Photocatalysis is a kind of chemical method that can be defined as "catalytic reaction involving the production of a catalyst by absorption of light" (*Lazar et al., 2012*). Also, photocatalysis method has some advantages, such as: simplicity, low cost, nontoxic, high degradation efficiency and excellent stability (*Jiang et al, 2012*). The catalyst is the most important part of the photocatalytic process and is commonly called semiconductor. There are many semiconductors used for photocatalytic properties, namely: TiO_2, ZnO, ZnS, WO_3, CdS, SnO_2, GaP. Titanium dioxide (TiO_2) is the most used photocatalyst for wastewater treatment, due to its chemical properties, is biologically and chemically inert, resistant to chemical corrosion and can be used at room temperature. The principle of photocatalysis is based on the excitation of a semiconductor (usually titanium dioxide TiO_2) by light (UV or visible). Organic pollutants adsorbed on the catalyst are then degraded by successive radical reactions in non-toxic mineral species (*Mokhbi et al., 2014*).

Coupling TiO_2 photocatalysis with other electrochemical techniques proved to be very effective in destroying pollutants in water. In Figure 2 is represented the photocatalysis reactor coupled with the electrochemical oxidation process (*Lazar et al., 2012*).

The advantage of photocatalysis in water treatment is the complete mineralization of organic pollutants due to the photogeneration of hydroxyl radicals originating from water on the surface of TiO_2.

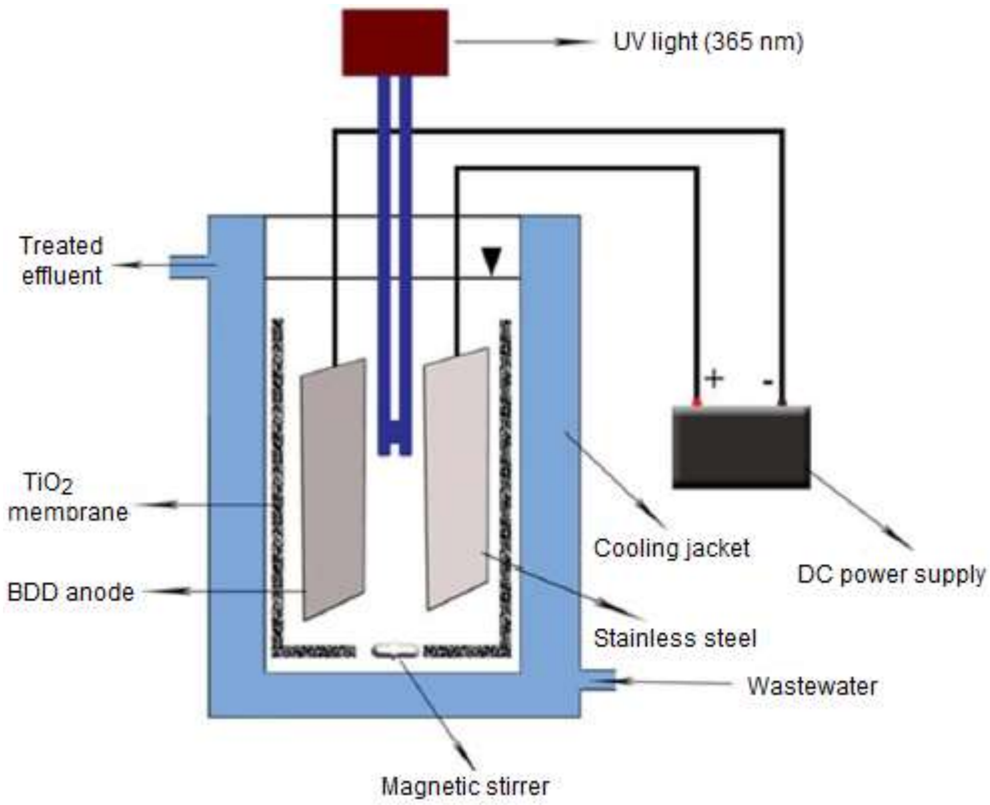
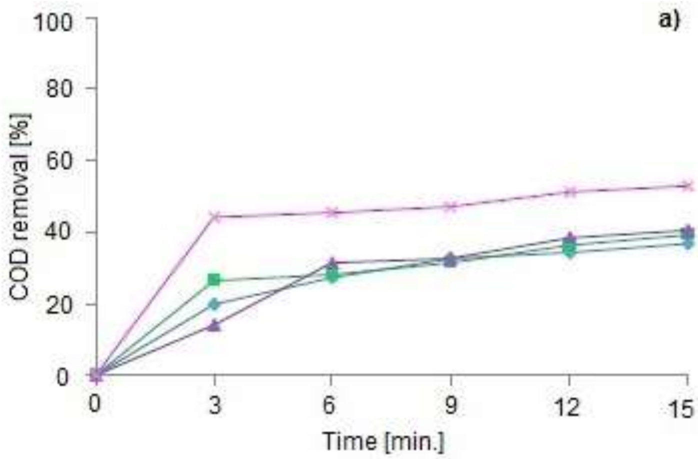


Fig. 2 - Photocatalysis reactor coupled with electrochemical oxidation treatment (*Lazar et al, 2012*)

RESULTS

Chakchouk et al. (*Chakchouk et al., 2017*) compared the effectiveness of electrocoagulation and electrooxidation methods for pollutant removal from dairy effluent. The autors investigated the removal of chemical oxygen demand (COD), color and turbidity at various current intensities by using different electrodes and at various electrolysis times. In order to obtain complete pollutant removal from wastewater, researchers identified the optimal conditions for each method and after that combined them.

The results showed that the time to reduce the COD to about 40% using electrooxidation process (fig. 4) takes about 27 minutes, while using electrocoagulation process (Fig. 3) takes less than 6 minutes. Electrocoagulation process is fast but incomplete in wastewater treatment, so in order to improve the removal of COD, the two processes were combined.



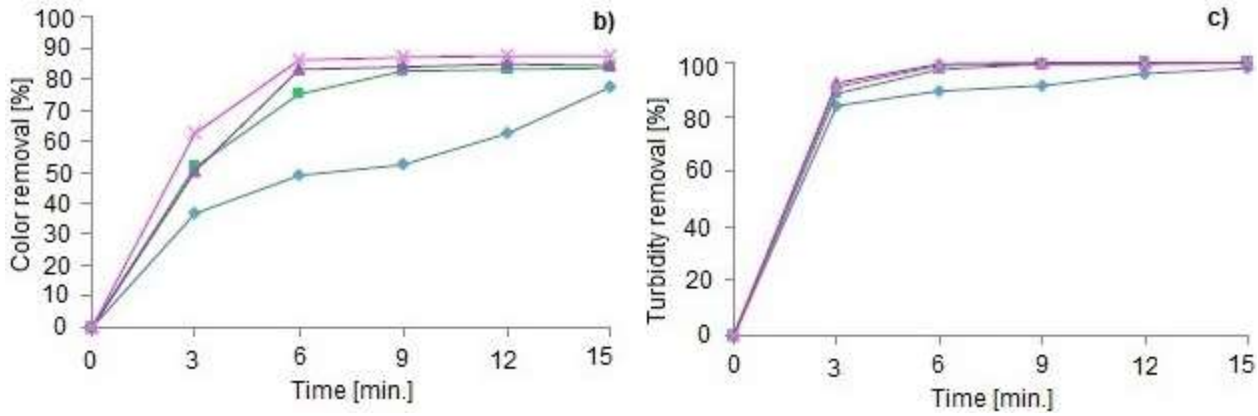


Fig. 3 – The influence of electrocoagulation process on a) COD, b) color and c) turbidity removal as a function of electrolysis time

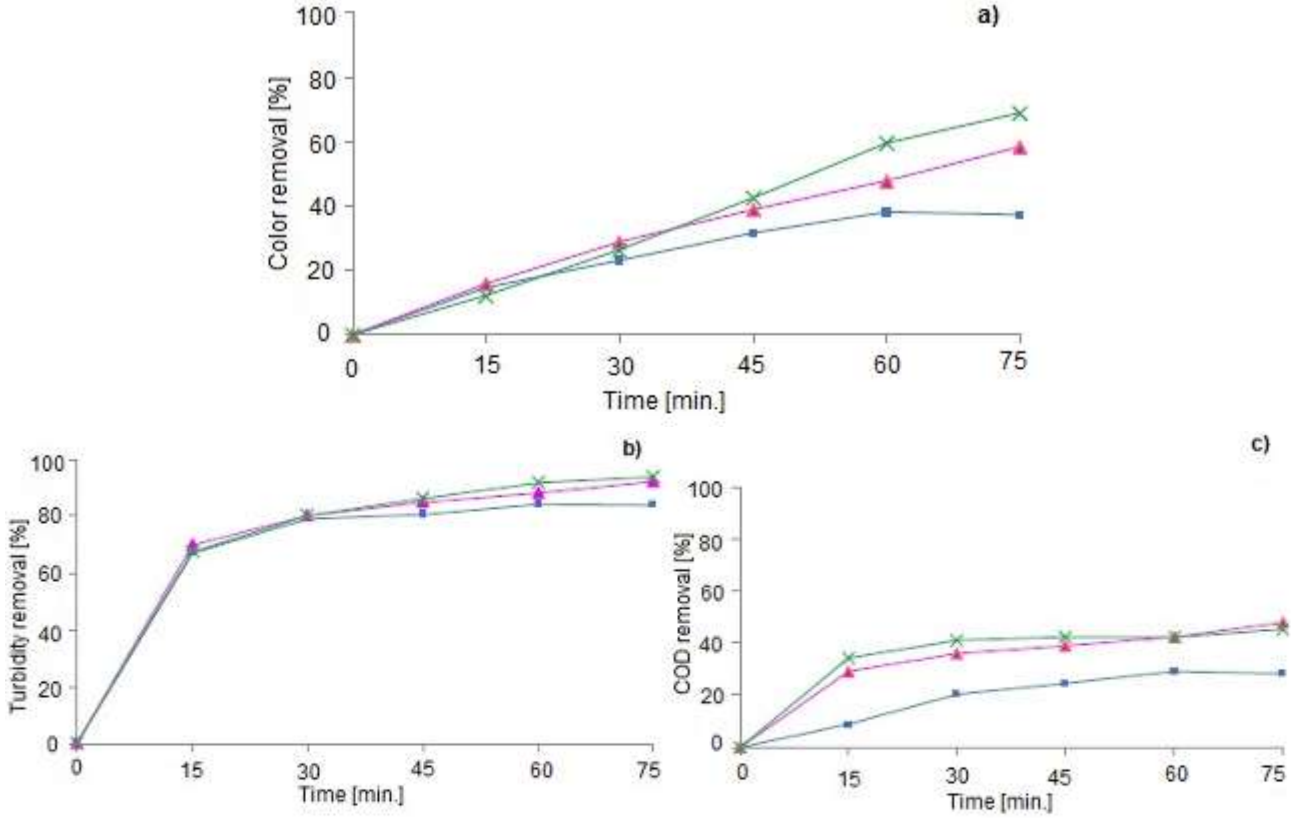


Fig. 4 – The influence of electrooxidation process on a) color, b) turbidity and c) COD removal as a function of electrolysis time

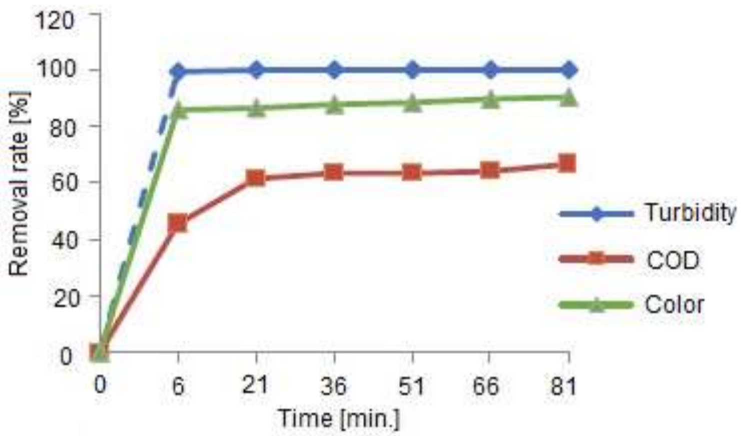


Fig. 5 – Combined treatment: electrocoagulation and electrooxidation processes

The results indicate that the combined treatment was more effective than electrocoagulation or electrooxidation alone (Fig. 5). The coupled processes eliminates 100% turbidity, 90.4% color and 66.4% COD, in 21 minutes for an initial COD concentration of 3850 ppm.

On the other hand, *Murcia et al*. *(Murcia et al., 2018)* evaluate the effectiveness of flocculation-photocatalysis as combined processes in the treatment of dairy industries wastewater. The authors tested the TiO_2 photocatalyst prepared in laboratory, commercial TiO2 P25 Evonik, fluorinated TiO_2 and sulfated TiO_2. The best results were recorded for the TiO_2 P25 Evonik catalyst. In Figure 6 can be seen that after photocatalytic treatment at 30 W/m² light intensity, the COD value significantly decreases.

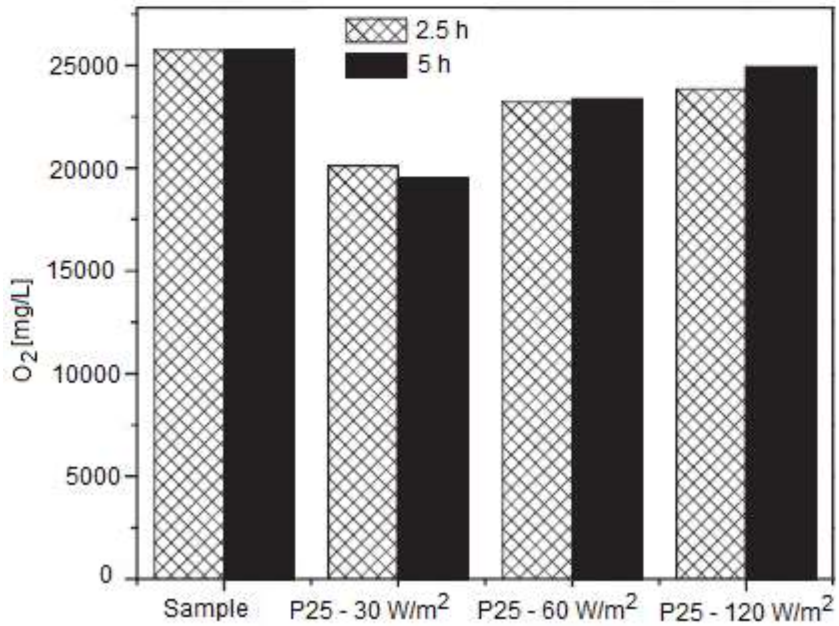


Fig. 6 – COD removal after photocatalytic treatment at different light intensities

Regarding the removal of *E. Coli*, the total elimination was observed after 5 hours of photocatalytic treatment at a light intensity of 60 and 120 W/m² (Fig. 7 a).

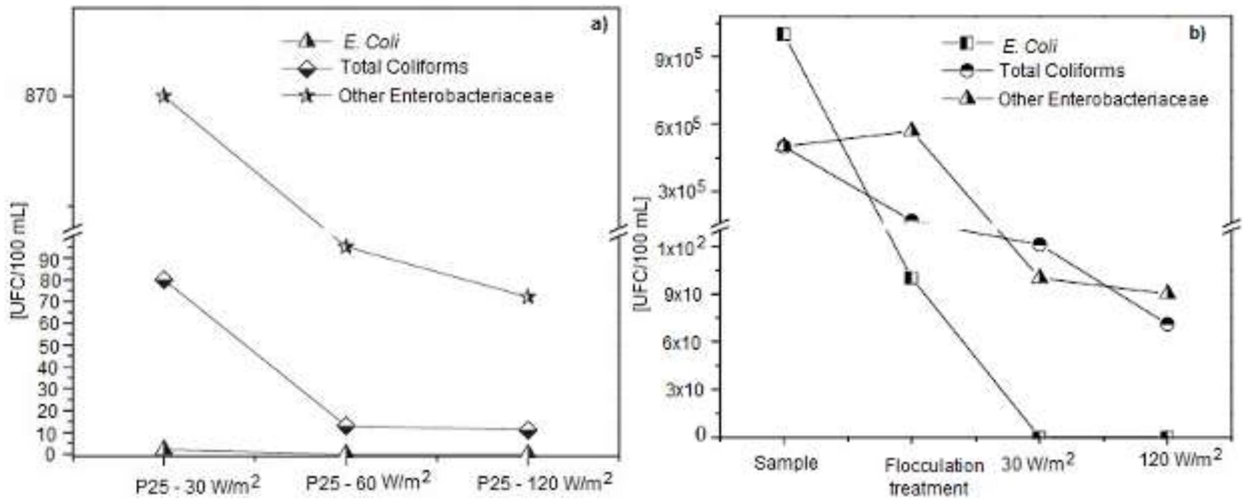


Fig. 7 – Bacteria population after a) photocatalytic treatment at different light intensities and 5 h of reaction and b) flocculation - photocatalytic treatment

Combining the two photocatalysis and flocculation treatments, at a low light intensity of 30 W/m² led to the total elimination of *E. coli* bacteria, and the reduction of total coliforms and other enterobacteria increased by 5.48% compared to individual photocatalytic treatment (Figure 7 b).

CONCLUSIONS

Nowadays, electrochemical technologies are promising alternatives for organic pollutants degradation from wastewater because of their environmental compatibility, versatility, simplicity and easy possibility of automation Experimental results showed that combining wastewater treatments was more effective than individual treatment. Combining electrocoagulation and electrooxidation processes eliminates 100% turbidity and photocatalysis combined with flocculation method led to the total elimination of *E. coli* bacteria from dairy wastewater.

ACKNOWLEDGEMENT

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STUDIES ON THE NEED TO APPLY IRRIGATION TO CROPS GROWN UNDER SANDY SOILS IN SOUTHERN OLTENIA
/
STUDII PRIVIND NECESITATEA APLICĂRII IRIGĂRII LA PLANTELE CULTIVATE ÎN CONDIȚIILE SOLURILOR NISIPOASE DIN SUDUL OLTENIEI

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Keywords: *drought, water stress, water consumption, irrigation methods*

ABSTRACT

In Romania, sand and sandy soils occupy an area of 439000 ha, of which 209400 ha are in Oltenia. Due to the poor pedoclimatic conditions in the low-soil areas, especially the reduced water retention capacity of the soil and the climatic changes of the last two decades, irrigation is a mandatory measure in order to ensure the water consumption of plants. Irrigation on sandy soils, as a technique to cover water scarcity to increase the average yield of crops, has some peculiarities both in terms of watering and irrigation methods.

REZUMAT

În Romania nisipurile și solurile nisipoase ocupă o suprafață de 439.000 ha, din care 209.400 ha se află în Oltenia. Din cauza condiţiilor pedoclimatice deficitare din zonele cu soluri nisioase, în special capacitatea redusă de reţinere a apei de către sol și modificările climatice din ultimele două decenii, irigaţia se impune ca o măsură obligatorie în asigurarea consumului de apă al plantelor. Irigaţia pe solurile nisipoase, ca tehnică destinată acoperirii deficitului de apă, în vederea sporirii randamentului mediu al recoltelor, prezintă unele particularităţi atât pe planul metodelor de udare cât şi pe cel al regimului de irigare.

INTRODUCTION

Existing pedoclimatic conditions and agrofitotechnical measures specific to the agricultural system practiced on sandy soils have led to some peculiarities of crop irrigation techniques. The range of available humidity, rather limited sandy soil, determined the essential characteristic of crop irrigation, namely reduced watering rules, applied at short intervals depending on the species of cultivated plants and the vegetation stage (*Șoimu et al., 2002; Marinică et al., 1999, 2003; Gheorghe et al., 2002; Ploae et al., 2001*). It is well known that Romania has a temperate continental climate, but the changes in the last decade of the year fragment this climate into one with nuances of excess. This is due to the high temperature variations between hot and cold, but also between daytime and nighttime temperatures. In addition to these aspects, there are extremely large variations of both the total amount of precipitation from one year to the next, but also their distribution over the year, which has led to water related deficits associated with high temperatures (*Meluț et al., 2014*). The heat is characterized by high temperatures and relative humidity of low air, below 18-20% conditions that are common in sandy soils (*Ploae et al., 2002; Drăghici et al., 2016*). These conditions cause an exaggerated intensification of plant perspiration, which leads to an imbalance between the power of soil water absorption by plants and the intensity of perspiration. The normal reaction of the plant to the action of atmospheric drought is wilting, a phenomenon that can occur even when sufficient water reserves can still be found in the soil. If the atmospheric drought is short, the plant recovers and can fructify (*Wani et al., 2004; Dincă, 2014*). There is a study conducted under the conditions of the South Pyrenees (*Reynaud, 2009*), which highlights the impact of drought risk on farmers, distinguishing the optimal short term decision (choice of irrigation strategies) and long-term optimal decisions (choice of crop systems). The developed method consisted in using some types of simulations of an agronomic model (STICS) in a model for economical optimization of farmer behavior. The effects of climate uncertainty on irrigation technology adoption alternatives have been the subject of numerous studies in the agricultural economy (Caswell and Zilberman, 1985; Schaible *et al.*; 1991; Koundouri *et al.,* 2006). Zilberman *et al.* (2003) shows, for example, that after five years of drought, between 1987 and 1991, California has been involved in a process of intensifying the use of high-performance irrigation technologies. Thus, drip irrigation increased during this period by 40% for fruit and vegetable crops. An extensive study in Ethiopia shows that climate change will change the hydrology of water resources (currents, rivers, lakes, etc.), thus affecting spatial and temporal availability as well as water resource productivity (*Zegeye, 2018*). Future expansion of food production will increase and will depend on irrigation systems and water management (*Indhumathi et al., 2017*). Addressing the role and place of irrigation in Romania's agriculture is one of the most debated issues. Irrigation is one of the most important technological sequences with a strong impact on the physical characteristics of the soil through the wetting process with positive implications in plant metabolism (*Ploae et al., 2002, Petcu, 2008, Burcea et al., 2009*).

MATERIAL AND METHOD

The research was carried out on sandy soils from Sadova - Corabia hydroelectric settlement, soils characterized by reduced natural fertility and poor physical characteristics (*Canarache et al., 1984; Parichi and Oancea, 1984*) (Table 1).

Table 1

Characterization of sandy soils in the complex hydro-ameliorative arrangement Sadova - Corabia regarding the humus content and granulomentric fractions in the surface layer and their degree of exposure to deflation

The type of soil	Texture	Surface		Humus (%)	Granulometric composition				The degree of exposure to deflation
		ha	%		coarse sand 2.0-0.2 (mm)	fine sand 0.2-0.02 (mm)	Dust 0.20-0.002 (mm)	Clay <0.002 (mm)	
Sands and psamosols	Sand	28.440	61.1	0.2-1,0	70-75	20-25	2.5-3.0	3.0 – 4.0	Very large - big
Cambic chernozems	sand - sandy clay	7.350	15.8	1.0-2.9	65-70	20-25	3.0-3.5	6,.0 – 6.5	moderately lower
Chernozems and cambic chernozems	sandy clay	7.220	15.5	1.3-2.6	30-40	40-90	7.0-8.5	11.0 - 12.0	absent
argillic brown	sandy clay	2.230	4.8	0.2-1.6	55-60	25-30	5.0-6.5	8.0 – 9.0	little
Reddish brown	sandy clay	1.320	2.8	0.4-1.2	40-45	30-35	9.5-10	14.0 – 15.0	absent
TOTAL		46.560	100						

Research has been carried out on the climatic assessment of the sandy soil area and the physiological behavior and the establishment of the irrigation regime in some crop plants adapted to the pedoclimatic conditions.

RESULTS

Climate and soil conditions. From a hydrophysical point of view, the sandy soils in southern Oltenia are characterized by low values of the wilting coefficient (1.2-2.1%), the field capacity (7.5-9.3%) and high values of of apparent density (1.47-1.48 g / cm^3). They have high mobility, high permeability and low water retention capacity (*Dumitru, 2011*). From the climate point of view, the southern extremity of the sandy soils on the left bank of the Jiu River is affected by drought and heat and the frequency of the dry years from the agricultural point of view exceeds 40%. The climatic characterization of the area of sandy soils in southern Oltenia using aridity indexes (*De Martonne, Donciu*) and the hydrothermal index (Seleaninov) highlighted that during the analyzed years (1985-2002), during the vegetation period (April- September), there was a semiarid climate with a type of excessively dry weather humidity and insufficient soil moisture (Table 2).

Table 2

Climatic characterization of the area of sandy soils in southern Oltenia during the vegetation period (1985-2002) (*Ploae P., 2002*)

Month	Climatic indices					
	12 rainfall / (t+10) (De Martonne)		100 rainfall / PE* % (Donciu)		(Σ rainfall / Σ temperature)10 (Seleaninov)	
	value	qualification	value	qualification	value	qualification
April	24.8	moderately dry	79.5	dry	15	sufficient
May	26.1	moderately dry	55.8	very dry	1.1	sufficient
June	22.0	semiarid	42.6	excessively dry	0.9	insufficient
July	20.2	semiarid	31.4	excessively dry	0.8	insufficient
August	11.1	arid	23.2	excessively dry	0.5	insecure agriculture
September	13.1	arid	50.6	very dry	0.7	insecure agriculture
Average (1985-2002)	19.6	semiarid	47.2	excessively dry	0.9	insufficient

***** potential evapotranspisation

From the analysis of the climatic conditions recorded by the RDSPCS Dabuleni weather station, during the vegetation period of most agricultural plants (Mai-Auguat), the temperature increase in the last 10 years, compared to the multiannual average, which corroborates the recorded rainfall, led to an increase in the drought phenomenon (Figure 1). Thus, compared with the multiannual average, the average air temperature increased by 1.01^{0}C, and rainfall increased insignificantly (5.97 mm). The amount of 227.82 mm rainfall recorded during the period 2008-2017 was unevenly distributed in relation to the requirements of the hoeing plants (cowpea, sorghum, maize, peanuts), therefore, the application of modern irrigation is a measure to counteract the negative effect of the drought. The beginning of the drought is considered to be when the difference in monthly values between rainfall and evapotranspiration becomes negative, which leads to a reduction in the water reserve in the soil and can affect quantitatively and qualitatively the harvest (*Petcu, 2008; Narayanan, 2013; Earl and Davis, 2003).*

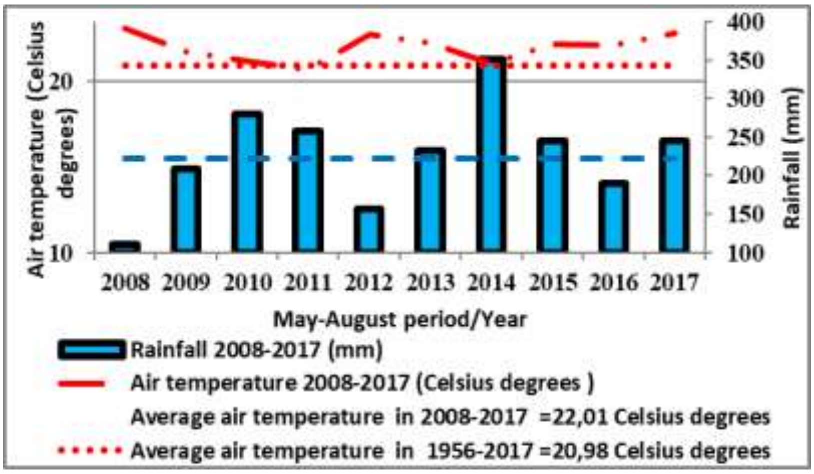

Fig. 1 - Climatic conditions recorded at the meteorological station of RDSPCS Dabuleni during the vegetation period of the plants grown in the area

Plant response to irrigation. Research results obtained under non-irrigation conditions show that yields on most plants grown on sandy soils are incidental, depending on the amount of the rainfall and the distribution over time, and the production increases due to irrigation are substantial (Figure 2). The direct effect of completing the water deficit in soil through irrigation is reflected in the crop yields obtained from irrigated crops compared to non-irrigated crops.

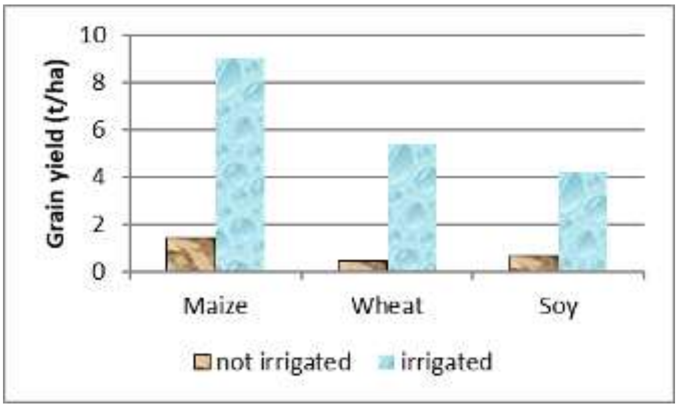

Fig. 2 - Spores of production obtained by irrigation at some plants grown on sand leveled and fited anti-erosion, in the Sadova-Corabia area

In the correct management of the supplementation of plant water requirements, through irrigation, an essential role is the knowledge of the water consumption of plants under the given edafoclimatic conditions. The researches revealed high evapotranspiration values due to high temperatures, dry winds and reduced atmospheric humidity during the active period of the plants (Fig. 3). Potential evapotranspiration represents the amount of water susceptible to evaporation and perspiration under conditions of sufficient water reserves to compensate for the maximum losses. Under such conditions, irrigation appears to be a mandatory measure for all plant species grown on sandy soils. Research conducted at Dabuleni (Table 3) emphasizes that for the water consumption of different agricultural plant species, sandy soils provide between 4 and 9%

of their own reserve (Marinică et al., 2003). The rest of the consumption needs are provided by irrigation of 29 - 60% and of precipitation 34 - 62%. Among the studied species, the following are shown with low water consumption (4160 - 4900 m³ / ha): cowpea, rye, wheat, sorghum. Maize and soybean recorded the highest water consumption (7340 - 7760 m³ water / ha). The behavior of sandy soils in relation to water has led to some peculiarities in the design of irrigation on these lands. Hydrotechnical schemes of facilities should ensure that small watering standards (300-400 m³ / ha) and frequent (5-7 days) are built on decentralized organizational structures (small plots) that are permanently operational in time and space. The contribution of irrigation water to the production of sandy soils is maximal in the dry years, when production increases in irrigated crops grow up to 10 times, compared to non-irrigated crops. Administration of these quantities of water by irrigation involves quite high costs with the application of watering, requiring between 8-12 watering, to soy and 2-3 watering, to cowpea (Table 4).

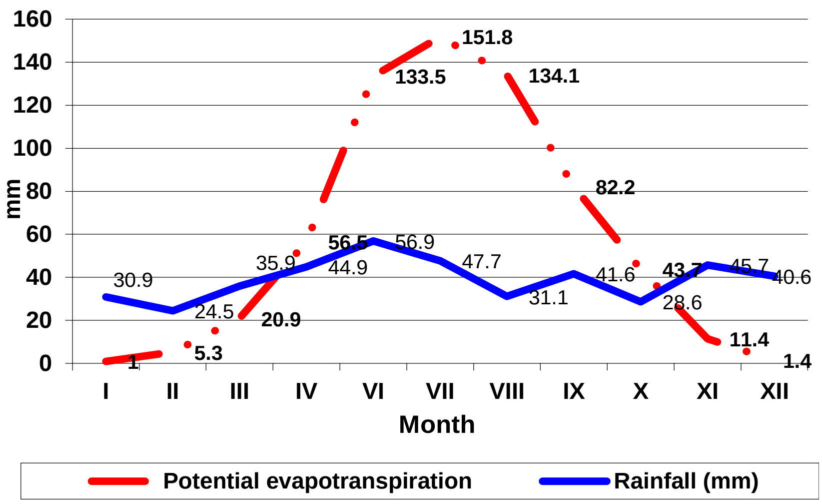

Fig. 3 - Potential evapotranspiration chart and multiannual monthly rainfall in southern Oltenia (1984-2002)

Table 3

Water consumption and sources of coverage to some plant species grown on sandy soils

Plant species	Average yield (kg/ha)	Water consumption (m³/ha)	Sources of water resources					
			soil reserve		rainfall		irrigation	
			%	m³/ha	%	m³/ha	%	m³/ha
Rye	3420	4165	9	385	62	2580	29	1200
Wheat	4070	4680	8	400	55	2580	37	1700
Sorghum	8540	4900	9	440	60	2960	31	1500
Maize	7080	7760	8	624	38	2960	54	4176
Cowpea	2570	4160	4	160	60	2500	36	1500
Soy	3020	7340	6	450	34	2500	60	4480

Table 4

Elements of the irrigation regime for some cultivated plant species on sandy soils

Plant species	Elements of the irrigation regime			
	Minimum recommended ceiling	The watering norm (m³/ha)	Number of waterings	The irrigation norm (m³/ha)
Rye	1/2 *a.h.r/ 50 cm	300-450	2-4	750-1650
Sorghum	1/ a.h.r./ 50 cm	300-450	3-4	1200-1650
Cowpea	1/3 a.h.r./ 50 cm	500-550	2-3	1050-1600
Wheat	1/2 a.h.r./ 50 cm	350-450	3-5	1250-2150
Maize	1/2 a.h.r./ 70 cm	350-450	7-11	3150-4800
Soy	2/3 a.h.r./ 50 cm	300-400	8-12	3200-4700

*a.h.r.= active humidity range

As watering methods used on sandy soils, it is recommended: sprinkler irrigation and localized irrigation (dripping, perforated ramps, subterranean-pointing).

The sprinkler irrigation method is most commonly used on sandy soils in southern Oltenia. The natural soil conditions, microrelief, slope, hydrogeological regime and irrigating crops do not limit the applicability of the method. Frequency and wind speed, and variability in land permeability and water retention of sandy soils is, however, restrictive factors method. Correlation of natural factors with technical elements and qualitative indices of sprinkler irrigation requires knowledge of the behavior of sandy soils in relation to water in order to achieve increased watering efficiency. On sandy soils in the irrigation system perimeter Sadova - Corabia, the adopted rainwater is 14.45 mm / hour. The sprinkler wing used is equipped with SENIOR sprinklers, with two nozzles having a length of 279 m design, and the effective length of wetting equal to 288 m. Organizing the application of watering requires different watering schemes, depending on the size of the watering standard, the crop species and the vegetation phase. Remedial effect of winds blowing at speeds greater than 3 m / s, is provided by the alternating operation of sprinklers, reducing the distance between sprinklers by 50-60% or by prolonging the standing time of the watering wings, accepting the reduction watering efficiency at 60%.

The furrow irrigation method is used on narrow areas in sandy soils (in the households when irrigating leguminous plants) due to their predominantly coarse granulometric composition. On typical sandy soils, it is not possible to count on furrow lengths greater than 50-70 m, if the criteria for uniformity of watering (*Croitoru, 1972 quoted by Ploae, 2002*). When the soil has a higher clay content (7-9%) and a slope ranging from 1-1.5%, the length of the furrow can reach 80-100 m, provided that the maximum non-erosive flow rate does not exceed 1.5 l / s and its value to be reduced by 50-60% after the water front has reached the downstream end of the furrow.

The drip irrigation method has a number of advantages compared to the traditional irrigation methods (sprinkling and furrowing), which result mainly from the high degree of control of water application. To determine the distance between the drippers on the watering pipe, we considered: the diameter of the wetted soil surface, the drip flow, the moisture present in the soil before applying the watering and the percentage of the wetted area of the total area occupied by the crop. The results obtained in sandy soil conditions showed that the higher the soil moisture level, when the dripping application is closer to the field capacity, the wetter diameter and, implicitly, the distance between the drippers are lower (Ploae, 2002). Application of watering when soil moisture was reduced from the 85% of the active humidity range per 1 m to 35% of the active humidity range per 1 m, causing the wetted diameter to be doubled by watering irrespective of the drip flow rate (Fig. 4).

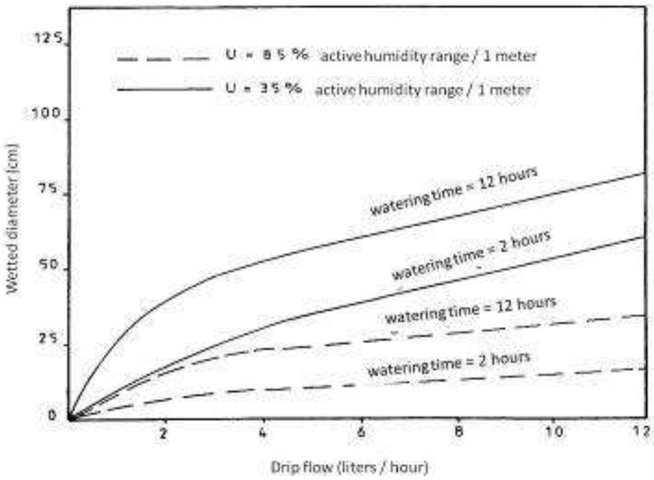

Fig. 4 - The diameter of the wetted surface according to the drip flow rate and soil moisture before watering

Correc adoption of the distance between drippers is another criterion for selecting the values obtained because it requires compliance with the requirement that the percentage of the wetted surface is greater than or equal to 20% of the total surface area planted. The value of 20% is recommended in the literature for areas with the rainfall exceeding 150 mm per year, and irrigation has a complementary role, which is also the case with the area of sandy soils in southern Oltenia. An important conclusion is that the minimum percentage of wetted area (at least 20%) is not achieved on sandy soils, if watering is applied when the moisture content in the soil exceeds 85% from a.h.r. / 1 m, unless the distance between rows is equal to or less than 0.70 m and the distance between drippers exceeds 0.20 m (Table 5).

Table 5

Percentage of wetted surface, depending on: the way the crops are laid in the field, the distance between drippers and the soil moisture before watering

The distance between drippers (m)	Distance between rows (m)					
	0.7	1.8	2.0	2.2	2.5	3.0
*U% = 85% a.h.r. / 1 m						
0.15	17	7	6	5	5	4
0.20	22	9	8	7	6	5
0.25	28	11	10	9	8	7
0.35	39	15	14	13	11	9
U% = 35% a.h.r. / 1 m						
0.45	50	20	18	16	14	12
0.55	62	24	22	20	17	15
0.65	73	29	26	23	21	17
0.70	78	31	28	25	22	20
0.75	84	33	29	27	24	21

*U%= soil moisture

Studies conducted over 40 years on irrigation techniques used in southern Africa have shown that irrigation efficiency should start from the establishment of a water balance in a given area, taking into account plant consumption, the type of soil and the climatic conditions of the area (*Reinders, 2011*). Three groups are described in the study: • Irrigation systems through which water flows under gravity to the soil, while irrigation is applied by flooding the land; • Mobile irrigation systems; • Static irrigation systems, that include all systems that remain stationary, while water is applied, using microspray or drip irrigation. Research in India - Gujarat State, highlighted the importance of drip irrigation systems to overcome various water loss problems (*Parmar et al., 2016*).

In Bangladesh, more than 70% of farmers and water users have appreciated the use of underground irrigation with the buried pipe system (*Rahman et al., 2011*). The results obtained in this regard highlight the efficiency of the irrigation system with PVC buried pipes, which shows a ratio of 90.46-94.46%, between the amount of water discharged at the outlet of the system and the quantity introduced at pumping in a system with a rate of water loss was 5.45-9.55%.

Within a research project coordinated by the Atomic Energy Agency Vienna and in partnership with 8 Southeast European countries, research has been carried out on the influence of fertirrigation on the increase of production and environmental protection under the conditions of sandy soils in Romania. The main objective of the experiment was to increase the quantitative and qualitative level of potato production, in conditions of increasing the efficiency of the use of irrigation water, fertilizers and environmental protection.Technical and exploitation characteristics of fertirrigation offers broad possibilities to achieve the proposed objective due to the flexibility of the fertilizer and water distribution method. Applying water and fertilizer doses only in the active root system area, increases the efficiency of their use, and reduces in-depth fertilizer washing when rainfall is recorded during the growing season. Some of these substances levy on the soil profile, others volatilize due to very high summer temperatures or are lost due to the phenomenon of deflation.

The construction of the Sadova - Corabia irrigation system in Romania has created the possibility of applying irrigation on 79,500 ha, of which about 36000 ha represent sands and sandy soils. The utilization of sandy soils with crop plants is done within an agricultural system specific to these soils, which requires respecting plant cultivation techniques in the context of sustainable agriculture. The creation of this system of agriculture, adapted to the new ecological conditions, consisted of the improvement of the traditional plant species, which, through extensive cultivation in an extensive system, proved their qualities. Also, the variety of plants was diversified, which led to an intensive, efficient and sustainable agricultural exploitation of sandy soils. For this purpose, 243 species with over 2000 varieties and hybrids were studied in RDSPCS Dăbuleni for the determination of plant species, varieties and hybrids that have a good adaptability to the pedoclimatic conditions of the area (*Marinică, 2003; Gheorghe, 2007*).

The thermal potential of the area of sandy soils in southern Oltenia, allows the cultivation of thermophilous species such as peanuts, cowpeas, melons and yellow melons, sorghum, sunflower, but also medicinal and aromatic plants (*Draghici, 2015; Drăghici et al., 2018; Dima et al., 2018*). To demonstrate the biological potential of crops grown on sandy soils, it is necessary to modernize crop irrigation techniques and technologies for rational use of existing water resources (localized watering, performing equipment).

CONCLUSIONS

The climatic characterization of the sandy soils in southern Oltenia highlights the existence of a semiarid climate, excessively dry and insufficient soil moisture during the vegetation period (April to September).

From a hydrophysical point of view, the sandy soils in southern Oltenia are characterized by low values of the wilting coefficient (1.2-2.1%), the field capacity (7.5-9.3%) and high values of apparent density (1.47-1.48 g / cm^3), high permeability and low water retention capacity.

In the area of sandy soils, high evapotranspiration values due to high temperatures, dry winds and reduced atmospheric humidity during the active period of plants.

Under non-irrigation conditions, most crops grown on sandy soils, production is incidental, depending on the amount of rainfall recorded and their distribution over time.

The direct effect of completing the water deficit in soil through irrigation is reflected in the crop yields obtained in irrigated crops compared to non-irrigated, which are 10 times higher.

It is necessary to modernize crop irrigation techniques and technologies, with a view to rational use of existing water resources (localized watering, performing equipment).

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CONTRIBUTIONS TO THE ANALYSIS OF THE VIBRATORY WORKING TOOLS BY FEM
/
CONTRIBUȚII LA ANALIZA SUPORȚILOR ORGANELOR DE LUCRU VIBRATOARE PRIN MEF

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Keywords: *cultivator, vibrations, draft force, finite element method*

ABSTRACT
Vibratory working tools are designed to maximize the results of the soil processing process. The paper presents the results of some theoretical researches on the use of the effect of vibrations for increasing the performance of working organs of agricultural cultivators. During the simulations, in which the calculation of the working parameters was made at different speeds of the cultivator, it was found that the maximum tensions, were recorded as expected in the upper part of the spring. The maximum displacements were observed near the area where the force is applied, with values within normal limits.

REZUMAT
Organele de lucru vibratoare sunt proiectate pentru a maximiza rezultatele procesului de prelucrare al solului. În lucrare sunt prezentate rezultatele unor cercetări teoretice privind utilizarea efectului vibrațiilor pentru creșterea performanțelor organelor de lucru ale cultivatoarelor agricole. În timpul simulărilor, în care calculul parametrilor de lucru s-a făcut la diferite viteze ale cultivatorului, a rezultat că tensiunile maxime s-au înregistrat după cum era de așteptat în partea superioară a arcului. Deplasările maxime s-au observat în dreptul zonei unde acționează forța, având valori în limite normale.

INTRODUCTION
The influence of vibrations is equivalent to the action of an additional T force applied to the working organ, which influences the traction and friction forces between the working organ and the ground (*Cabrera et al., 2011*).

Soil physical quality is the ability of a given soil to meet plant and ecosystem requirements for water, aeration and strength over time, and to resist and recover from processes that might diminish that ability. The soil physical quality is strongly affected by soil management including crops, fertilization, tillage, agricultural machinery traffic and drainage (*Naderi-Boldajia and Keller, 2016*).

The use of working tools with constructive-functional characteristics correlated with the parameters of the periodic process reflected by the effect of the performed operation or work process can also lead to the improvement of the quality of the working process by emphasizing the parameters characteristic of the performed work.

Fig. 1 - Working body of the cultivator

In agricultural cultivators, the support of the working body has a very important role because, besides providing a secure fixation on the machine frame, the support must ensure the protection of the working body when there is impact with an obstacle (stone), for which are used various technical solutions (Figure 1), (*TerraMix Cultivators, 2014*).

Currently, it is possible to shorten spectacularly the cycle of design concept - test - production of this type of equipment by using the Finite Element Method to analyze the distribution of stress and strains of their resistance elements (frames, tool holders, working bodies, etc.) (-).

MATERIAL AND METHOD

Vibratory working tools may reduce draught force compared with rigid tines. The reason for this reduction in draught for a flexible tine is due to lowering speed before maximum force is exerted and the soil fails (*Bernsten et al, 2006*).

According to [Popescu V, 2007] it is shown that the specific resistance to tilling is 35-45 kgf / cm^2 (3432327.5 - 4412992.5 N / m^2) on a light soil and reaches 61-75 kgf / cm^2 (5982056.5 - 7354987.5 N / on the heavy soil).

The problem of accurate estimation of specific resistance to tilling is a very important problem for users and producers of agricultural machinery for soil works (*Letoşnev, 1959*).

For the theoretical calculus of the specific resistance of the soil to deformation the following parameters were used:

- working speed, v = 5 km / h (1,389 m / s)
- mass of cultivator, m = 2100 kg
- the active surface on which the traction force acts, S = 0.0125 m^2
- soil density, ρ = 1100 kg / m^3
- number of vibratory working tools, n = 65

In Table 1 there are other parameters that were required for the calculation of soil deformation resistance.

Table 1

List of work parameters with NZ Aggressive

Nr.	Name	Notation	Unit of measure	Value chosen
1	Soil specific deformation resistance	k	N/m^2	6*10^4
2	Constant resistance given by the speed of movement of the tool in the soil	ε	Kg/m^3	1.393
3	Working depth	a	m	0.1
4	Working width	b	m	4.95
5	Speed of work	v	m/s	1.38-2.77

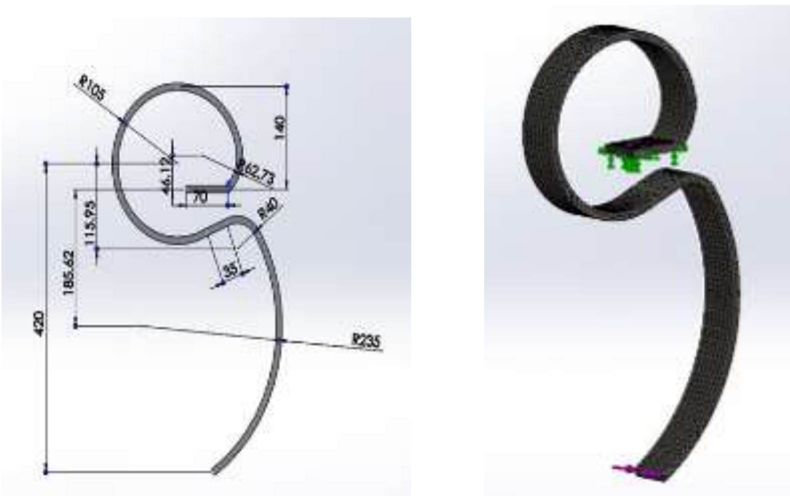

Fig. 2 - Geometric model of the support used in the analysis

RESULTS

The results of analysis of the models of support for the analyzed working bodies of the cultivator are presented in the Figures below. They consist of the distribution of equivalent stress according to the Von-Mises criterion, and the distribution of total deformations for one type of supports, at different values of draft force F.

The simulations were made with forces between 236-400 N. The discretization was done in 26097 elements with the dimensions l = 5.36 mm, with a total number of knots of 44425.

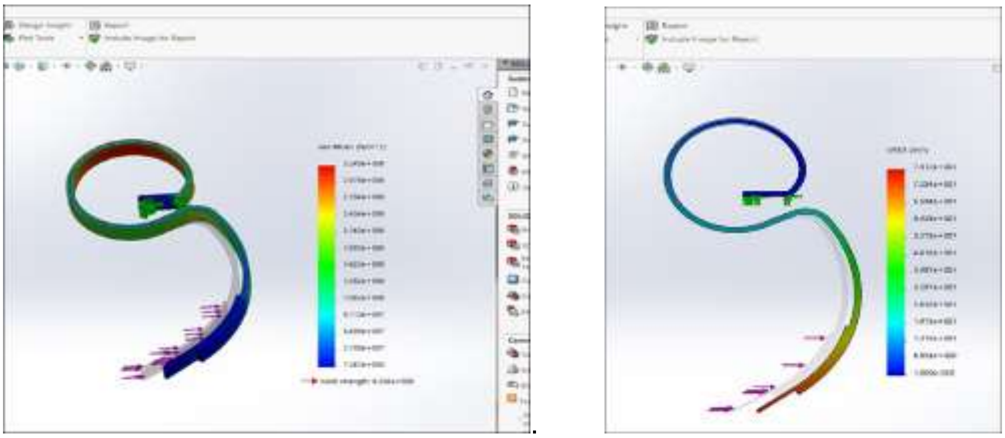

Fig. 3 - Distribution of stress and deformations for v=5 km/h

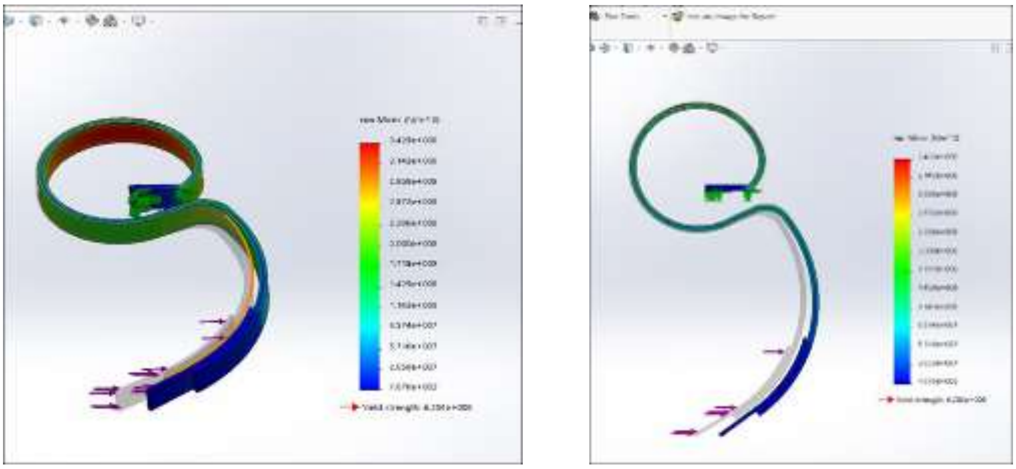

Fig. 4 - Distribution of stress and deformations for v=7 km/h

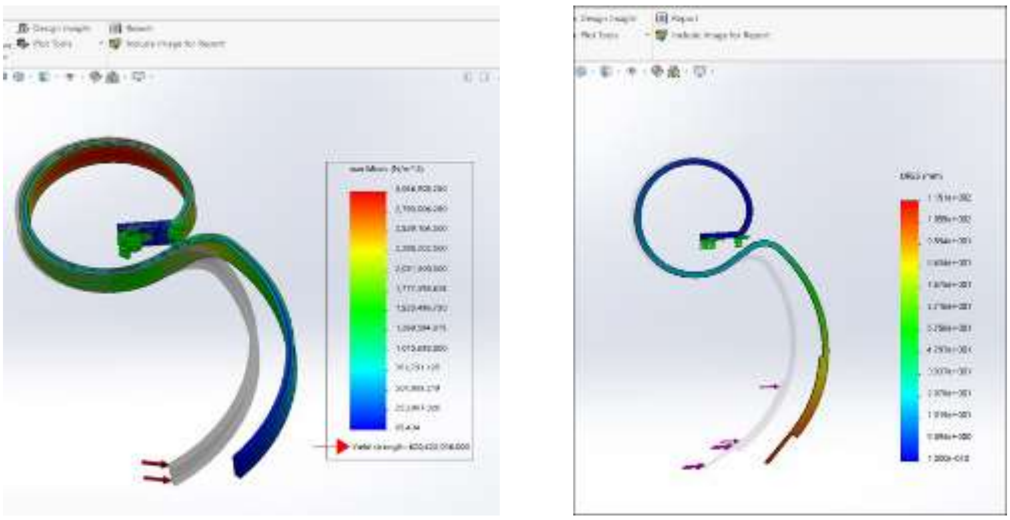

Fig. 5 - Distribution of stress and deformations for v=10 km/h

CONCLUSIONS

From the theoretical research it results that the obtaining of positive effects in the application of the vibrations is conditioned by the knowledge of the physico-mechanical properties of the processed material and their variation depending on various factors, the detailed knowledge of the working process and the negative phenomena that accompany it and their correct correlation with the applied vibration regime. The lack of these correlations can lead to effects opposite those that are being pursued.

An additional advantage comes from the fact that vibrations result in less wear in points, thus reducing operating costs and time spent on replacing or repairing components.

The use of mathematical modeling is very important, especially in the elaboration of a complex mathematical model that includes both constructive and functional parameters and the nature of the processed soil in order to achieve a better analysis of the working process.

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STARTING TRACTION EFFORT EVALUATION FOR A SIMPLE TILLAGE TOOL / *EVALUAREA FORŢEI LA PORNIRE PENTRU O SCULĂ SIMPLĂ DE LUCRAT SOLUL*

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Keywords: *starting force, tillage tool, draft force, soil-bin*

ABSTRACT

The paper presents an experimental study on the evaluation of the maximum draft force in the transient operation from standstill to constant working speed of a tillage tool with simple geometry. Experiment was performed in laboratory conditions in a soil-bin with washed and sorted quartz sand (0.3 mm grain diameter) a test environment without structure and cohesion. The measurements were made at a depth of 0.15, 0.20 and 0.25 meters at three rake angles of 25, 35 and 50 degrees and a constant velocity of 0.67 m/s. Results show that the starting force is 26-58% higher compared to the average drag force.

REZUMAT

Lucrarea prezintă un studiu experimental asupra evaluării forţei maxime de tracţiune în regimul de funcţionare tranzitoriu de la repaus la atingerea vitezei constante de lucru a unei scule de lucrat solul cu geometrie simplă. Încercările experimentale au fost realizate în condiţii de laborator pe un stand de încercare a sculelor de lucrat solul în nisip cu granulaţia de 0.3 mm, mediu de încercare fără structură şi coeziune. Măsurătorile au fost realizate la adâncimea de 0.15, 0.20 şi 0.25 metri, la trei unghiuri de aşezare 25, 35 şi 50 de grade la o viteză constantă de 0.67 m/s. În urma încercărilor experimentale realizate s-a determinat că forţa la pornire este mai mare cu 26-58% mare comparativ cu forţa medie de rezistenţă la înaintare.

INTRODUCTION

During the design process of tillage implements, accurate prediction of forces acting on tools is an important phase (*Manuwa, 2009; Moeenifar et al., 2014; Ani Ozoenema et al., 2018*). For that, several approaches are used, for example tillage tools are calculated for assigned tool design parameters and operational conditions considering soil engineering properties as constants (*Godwin, 2007; Godwin and O'Dogherty, 2007; Gheres, 2014; Ibrahmi et al., 2015*). A different approach is based on numerical methods as i.e. Finite Element Method or Discrete Element Method. Beside classical design approach, another one takes into consideration the integration of reliability analysis into the design and optimization process of tillage tools implements. As presented by (*Abo Al-Kheer et a.l, 2011, Kharmanda et al., 2014*) randomness of tillage forces is accounted for, respectively a reliability-based design approach based on uncertainty analysis of basic random variables and the failure probability of tillage machines. Taking into consideration the elements of systemic analysis method presented in (*Fechete et al., 2017*), the present paper proposes to determine for a tillage tool implement, with a simple geometry, the variability of the draft force, respectively the traction effort during the starting phase. The starting phase, as a transient working regime, will be considered from standstill until constant imposed velocity is reached.

MATERIAL AND METHOD

A simple tillage tool model (a tine) was used in this experimental study. The tool is made from polypropylene PP-C, a material used for its favorable mechanical properties and easy machining. Between the mechanical properties of this material can be enumerated: tensile strength 32 MPa, flexural strength 41 MPa, and density 900 kg/m^3. The model used was beveled on the cutting edge at an angle of 45 degrees and has dimensions of 100x100x10 mm.

Experiments were conducted in controlled conditions in a soil-bin at Automotive and Transportation Department, Technical University of Cluj-Napoca, Romania.

Testing equipment consist in an indoor soil-bin in which the tools can be moved on a circular trajectory with a diameter between 1700-2000 mm at a 900 mm maximum depth. Tool speed is assured by an electric motor (3.2 kW, 720 rpm) and a dual transmission system consisting in a gear reducer and belt driven transmission and a variable speed controller (Unidrive M200, 15 kW). The equipment is completed with a DAQ system (HBM Spider 8) and different force transducers for measuring draft force. An overview of the soil-bin is presented in Figure 1. The tool mounting frame fig. 2, allow the possibility of measuring draft force and offers several possibilities for adjusting angular and vertical position of the tool.

Fig. 1 - Soil bin assembly

Fig. 2 - Tool frame assembly

To reduce the influence of different physical parameters of agricultural soil, washed and sorted quartz sand was used. Sand particles diameter is between 0-0.3 mm which correspond to fine and medium sand according to ISO 14688. This way, the selected soil corresponds to a friction medium without cohesion and without structure. Soil penetration resistance (cone index) was measured and the results are presented in Table 1.

Table 1

Soil penetration resistance of the selected soil

Depth [mm]	**50**	**100**	**150**	**200**	**250**
Average resistance [N]	102.4	191.0	258.0	322.2	333.0
Dispersion	8.2%	19.4%	15.1%	17.9%	12.9%
Cone parameters	Cone no. 4; cone base diameter – 25.33 mm; base cone area – 500 mm^2				
Soil resistance [N/cm^2]	20.48	38.20	51.60	64.44	66.60

Variation of draft force of the tool from standstill to imposed speed inside the soil bin was measured and recorded with the DAQ system at a rate of 50 measurements/sec. Experimental trials were carried out nine times at three depths (0.15, 0.20 and 0.25 m) and at three different rake angles (25, 35 and 50 deg.) resulting 9x9 measurement data sets. An example of measurement data set for the draft force variation during starting phase is presented in Figure 3.

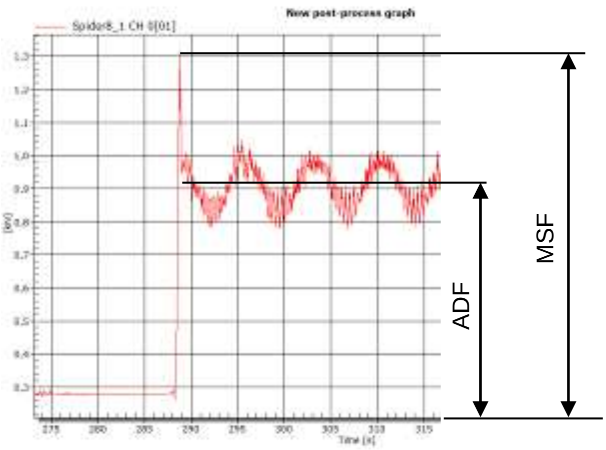

Fig. 3 – Catman Easy print screen of recoded data during the starting phase.

ADF – Average Draft Force, MSF – Maximum Starting Force.

RESULTS

The results obtained consists in mean values of draft force ($ADF_{avg.}$) during constant working speed, the maximum ($MSF_{max.}$) and mean ($MSF_{avg.}$) values of starting force. All the other data are calculated according to the formulas presented in Table 2. The relative difference (6) is calculated to show the magnitude of *maximum maximorum* starting force relative to average draft force. Also, the average relative difference (9) is calculated to show the magnitude of the mean starting force of all nine replications relative to average draft force.

Table 2

Statistical data of the experimental measurements

Rake angle [deg.]	Tool depth [m]	$ADF_{avg.}$ [N]	$MSF_{max.}$ [N]	Diff. [N]	Rel. diff. [%]	$MSF_{avg.}$ [N]	$Diff._{avg.}$ [N]	Rel. $diff._{avg.}$ [%]
(1)	*(2)*	*(3)*	*(4)*	*(5)=(4)-(3)*	*(6)=(5)/(3)*100*	*(7)*	*(8)=(7)-(3)*	*(9)=(8)/(3)*100*
25	**0,15**	96,09	153,00	56,91	59,23	128,96	32,87	34,20
	0,2	202,81	255,60	52,79	26,03	239,49	36,68	18,08
	0,25	329,14	470,20	141,06	42,86	426,42	97,28	29,55
35	**0,15**	167,70	241,90	74,20	44,25	219,87	52,17	31,11
	0,2	314,22	415,60	101,38	32,26	394,17	79,94	25,44
	0,25	490,66	714,10	223,44	45,54	647,29	156,63	31,92
50	**0,15**	288,97	433,80	144,83	50,12	387,83	98,87	34,21
	0,2	526,70	828,40	301,70	57,28	732,42	205,72	39,06
	0,25	791,34	1001,60*	210,26*	26,57*	982,10*	190,76*	24,11*

* The values are corrupted due to limited working range of force transducer.

The results show an increase of the maximum starting force between 26 – 59% relative to average draft force. For a different perspective the average of maximum starting forces shows an increase between 18-39% related to average draft force. This increase of the draft force can be attributed to the soil acceleration components. Considering mechanical - electrical analogies, the average draft force can be associated with nominal current and starting force with inrush current.

As it can be seen in Figure 4, an increase of working depth or rake angle will lead to a proportional increase of the starting force.

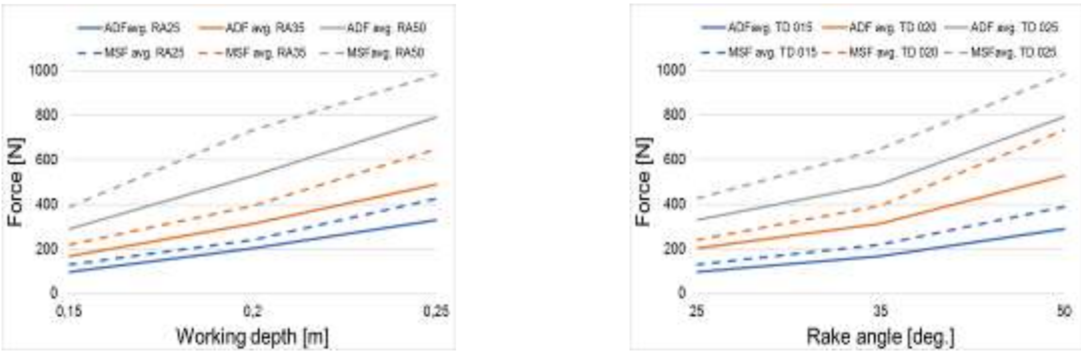

Fig. 4 – Variation of draft force and starting force with working depth and rake angle of the tool.

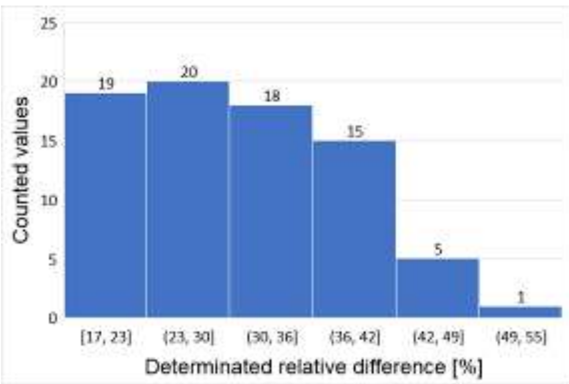

Fig. 5 - Distribution histogram of differences between MSF and ADF.

When designing tillage implements to ensure its necessary resistance a safety factor (1.3 - 4.0) is usually used due to uncertainties that may occur in the strength of a part and the uncertainties that may occur related to loads acting on the tool (Ogbeche and Idowu, 2016). Related to relative difference (6) calculated in Table 2 the results suggest that the safety factor should be at least 1.6 for the considered experiment. When related to average relative difference (9), calculated in table 2 and considering distribution histogram of differences (Figure 5) the safety factor may take lower values.

Due to uncertainties that may occur in real field conditions, a minimum safety factor used should be at least 1.6 for sandy soils. For harder soils the safety factor should be higher and to establish that, more experimental studies need to be carried out.

CONCLUSIONS

The traction effort, on simple tillage tool, during the starting phase was evaluated in an indoor controlled conditions soil-bin experiment. During the transient phase until constant working speed an increase of the draft force with 26-59% was recorded. Based on the results obtained a safety factor of minimum 1.6 should be used for tillage tool design. The information obtained in this experiment can improve the optimization process related to tillage tool design based on systemic analysis procedures.

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CHARACTERIZATION OF CIDERS BASED ON TOTAL POLYPHENOLS CONTENT, ANTIOXIDANTS CAPACITY AND TOTAL ACIDITY
/
CARACTERIZAREA CIDRURILOR PE BAZA CAPACITĂȚII ANTIOXIDANTE TOTALE, A CONȚINUTULUI TOTAL DE POLIFENOLI SI A ACIDITATII TOTALE

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Keywords: *Romanian cultivated apples, commercial ciders, fingerprint*

ABSTRACT

Cider defined as an alcoholic beverage made from fermented juice of apples or concentrated apple juice is a popular drink worldwide. In Romania, until recently, cider was a long time forgotten product, in spite of regularly produced in ancient times, as described by historicist and archaeologists. The aim of the present study was to evaluate the total antioxidant capacity (AC), total polyphenols content (TPC) and total acidity(TA) of ciders and to compare the available commercial ciders with those obtained from different apple varieties cultivated in Romania. The ciders produced using Romanian cultivated apples present higher content of TPC and AC, that recommend them for consumption.

REZUMAT

Cidrul definit ca o băutură alcoolică obținută din sucuri fermentate de mere sau suc concentrat de mere este o băutură populară în întreaga lume. În România, până în prezent, cidrul a fost un produs uitat, în ciuda faptului că a fost produs în mod regulat în vremuri străvechi, după cum au descris istoricii și arheologii. Scopul studiului a fost de a evalua capacitatea antioxidantă totală (CA), conținutul total de polifenoli (CTP) și aciditatea totală (AT) a cidrului și de a compara cidurile comerciale disponibile cu cele obținute din diferite soiuri de mere cultivate în România. Cidrurile produse cu mere cultivate în România prezintă un conținut mai ridicat de CTP și CA care le recomandă pentru consum.

INTRODUCTION

Together with a very good taste, refreshing and energizing properties the apples contain mainly phenolic acid derivatives and other flavonoids proving to be a very important source of polyphenols. Ciders can be obtained by fermenting the fresh juice of apples or from concentrated apple juice. Cider is considered one of the oldest alcoholic beverage made from apple juice (*Kowalczyk A., 2015)*. Amongst the drinks of Ancient Romania, after water and wine, the „sichera" (cider), mead and beer were trying to take an important place in the food of the people. England, France, Spain have a huge experience in producing ciders, but for Romania, until recently, the production of apple cider was almost forgotten in the last centuries *(https://mihaiandreialdea.org).* The first record regarding cider making seems to be made by Strabo, a Greek geographer which describes „sidra" in 60 B.C, while British and Celtic people were producing cider in 55 B.C. (*Jarvis, 2014*).

On the Romanian market the assortments of cider is still quite small, but increasing, according to recent statistics (*Cider/Perry in Romania*). All kind of apple varieties are used as raw material for cider production. The commercial unpasteurized cider composition is strongly correlated with the apple varieties used and the manufacturing process. These led to examined characteristics variation like pH, total acidity (TA) and °Brix (*Jarvis, 2014*).

In todays world many of the millenium disorders, in special neurovegetative diseases like Parkinson [13] and Alzheimer and/or cancer, are connected with oxidative stress and therefore exists an increasing interest for gaining information regarding the antioxidant activity of different natural compounds in beverages (*Fernández-Mar et al, 2012; Kowalczyk A., 2015*).

The aim of the present study was to evaluate the total antioxidant capacity (AC), total polyphenols content (TPC) and total acidity (TA) of ciders and to compare the available commercial ciders with those obtained from different apple varieties cultivated in Romania.

MATERIAL AND METHOD

For the development of the present study, were analyzed eighteen ciders samples (eight ciders assortments available on the Romanian market and ten cider samples produced at the research pilot station at Banat's University of Agricultural Sciences and Veterinary Medicine ”King Mihai I of Romania” from Timisoara).

Reagents and solutions

All reagents were of analytical-reagent grade and all solutions were prepared using deionized water.

Samples collection and preparation

Ten cider samples processed at the research pilot station using different apple varieties cultivated in Romania and ten different cider brands purchased from Romanian supermarket were analysed.

Cider processing

The cider production process comprises of several steps. The selected apples were washed, disinfected, again washed and then rinsed. Clean apples were chopped, squeezed and the resulted juice was filtered for removing the rough impurities. The brut apple juice was clarified with the RohaPect (PTE 100) enzyme and CaCl2 solution and the obtained cleared juice was set for the fermentation faze. The fermentation was conducted in the presence of dry yeast brand Mangrove Jack's - especially created for cider production. The yeast culture can be activated in the apple juice, when the culture is ready after 24 h and 2–5% of the active culture is added to the must. Compressed yeast can be added directly to the must as described by *Lee (2015).* The fermentation was conducted at a constant temperature (18°C) because a temperature higher than 25°C causes the loss of volatile compounds (*Lee, 2015*).

At six degree BRIX (6 gram sucrose/100 grams of aquatic solution), the cider was placed at 4-5°C, the fermentation process was stopped and the residual insoluble impurities were separated by several decantation operations. The clear raw cider was bottled, labeled and then matured in a dark room at 10-12°C for two months as described by (*Bogdanescu et al., 2017*).

CUPRAC method

The analysis of total antioxidant capacity of ciders is based on cupric reducing antioxidant capacity (CUPRAC method), as described by (*Apak et al, 2008*), and of apple fruits as presented by (*Pirvulescu, 2015*).

Folin- Ciocalteu method

Total poly-phenols content determination (TPC) were analyzed using Folin–Ciocalteu reagent, measuring the absorbance of prepared samples at 750 nm and compared to Gallic acid calibration curve. TPC was expressed as mg Gallic acid equivalents per gram of dried weight (mg GAE g^{-1}) (*Singleton et. al., 1999*).

Total phenolic content was expressed as g Gallic acid equivalents/L. The extracts were oxidized with Folin-Ciocalteu reagent, and the reaction mass was neutralized with sodium carbonate. The absorbance of the resulting blue colour was developed in 120 min in a dark place, and the absorbance was determined (*Budak et al, 2015*).

Total acidity method

Titratable acidity (TA) was determined according to method described by Garner et al, using CDR CiderLab Touch [7]. The TA was reported as g/L malic acid based on equation 1.

$$malic\,acid\,[\%] = \frac{(Volume\,of\,0.1\,M\,NaOH)\cdot 10\cdot 0.067}{Volume\,of\,sample} \tag{1}$$

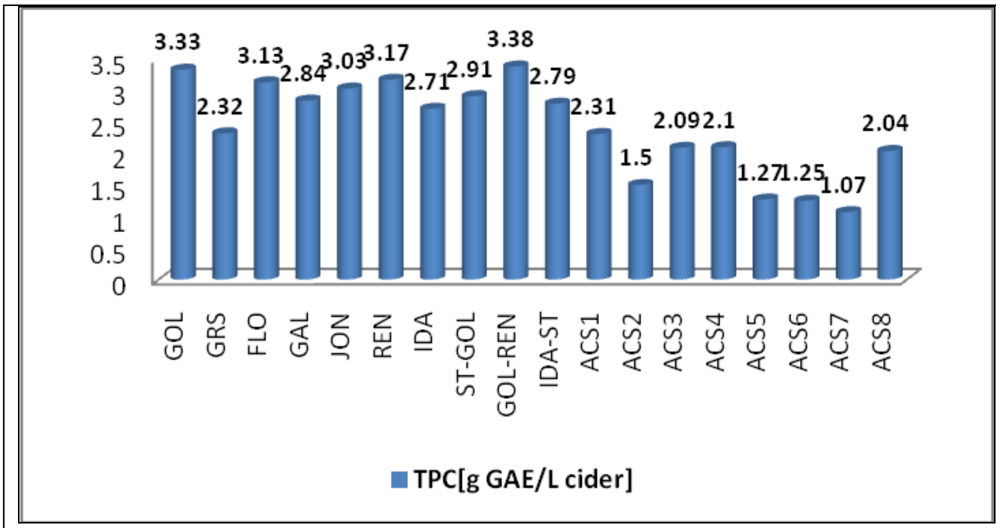
where 0.067 = Equivalent weight of malic acid (*Garner et. al.).*

Statistical analysis and fingerprint

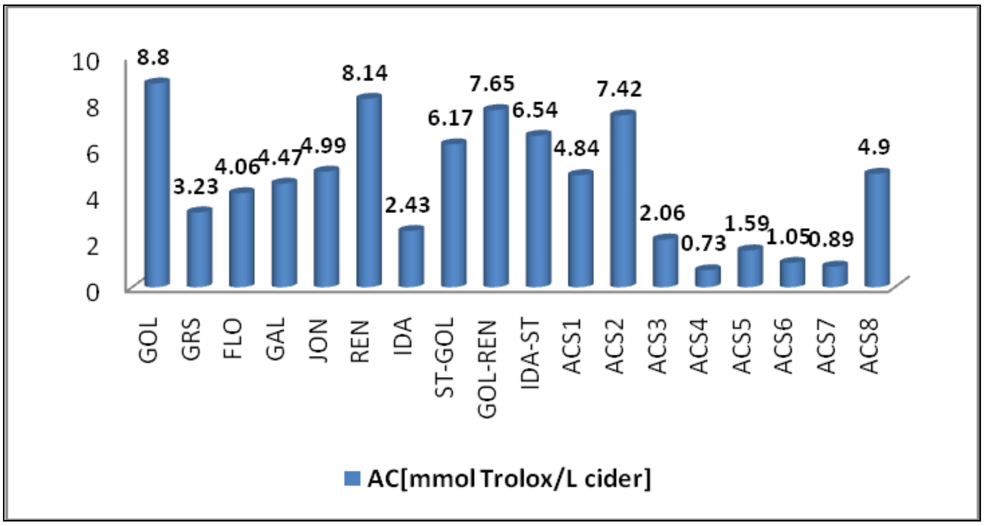
Statistical analysis and fingerprint was performed using the statistical software program PAST version 2.17 and MVSP, version 3.22.

RESULTS

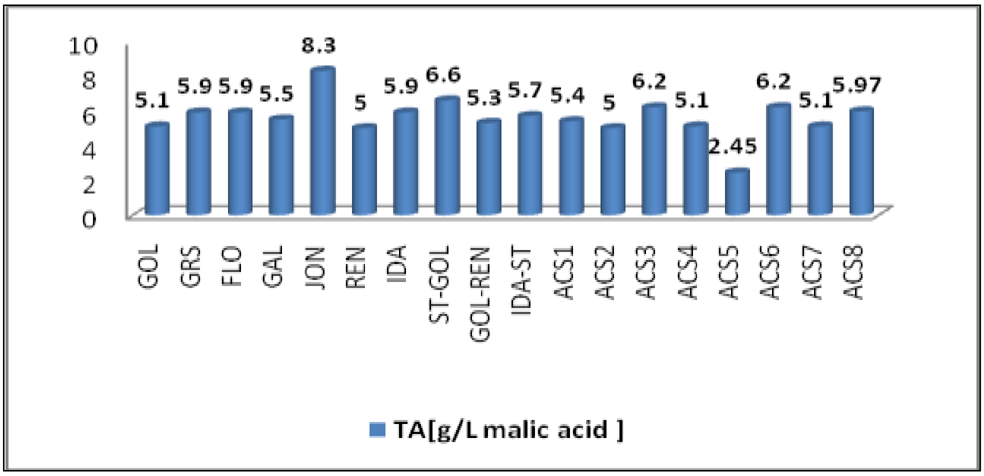
Regarding the comparative analysis for ten commercial samples of cider varieties (ACS1-ACS8) available on the Romanian market compared to the ciders produced in the research facility (Golden, Granny Smith, Florina, Gala, Jonathan, Rennet, Idared and from different apple mixtures in different proportion of mixing), presents significant differences between the studied samples. The results are shown in Figure 1.



Ciders Total Polyphenol Contents (A)



Ciders Total Antioxidant Capacity (B)



Ciders Total Acidity (C)

Fig. 1 - Representation of total polyphenols content (TPC), total antioxidant capacity (AC) and total acidity (TA) of commercial and lab made ciders

Legend: GOL=cider produced using Golden Apples; GRS= cider produced using Granny Smith apples; FLO= cider produced using Florina apples; GAL= cider produced using Gala apples; JON = cider produced using Jonathan apples; REN= cider produced using Rennet apples; IDA= cider produced using Idared apples; ST-GOL= cider produced using apple mixtures Starkrimson/Golden; GOL-REN= cider produced using apple mixtures Golden:Rennet in proportion of 1:1; IDA-ST= apple mixtures Idared/Starkrimson in the proportion of 3:1; ACS1- ACS8 = commercial ciders

It can be noted that all analyzed cider varieties available on the Romanian market have low total polyphenol content (TPC) compared to the ciders produced from apple varieties cultivated in Romania at the research pilot station facility. The highest TPC corresponds to the cider obtained from a mixture of equal parts of Golden and Rennet apples (3.381). The commercial analysed cider varieties, present 25-50% lower TPC compared to the ciders samples produced by us. Antioxidant capacity (AC) and total acidity (TA) vary a lot from those commercially available to those produced by us, the differences are viewable in Fgure 1, b. The chemistry of cider making requests a good total acidity, practically between 5 to 6 g/L T.A. as Malic acid (*Calvi B., 2015*). The analyzed samples presented TA as requested with two exceptions: one, the Jonathan apple cider with a TA of 8.3 g/L and a commercial cider with TA = 2.45 g/L.

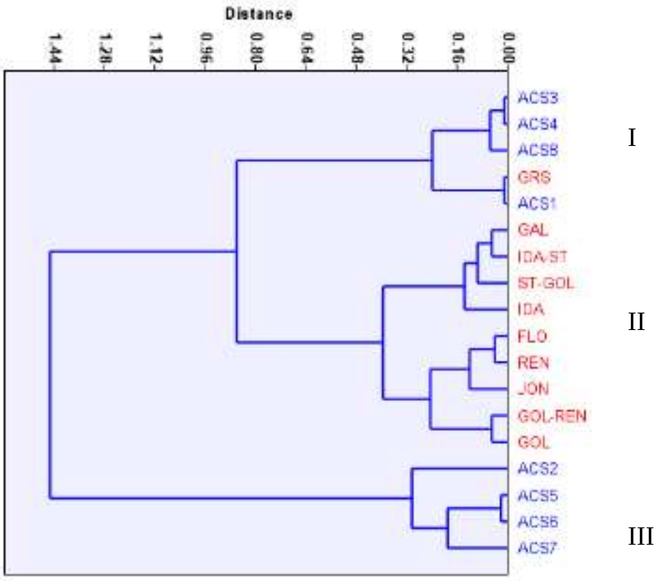


Fig. 2 - Cluster analysis of data corresponding to the analyzed cider samples

Legend: GOL=cider produced using Golden Apples; GRS= cider produced using Granny Smith apples; FLO= cider produced using Florina apples; GAL= cider produced using Gala apples; JON = cider produced using Jonathan apples; REN= cider produced using Rennet apples; IDA= cider produced using Idared apples; ST-GOL= cider produced using apple mixtures Starkrimson / Golden; GOL-REN= cider produced using apple mixtures Golden: Rennet in proportion of 1:1; IDA-ST= apple mixtures Idared / Starkrimson in the proportion of 3:1; ACS1- ACS8 = commercial ciders

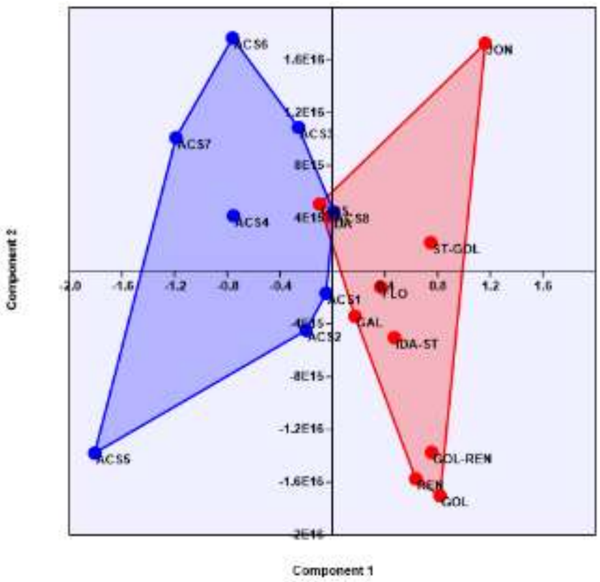


Fig. 3 - Representation of Principal Component Analysis of Ciders

Legend: GOL=cider produced using Golden Apples; GRS= cider produced using Granny Smith apples; FLO= cider produced using Florina apples; GAL= cider produced using Gala apples; JON = cider produced using Jonathan apples; REN= cider produced using Rennet apples; IDA= cider produced using Idared apples; ST-GOL= cider produced using apple mixtures Starkrimson/Golden; GOL-REN= cider produced using apple mixtures Golden:Rennet in proportion of 1:1; IDA-ST= apple mixtures Idared/Starkrimson in the proportion of 3:1; ACS1- ACS8 = commercial ciders

Cluster analysis of data (Figure 2) was performed using Paired Group Algorithm and Euclidian Similarity Measure and the Correlation Coephicient (0.8417). Based on the cluster analysis we can affirm that the ciders obtained at the research pilot station present higher quality compared to those available on the Romanian market. They apear three groups: Group I (ACS3, ACS4, ACS8, GRS, ACS1); Group II (GAL, IDA-ST, ST-GOL, IDA, FLO, REN, JON, GOL-REN, GOL) and Group III: (ACS2, ACS5, ACS6, ACS7). As we can observe, group II contains only pilot produced ciders and group III, only commercial ciders, while group I contains also commercialy produced ciders but also a cider produced from Granny Smith apples characterised by a low AC and medium TPC.

As presented in Figure 3 the principal analysis using correlation matrix between groups at a Jolliffe cut off equal to 2.1 shows that commercial ciders versus ciders produced at the research facility present different polygonal areas, proving that figerprint associated with mathematical models are suitable to identify the origine or chemical properties of ciders.

CONCLUSIONS

The analysis of antioxidant capacity and total polyphenol content are important to be investigated in order to confirm the health benefits offered to consumers by cider.
Resulting from our studies the apple ciders available on the Romanian market respect the request regarding TA but present very low TPC and AC compared to the samples produced at the pilot station. Based on the results we can affirm that the ciders obtained from Romanian apples have properties that are more attractive.

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Corresponding author E-mails: valentin_vladut@yahoo.com, cabaioan@yahoo.com, despina.bordean@gmail.com. The results of this research will be included in the PhD Thesis of Dana Bogdanescu, PhD student at Banat's University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" from Timisoara. Assistance provided by Bio Banat-D SRL and "Corozin SRL" - with the collection of my data was greatly appreciated. In addition, we are grateful to "WEBOMATIK RO SRL" for permission to use statistical package MVSP 3.1 and technical assistance.

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CONTRIBUTIONS TO THE DEVELOPMENT OF THE FIELD OF FERTIGATION EQUIPMENT
/
CONTRIBUTII LA DEZVOLTAREA DOMENIULUI ECHIPAMENTELOR DE FERTIRIGATIE

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Keywords: *fertigation, injection device, horticultural crops*

ABSTRACT

Specialists in agriculture appreciate that fertigation, due to the many advantages it presents compared to the situation where irrigation and fertilization are performed as distinct technological sequences, is the most efficient method by which the water and fertilizers necessary for the growth and development of plants can be provided.

Through the implementation of the project "Innovative Technologies and Equipment for Irrigation Implementation of the Modern Fertigation Concept" - contract 158/2014, INOE 2000-IHP has made an important contribution to the development of the field of fertilization equipment for fertilization of horticultural crops from protected areas of fruit crops.

REZUMAT

Specialiștii din agricultură apreciază că fertirigația, datorită multiplelor avantaje pe care le prezintă comparativ cu situația în care irigarea și fertilizarea sunt efectuate ca secvențe tehnologice distincte, este cea mai eficientă metodă prin care pot fi asigurate apa și fertilizanții necesari creșterii și dezvoltării plantelor.

Prin derularea proiectului "Tehnologii și echipamente inovative pentru implementarea în agricultura irigată a conceptului modern de fertirigație"- contract 158/2014, INOE 2000-IHP și-a adus o contribuție importantă la dezvoltarea domeniului echipamentelor de fertirigație destinate fertirigării culturilor horticole din spații protejate și culturilor pomicole.

INTRODUCTION

Fertigation is the method by which water and fertilizers (solutions obtained by dissolving water-soluble solid fertilizers) are administered simultaneously with irrigation facilities.

The use of modern localized irrigation techniques (dripping, micro-spraying, underground) leads to a significant reduction in nutrient losses by percolation, allowing for the use of minimal amounts of fertilizer with water spray, minimizing soil and surface water and groundwater pollution.

Choosing the right fertilizer equipment is just as important as choosing the correct nutrients. Incorrect selection of fertilizer equipment may damage parts of the irrigation system, affect the efficient operation of the irrigation system or reduce the effectiveness of nutrients (*Biolan et al, 2010*).

Within the project were used innovative and original technical solutions for the field of fertilization, which focused especially on the injection device, such as double membrane pump (*Avram M., 2005*) with hydraulic control - the switch of slide valve of directional control valve is made hydraulically.

The injection device uses irrigation water as working fluid (drive) from the same pipeline into which the primary solution is injected, which in combination with the irrigation water forms the fertilizer solution.

Compared to membrane pumps available on the market, products of prestigious companies in the field: VERDER AIR, DEBEM, TUV, TAPFLO, the injectors constructive variants made within the project do not require electrical energy or compressed air, which ensures their autonomy in operation in any point of the irrigation arrangement.

The overpressure required to the injection of the primary solution is based on the principle of the difference between the active surfaces of the drive chambers and the injection chambers and can be precisely determined, depending on the hydraulic parameters of the irrigation system with which they work in the aggregate, from the design phase of the device.

The flow rate of the injected primary substance can be adjusted to a very large extent by altering the feed rate of the drive chambers by altering the frequency of the central axis of the pump (solidary with the membranes that separate the drive and injection chambers); thereby facilitating the administration of both fertilizers based on nitrogen, phosphorus, potassium, which involves high injection rates and microelements, administered in very low doses.

The fertilization equipment is installed in parallel with the main circuit of the irrigation plant (bypass system) by two quick thimbles, to take off the water used as a moving fluid and to inject the primary solution; this mounting system does not introduce any load losses in the main pipeline of the irrigation installation.

The experimental model of the injection device was made in three constructive variants, getting at the Prototype stage, to obtain a device with technical-functional performances at the level of the requirements of fertigation process for the horticultural crops in the protected areas and the fruit crops, aggregated with drip irrigation and micro-sprinkler systems.

Fertilizer equipment (*Sovaiala Gh., 2014*) includes as basic elements: an injection device mounted by quick thimbles on a hydraulic circuit parallel to the main circuit of the irrigation system (by-pass system), from which the water used as the moving fluid is taken and in which is injected the primary solution, the primary solution preparation vessel, the monitoring parameters and the adjustment of the working parameters.

MATERIAL AND METHOD

The moving fluid (water from the main hydraulic circuit of the irrigation system) passes through the pressure filter and reaches the hydraulic directional control valve A3.1 (5/2-5 ways and 2 positions) (Figure 1). When the slide valve of the directional control valve is in the right position, the connection between the P and A connections is established, supplying the left drive chamber of the pump A1 and the left chamber of the inverter A3.2, which causes the displacement of the mobile assembly of the pump to the right or between the connections B and Drainage, allowing the water to drain from the right drive chamber of the pump and the right chamber of the invertor. During this stroke, from the left injection chamber, by compressing the associated membrane, the injection process of the primary solution through the lower branch of the A2 valve block is performed. The injection pressure places on the seat the left valves - the bottom branch, the right valves - the upper branch and opens the right valve - the bottom branch, thereby injecting the primary solution into the main hydraulic circuit of the irrigation system.

At the same time, the right injection chamber creates a depression, causing the primary solution to flow through the upper branch of the valves block (the left valve is open, the right valve is on the seat). When the C1 hole is released from the inverter body, the connection to the hydraulic directional control valve command is established, causing the slide valve to be switched to the other position.

Double pump with membranes, Figure 2, can be assimilated to a hydraulic amplifier with two identical sections separated by a central disk (4). Rubber-bonded rubber membranes (3) are in the form of discs with a central hole. These are attached between the outer caps of the pump (2, 6) and the front faces of the disc on the outer contour, respectively the front faces of the cylindrical slide valve (5) and the special construction nuts on the inner contour. The membranes separate the drive chambers of the hydraulic amplifier (located on the outside) from the injection chambers (located on the inside).

The connection between the drive chambers and the external hydraulic circuit for the working fluid is achieved through the holes in the lids, and the connection between the injection chambers and the exterior circuit of inlet-discharge primary solution is made through the holes in the central disk. Reversing the movement direction of the mobile pump assembly is accomplished with the hydraulic inverter whose slide valve is integral with it. The difference between the active surfaces of the membranes, which are in contact with the moving fluid (irrigation water) on the outside and the primary solution on the inside, generates the overpressure necessary to carry out the injection process.

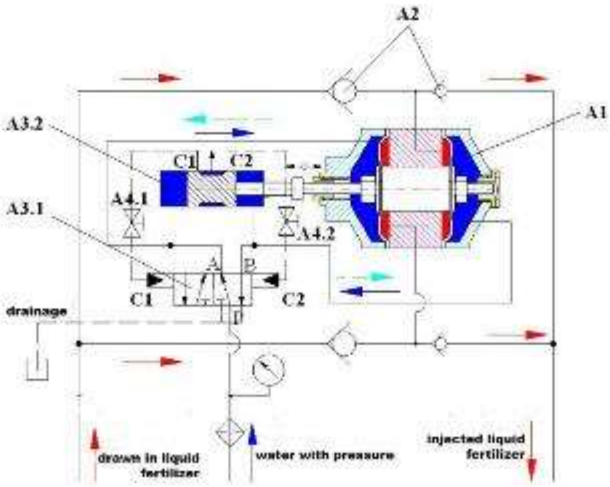

Fig. 1-The operating principle of the injection device:
A1 double membrane pump (hydraulic amplifier); A2- Block of injection circuit check valve A3.1- Directional control valve of drive chamber actuator A3.2- Hydraulic sense inverter; A4.1, A4.2-cocks; C1, C2 control chambers (actuators) of the actuator directional control valve.

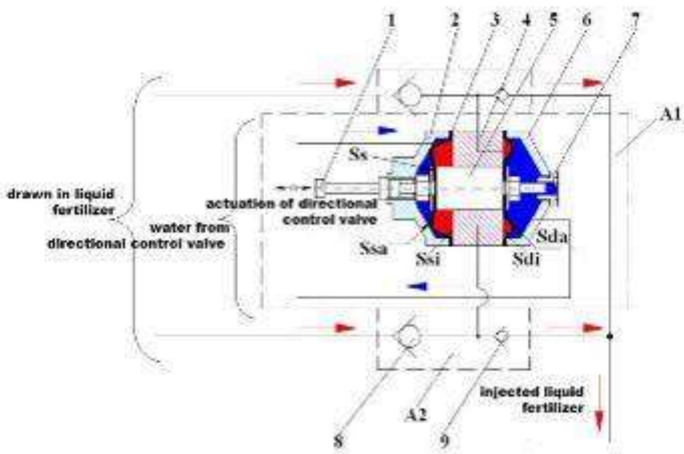

Fig. 2 -The hydraulic scheme of injection device:
1-axial drive rod, 2-left cap, 3-membrane, 4-housing, 5-slide valve, 6-right cap, 7-stop valve, 8-intake valve,9-discharge valve.
- Ssa, Sda - the left and right circular surfaces on which water acts; - Ssi, Sdi - the left and right circular surfaces on which the liquid fertilizer acts; - Ss - the circular surface of the slide valve

The main scheme of the fertilization equipment, variant II (*Sovaiala Gh., 2014*), is presented in Figure 3. An innovative solution for command of directional control valve has been adopted in the injection device, by taking over some hydraulic signals at the stroke ends of the pump mobile assembly by way of constructively solving the slide valve of the directional control valve so as to: provide a short switching time; in the switching phase does not generate a pressure drop in the installation, which will lead to blocking of the pump mobile assembly; once switched, there are forces to keep him in position.

The hydraulic directional control valve, Figure 4, controls the movement direction of the mobile assembly of the injection device; is supplied with pressurized water from the irrigation line before the tap R, which it alternately distributes in the two drive chambers. In this way, the injection chambers increase or decrease their volume by aspirating the primary solution from the Bf container and floating it through the branch with its anti-return valve in the same irrigation line downstream of the R valve at a pressure greater than that in the pipe.

The directional control valve contains a slide valve on which two valves and two command pistons are mounted. On the central position the valves completely close the P port (positive cover).

At the end of the slide valve (eg extreme right position), the right valve seals frontally on a seat ϕD, and the left valve on the cylindrical surface ϕd, in contact with the directional control valve body. Due to the difference between the ϕD and ϕd surfaces, the water under pressure in the pressure circuit P generates a force that opposes switching of the directional control valve:

$$\phi D > \phi d;\ A_D > A_d;\ \text{deci}\ F_D > F_d, \tag{1}$$

where:

D, d are the diameters of the sections on which the water pressure acts;

AD, Ad areas of the two sections;

F_D and F_d forces acting on the valve assembly; $F = A \cdot p$, p-water pressure, A-area.

In this position of the slide valve, the paths P are set to the drive chamber B of the pump, respectively the engine chamber A at the drainage-Dr.

On switching, by pressure drops the forces unbalance:

$$F_D < F_d + F_{ccd}, \tag{2}$$

where

F_{ccd} is the force produced by the pressure at the end of the control piston, which is no longer balanced.

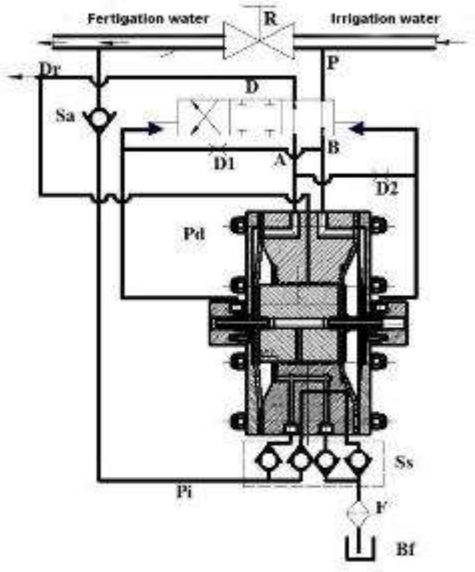

Fig. 3 -The main scheme of the fertigation installation- constructive variant II

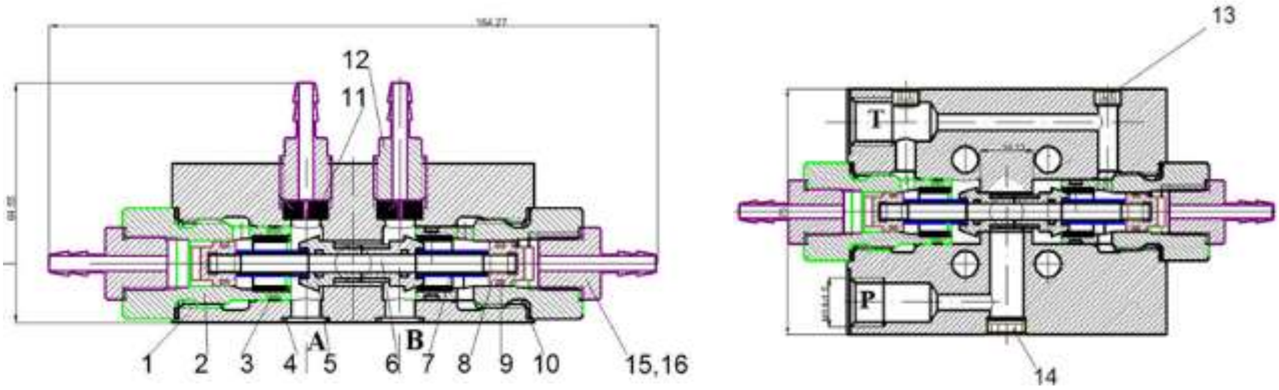

Fig. 4 - Sections through the hydraulic directional control valve of the injection device:
1, 3, 4, 9, 10-hydraulic seals; 2- the chamber of the control piston; 5- the body of the directional control valve; 6-slide valve; 7bushing spacing positioning control piston; 8-control piston; 11, 12- supply fitting of drive chambers; 13, 14- technological cork; A, B- supply ports of drive chambers; P-hole of the pressure connection; T-hole of the tank connection

In the fig.5 shows the hydraulic scheme of the directional control valve.

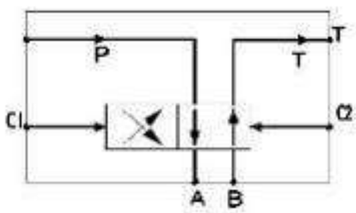

Fig. 5 - The hydraulic scheme of the directional control valve
A, B-links to drive chambers P-pressure connection; T-tank connection;
C1, C2-pistons control chambers

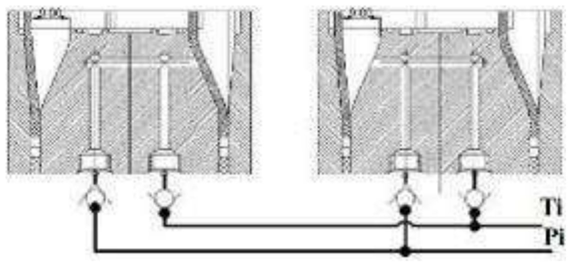

Fig. 6 - Installation diagram for inlet / discharge valves of primary solution

The primary solution inlet / outlet valve block is made up of four check valves with clack and related connecting elements.

The valves are arranged in two parallel planes, at each of chamber an inlet valve and a discharge valve been connected, Figure 6. Inlet valves are connected to the Ti branch, whereby the primary solution aspirated from the Bf container reaches alternately in the two chambers, and the discharge valves in the Pi branch, through which the primary solution is injected into the main pipe of the plant irrigated.

Injection device from the component of fertigation equipment, in the constructive variant III – EM (experimental model) improved / Prototype, (*Sovaiala Gh., 2016*), was designed and built in a compact construction, the piston-membrane mobile assembly, the hydraulic directional control valve, the driving of hydraulic directional control valve, the throttles of the control chambers of hydraulic directional control valve, the block of suction / discharge valves of primary solution being integrated in the carcass . The connection between the functional elements is achieved through holes in the body of the device and the piston of the mobile assembly, being eliminated the external connections, except for those associated with the control chambers of the directional control valve.

The main scheme of the fertilization equipment is shown in Figure 8.

The mobile assembly, fig. 8-sect D-D consists of piston, membranes, outer and inner flanges, special screws for fixing the piston membranes.

Primary solution suction / discharge valve assembly; each injection chamber is connected to an intake and discharge valve. The suction / discharge valves of the two injection chambers are interconnected and connected to the suction nozzles of the primary solution and to the discharge nozzles of primary solution.

In the construction of the two-positions and four-orifices type directional control valve, the alternative with slide valve, with O-rings seal was chosen to allow the components to be executed in H8 / f7 tolerance fields, thus avoiding the extremely precise execution of the hydraulic directional control valve with classic slide valve, where the lost motions between the slide valve and the body are of the micron order. The constructive version of the directional control valve allows operation with irrigation water with a low level of filtration.

The seals have been designed and made with tightening as low as possible, so that the friction forces of the mobile elements are as small as possible.

The slide valve of the directional control valve has a positive coating, the switching is done without loss of pressure.

The control valve of the hydraulic directional control valve, Figure 8 sect. E-E are unblocking valves located in the water tank discharge holes in the control chambers operated in the pump body, to ensure hard closure and opening and to reduce the switching time of the directional control valve.

The drive chambers are delimited by the outer surfaces of the membranes and the lids, and the injection chambers by the inner surfaces of the membranes and the body.

Depending on the position occupied by the slide valve of the directional control valve, Figure 7, the orifice P is connected with the orifices A or B, from which, through internal holes in the body and the piston, the pressurized water supply of the drive chambers is provided. Outside, holes A and B are plugged with technological plugs.

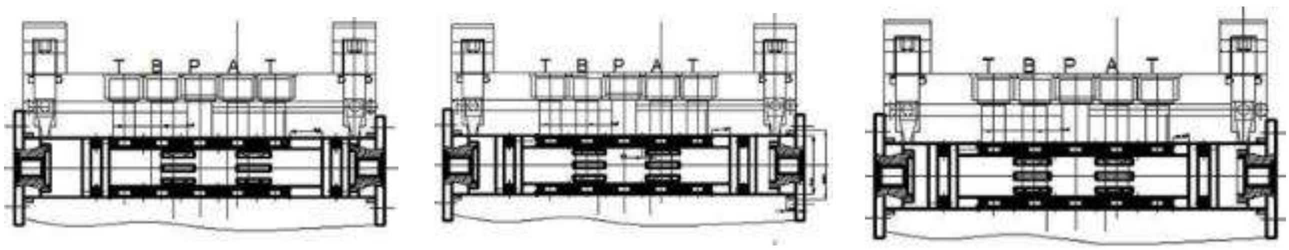

Fig. 7 - Positions of the slide valve of the directional control valve

The T-holes alternately drain the water from the drive chambers (A to T or B to T) during the withdrawal phase of the membrane assembly (reducing the volume of the drive chambers). The water discharged from the drive chambers is distributed to the plants through an assignment tube with dropper built-in.

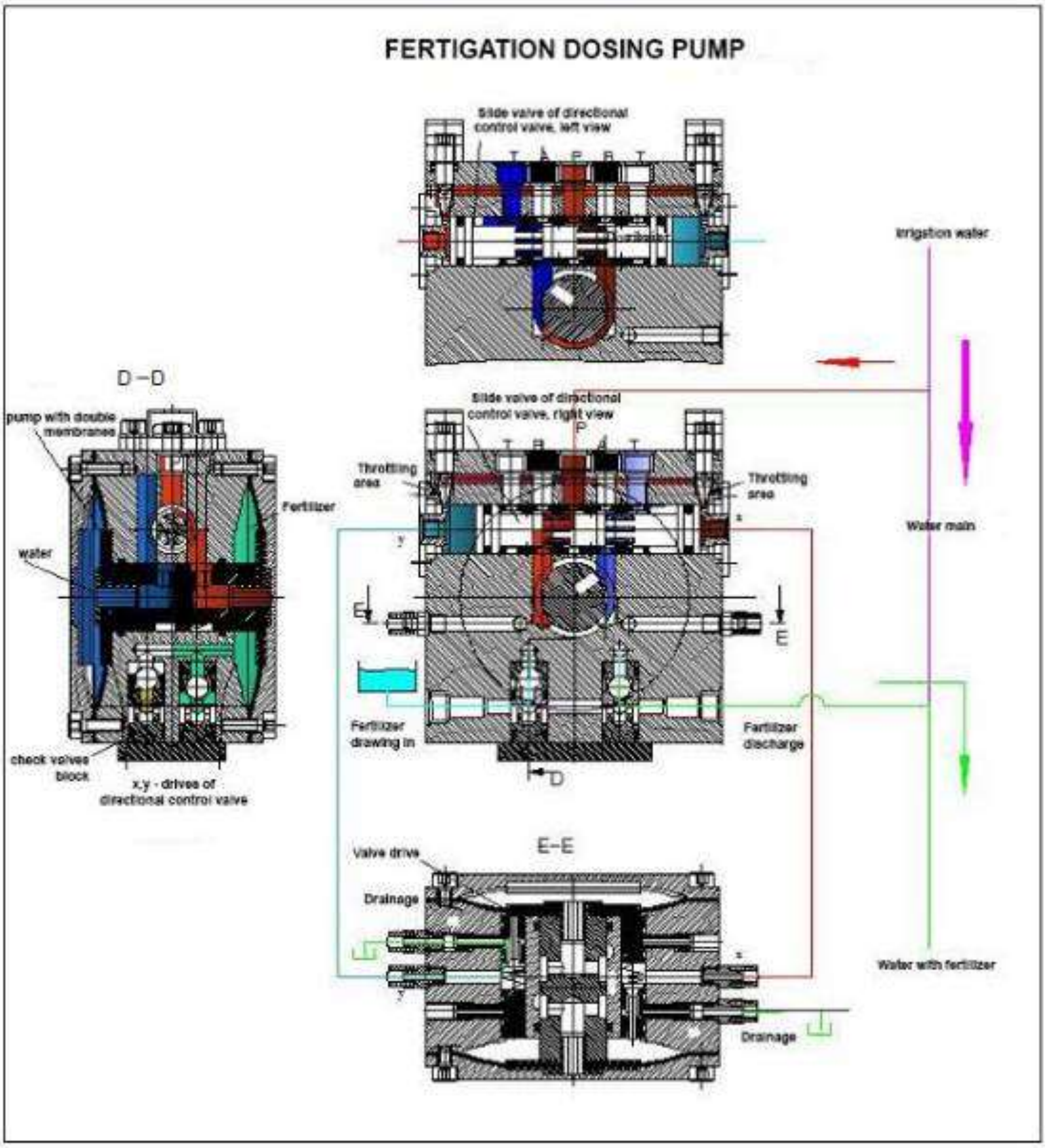

Fig. 8 - Scheme of principle of fertigation equipment

Also from the P port, the Ccs-Ccd control chamber of the hydraulic directional control valve are continuously supplied with pressurized water. The mobile assembly alternately operates through the internal flanges the unblocking valves, which shortly before reaching the end of the stroke, connect one of the control chambers to the atmosphere, causing the switching of the slide valve of the directional control valve from the control chamber under pressure to the pressure discharge chamber.

The mecano-hydraulic switching of the slide valve is made by means of two identical hydraulic circuits, controlled at the end of the mobile assembly, consisting of a throttle and a mechanically unblocking valve (see figure below). The slide valve of the directional control valve may take different positions in the directional control valve depending on the fluid pressure on the ends (Pcs is the left control pressure, Pcd is the right control pressure). If the two valves are closed, the pressure on the ends is equal to the water pressure (Pcs = Pcd) and the slide valve locks in position. If one of the valves is unlocked then the liquid behind the throttle is removed from the outside, the Pcs or Pcd pressure drops only on the throttle, different pressures are applied to the ends of the slide valve and then the slide valve moves in the direction of the lower pressure switching the directional control valve.

Thus, when the shaft with the membranes reaching the end of the stroke, the shaft plate reaches the end of the check valve to unlock it and the pressure switches the slide valve that changes the hydraulic connections to the membranes pump chambers, thus changing the direction of movement of the membranes shaft. After the shaft - membranes assembly moves backwards, the valve closes and locks the slide valve of the directional control valve in position. At the other end of the stroke the other valve is actuated, that changes the slide valve position commanding the movement in the opposite direction. The operation is repeated. Throttles regulate the fluid flow that fills the left and right control chambers of the slide valve, obtaining a work frequency adjustment.

The pressure in the control chambers of the directional control valve takes values between 0 and the pressure P from the plant according to the state of the unlocking valves, commanding the switching of the directional control valve. The check valves open by actuating the disk in the shaft membrane assembly, namely at the ends of the stroke.

The throttles, which regulate the flow of water that arrives into the control chambers, keep the slide valve of the directional control valve in an equilibrium position and dictate the frequency of the pump mobile assembly.

The pressurized water supply of the left drive chamber causes the mobile assembly to move to the right, with the following effects:

-discharging of the moving fluid from the right drive chamber;

-suction of the primary solution in the right injection chamber;

-injection of the primary solution from the left injection chamber.

The volume reducing of the left injection chamber (implicitly increasing the pressure) causes the inlet valve ball to be seated and lifting the discharge valve ball out of the seat. Increasing the right injection chamber volume (implicitly producing a depression) causes the inlet valve ball to be lifted from the seat and seating the discharge valve ball. Injection chambers are alternately connected to the common suction connections (from the primary solution reservoir), respectively to the discharge (in the supply pipe of the irrigation system), Figure 8.

The physical realization of the injection device - the construction variants I- III - is shown in Figure10 a, b, c.

Fig. 9 a - Metering pump for injection of primary solutions - constructional version I

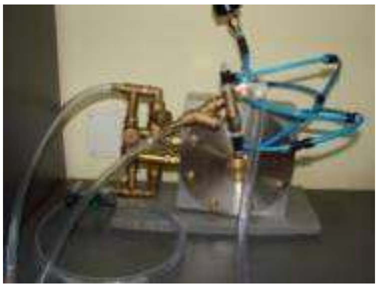

Fig. 9 b - Injection device construction variant II

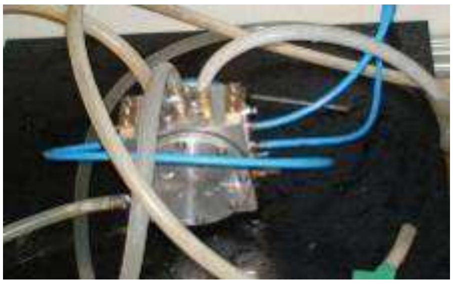

Fig. 9 c - Diaphragm double pump type injector with mechano-hydraulic control of the slide valve of the directional control valve

The fertilization equipment developed within the complex project Technologies for irrigation of agricultural crops in arid, semiarid and subhumid-dry climate, project number PN-III-P1-1.2-PCCDI-2017-0254, Contract no. 27PCCDI / 2018, within PNCDI III, will be designed for aggregate operation with drip, micro-sprinkler and underground irrigation installations. Critical parameters for the injection device of the fertigation equipment, which work in a dynamic regime, are the flows and pressures specific to the underground irrigation systems lower than those for drip and micro-sprinkler irrigation (*Blidaru et al, 1981*).

The drive part of the injection device, the differential piston type, will have to ensure the injection parameters (injected flows, injection pressures, primary solution concentrations) for the localized watering installations mentioned. The irrigation water used as a moving fluid and the primary solution will form the fertilizer solution in the body of the device, being injected into the irrigation water supply pipe without external moving fluid loss (*www.dosatron.com*).

Since conventional agricultural production systems have caused soil degradation, technologies about arrangement of land and crop rotation, work and fertilization systems, soil ameliorative works and crop protection systems have to be adapted to soil and water protection requirements, and in areas with soils more vulnerable to degradation (including sandy soils in arid, semiarid and subhumid- dry regions that are the subject of the project), soil conservation works are required (*Lal R., 2006*). In fact, the evolution of soils under irrigated regime is more complex and differs from that of other non-irrigated soils (*Paltineanu et al*, 2003), the application of irrigation and fertilization of crops gaining a special character in the sense of the phase recommendations (*Tiscovschi et al, 2013*).

RESULTS

Fertigation equipment was tested under laboratory conditions at IHP Bucharest, in the Environmental Protection Laboratory, on a stand designed to test apparatus and equipment that uses water under pressure as a working fluid.

The test stand, Figure 10, (*Sovaiala Gh., 2016*), provides hydraulic parameters (flow, pressure) necessary for the functioning of the fertilization equipment, simulating the irrigation plant with which it works in the aggregate, that consists of the following components:

-pumping group with water recirculation used as working fluid;

- the water tank with the dimensions of 1130x900x785 and the useful volume of 0.6 m^3;

-the system for adjusting and monitoring the working parameters.

Fig. 10- Testing stand of the fertigation equipment

The WILO ECONOMY CO-2 MHI 206 / ER-RBI-CALOR pumping group, equipped with two high-pressure horizontal, self-priming centrifugal pumps connected in parallel, provides a maximum flow of 10 m^3 / h and a maximum pressure of 6.7 bar.

The water intake in the pumping group is made by an elastic connection element with an end type **holender**; discharge is done in the same tank, thus ensuring water recirculation.

The injecting device is mounted in a bypass system on a hydraulic circuit parallel to the group discharge pipe, similar dimensionally and from the point of view of hydraulic parameters of the liquid transited with the main pipe in the drip or micro-sprinkler irrigation installations.

Connecting pipe of the injector device, Figure 11 a, b, includes connecting elements (nipples, sockets, reducing pieces, elbows) and elements that ensure the functionality, respectively adjustment and monitoring of the working parameters (taps, Y path filter, check valve, pressure gauges, pressure reducer with pressure gauge, flow meter).


a


b

Fig. 11 a, b - Injection device connection

The injection device is provided with the following connections, Figure 12: The P-pressure connection, from which the drive chambers and control chambers of the directional control valve are fed; T_{cm} - water exhaust connections in drive chambers; T_{cc} - water outlet connections in the control chambers of the directional control valve; A_f- the fertilizer aspiration connection; R_f - fertilizer discharge connection.

The pressure connection of the injection device is made from the downstream end of the line. With the drive and control chamber tank connections, after performing the moving fluid function, the water is freely discharged into the stand tank. Through the A_f connection, the primary solution from the fertilizer tank B_f is absorbed, Figure 13, and the primary solution is injected through the R_f connection. The circuit of the R_f connection is provided with a tap and pressure gauge to simulate the injection / measure the injection pressure value.

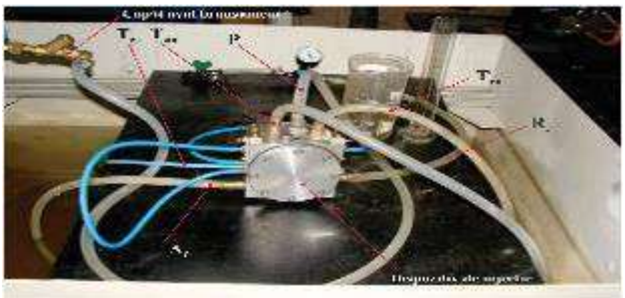

Fig. 12 - Attaching the injection device to the test stand

Fig. 13 - Recipient for the preparation of primary solutions; connections for suction-A_f / discharge-R_f of primary solution

Considering the corrosive action of the fertilizers, in order not to affect the components of the test stand, the aspiration / discharge of the primary solution is made from the mixing vessel on a hydraulic circuit separated from the drive fluid supply circuit of the injection device; the injection pressure value, at which the device operates uniformly and ensures the required parameters, is adjusted from the valve mounted on the discharge hose and is measured with the manometer attached upstream of the tap.

Technical and functional parameters achieved by the injection device are highlighted in the Table 1.

Table 1

The technical and functional characteristics achieved with the injection device under laboratory conditions

Pressure in the watering pipe, bar	Working pressure of injection device, bar	Injection pressure, bar	Supply flow of injection device l/min	Exhaust flows from drive chambers 1 and 2, l/min	Volume of drive chambers 1 and 2, ml	Control chambers volume of directional valve 1 and 2, ml	Injected flow rate of primary solution, l/min
3,7	3,5	3,4	3,89	1,596/1,444	42/38	11,1/11,6	1,400
4,0	3,0	2,5	4,22	1,720/1,650	19,5/19,0	9,5/8,0	0,570
3,8	3,0	2,4	2,35	0,712/0,736	15,0/15,5	9,5/9,5	0,265
2,8	2,6	2,3	2,34	0,647/0,647	17,5/17,5	14,5/14,0	0,235
2,8	2,0	1,5	2,31	0,612/0,616	17,5/17,6	15,5/15,5	0,335

Frequency of mobile assembly, double strokes/min	Control chambers flow of directional valves 1 and 2, l/min	Efficiency of injection device η $= Q_{inj}/Q_{supply\ of\ inj.\ device}$, %
38	0.418/0.432	35.9
98	0.465/0.392	13.5
95	0.451/0.451	11.2
74	0.536/0.518	10.0
70	0.542/0.542	10.0

CONCLUSIONS

Experiments lead to the following conclusions:

1. The minimum pressure at which the injection device operates uniformly and continuously, with the free discharge of the primary solution (without load) being 1.2 bar;
2. The injection device has been tested at preset working pressures in the range of 2-3.5 bar;
3. The minimum bypass flow rate that ensures device operation is 5 l / min;
4. The injection pressure is proportional to the supply pressure of the motor chambers and has values ranging from 3.4 to 1.5 bar;
5. To facilitate the injection process, a tap with slide valve (fine flow adjustment) is installed between the connecting points of the device, generating a local pressure drop;
6. Injected primary solution flow rate is between 1.4-0.235 l / min (84-14 l / h); the fertigation equipment, depending on the preset working parameters, can administer both basic primary solutions, currently used in fertigation, as well as microelements, which are administered in very small doses;
7. The injection device was tested with a 0.2% primary solution prepared from the Magnisal chemical;
8. Equipment samples under operating conditions have validated the reliability of laboratory samples demonstrating the functionality and utility of the product.

ACKNOWLEDGMENTS

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ADVANCED TECHNOLOGIES FOR WASTEWATER TREATMENT BY OZONATION – A REVIEW
/
TEHNOLOGII AVANSATE DE EPURARE A APELOR UZATE PRIN OZONIZARE- REVIEW

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Keywords: *wastewater, ozonation*

ABSTRACT

Water pollution due to animals, human faeces or sewage systems is one of the most dangerous sources of contamination because they contain many pathogenic microorganisms. Disinfection is a necessary step to destroy or inactivate micro-organisms and prevent the spread of dangerous diseases. The properties of ozone, especially the ability to oxidize, have led to its use in water treatment. Ozone is an "ideal" reagent because it does not introduce, in water or in the atmosphere, reaction products with unfavorable effects. In this paper are presented the most representative studies on the use of ozone in wastewater treatment.

REZUMAT

Poluarea apei, din cauza animalelor, materiilor fecale umane sau a sistemelor de canalizare, reprezintă una din cele mai periculoase surse de contaminare din cauza faptului că acestea conțin numeroase microorganisme patogene. Dezinfecția este o etapă necesară pentru a distruge sau a inactiva microorganismele și a preveni răspândirea unor boli periculoase. Proprietăţile ozonului, mai ales capacitatea sa de oxidare, au condus la utilizarea lui în tratarea apei. Ozonul este un reactiv „ideal” deoarece nu introduce în apă sau în atmosferă produşi de reacţie cu efecte nefavorabile. În această lucrare sunt redate cele mai reprezentative studii privind utilizarea ozonului în tratarea apei uzate.

INTRODUCTION

Water pollution due to animals, human faeces or sewage systems is one of the most dangerous sources of contamination because they contain many pathogenic microorganisms. Disinfection is a necessary step to destroy or inactivate micro-organisms and prevent the spread of dangerous diseases. The disinfecting process has been considered as one of the most important steps in wastewater treatment and improper attention to this process can caused a social disaster.

The application of the disinfection process is necessary in the case of industrial waters from slaughterhouses, breeding establishments, tanning, canning factories, food industry where fermentation processes take place. The disinfection mechanism comprises two phases: penetration of the disinfectant through the cell wall and denaturation of protoplasmic protein, including enzymes. Until now, different methods have been used for drinking water disinfection, such as using the ultra-violet light and adding ozone or chloride (*Bidhendi et al., 2006*).

Disinfection is considered to be the primary mechanism for the inactivation/destruction of pathogenic organisms, aiming to prevent the spread of waterborne diseases to downstream users and the environment. Wastewater must be adequately treated prior to disinfection in order for any disinfectant to be effective. Disinfection can be accomplished by physical or chemical procedures. The most used means of disinfection of water are: ozonisation (chemical disinfectant) and ultraviolet radiation (physical disinfectant) (*Dokovska et al., 2014*). Ozone properties, especially its oxidation ability, have led to its use in water treatment. Ozone is an "ideal" reagent because it does not introduce, in water or in the atmosphere, reaction products with unfavorable effects.

The first ozone decontaminating facilities were built at the end of the nineteenth century, when in 1898 in Berlin, Siemens and Halske had experienced the use of ozone in water treatment. The first treatment plant equipped with ozone was built in 1906 at Nissa by Marius Paul Otto. The use of ozone for water disinfection increased after 1968, following the studies by Coin and Gomella, which demonstrated its ability to inactivate viruses (*Blăgoi and Puscaș, 1997*).

Ozone requires less contact time and lower concentrations than chlorine, chlorine dioxide and chloramines to achieve disinfection, but its instability and reactivity means that it is unable to provide an enduring disinfection residual in distribution. The stability of ozone decreases with increasing pH and temperature. At 15°C and a pH of 7.6 the lifetime of the residual is reported to be in the order of 40 minutes, but at higher temperatures it can be as low as 10 - 20 minutes. This occurs due to a decrease in the efficiency of transfer of ozone into water as temperature increases. Ozone disinfection is generally used at medium to large sized plants after at least secondary treatment. In addition to disinfection, another common use for ozone in wastewater treatment is odor control.

Ozone treatment has the ability to achieve higher levels of disinfection than either chlorine or UV, however, the capital costs as well as maintenance expenditures are not competitive with available alternatives. Ozone is therefore used only sparingly, primarily in special cases where alternatives are not effective. The cost of ozone disinfection systems is dependent on the manufacturer, the site, the capacity of the plant, and the characteristics of the wastewater to be disinfected. Ozonation costs are generally high in comparison with other disinfection techniques.

Ozone is the most powerful oxidant used to treat water for disinfection. According to this, numerous studies have been carried out, and some of the most representative ones are presented in this paper.

MATERIAL AND METHOD

The microbicidal activity of ozone has been demonstrated since the late 1800. The first municipal water purification plant dates back to 1906 (*Tordiglione et al., 2014*). Ozone is the most powerful oxidizing agent, showing ten times the effectiveness of chlorine, and it's currently used to potabilize water (*Boyce et al, 1981*), disinfect swimming pool water (*Glauner et al., 2005*) and decontaminate bioclean rooms (*Masaoka et al, 1982*). Ozone bactericidal activity seems to be primarily resulting from direct oxidative damage and the effects of ozone have been tested on different bacterial strains, including *E. coli, Salmonella sp., S. aureus* and *Bacillus subtilis* (*Stoll et al., 2008*).

When ozone decomposes in water, the free radicals hydrogen peroxy (HO_2) and hydroxyl (OH) that are formed have great oxidizing capacity and play an active role in the disinfection process. It is generally believed that the bacteria are destroyed because of protoplasmic oxidation resulting in cell wall disintegration (cell lysis). The effectiveness of disinfection depends on the susceptibility of the target organisms, the contact time, and the concentration of the ozone.

A line diagram of the ozonation process is shown in Figure 1. The components of an ozone disinfection system include feed-gas preparation, ozone generation, ozone contacting, and ozone destruction.

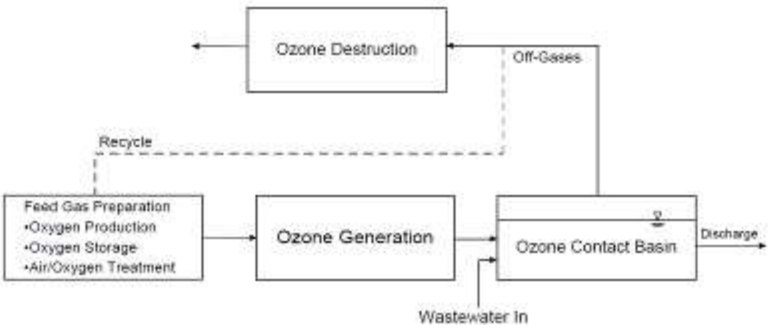

Fig. 1 - Ozone process schematic diagram

Ozone disinfection has been proven to be one of the most effective methods and is widely used to inactivate pathogens in water, particularly in Europe, the US and Canada, since the first treatment plant in Nice was built in France.

RESULTS

Due to its high oxidation potential, bactericidal properties, ease of on-site generation from air or oxygen, and ease of destruction to form ordinary oxygen, ozone has become widely used in a large number of applications, the most representative being the wastewater treatment field. In the following, are presented the most representative studies in this area.

Birks et al. (2015) have studied uncontaminated measurement of ozone dissolved in wastewater using a new MicroSparge ™ technology. The authors describe a new approach to the measurement of dissolved ozone and provide an example of its use in ozone monitoring during waste water treatment in the tertiary stage. Figure 2 is a schematic diagram of the ozone monitor showing additional components.

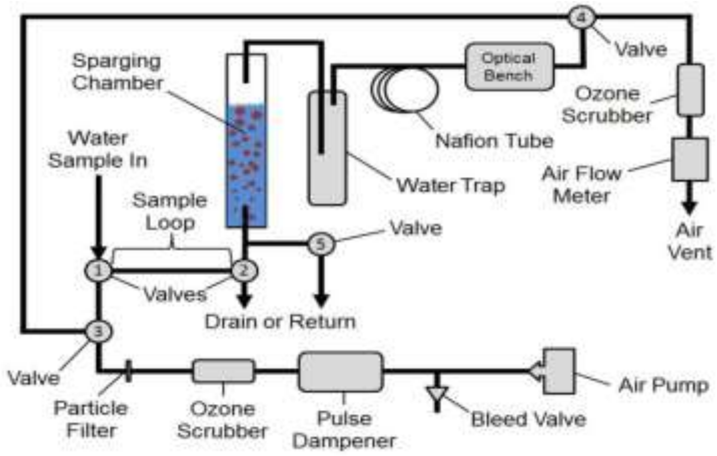

Fig. 2 - Detailed schematic diagram of the MicroSparge™ ozone measurement instrument

The MicroSparge™ instrument was evaluated by continuously monitoring dissolved ozone concentration in a potable research demonstration project, specifically a project in which water of wastewater origin is treated to a point where it can ultimately be reused as drinking water.

Measurements were made during three multi-day periods for a total of 20 days, as shown in the three graphs of Figure 3. Grab samples were occasionally obtained and analyzed by the indigo method using a Hach colorimeter. The continuous ozone measurements show the high degree of variability of ozone during the treatment process despite application of a nearly constant ozone dose rate. The sharp positive excursions in ozone were found to be due to the chlorine in the feed water, thereby reducing the ozone demand and allowing higher ozone concentrations. The high variability in dissolved ozone concentration as function of time, despite constant applied ozone dose, demonstrates the possibility of reducing cost in ozone treatment by using a feedback from the dissolved ozone monitor to control the ozone generator. Note that occasionally the treatment process was shut down to allow back flushing of the activated carbon filters. As seen in Fig.3, during those times, the ozone measurements decreased to zero, as expected, and with a very fast response time.

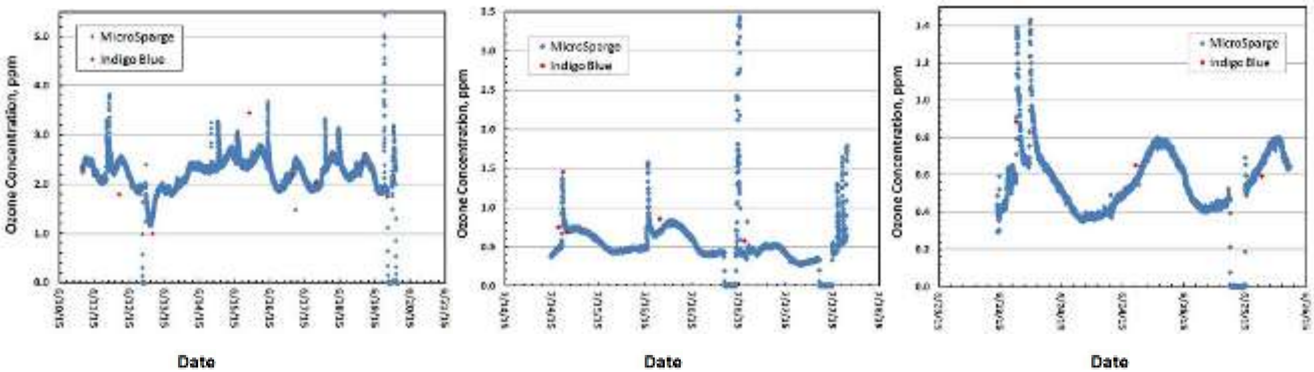

Fig. 3 - Comparison of MicroSparge™ and indigo blue ozone measurements in treated wastewater

The method has a fast response time (20 s, the average of 2 independent 10-s measurements) and good precision of <0.05 ppm. This new method for measurement of dissolved ozone concentration currently is being applied to a wide range of waters to determine the limitations of the technique with respect of loadings of organic compounds and particulate matter.

In their study, *Marcelino et al. (2016),* have proposed a multistage treatment system to treat real pharmaceutical wastewater containing the antibiotic amoxicillin.

Ozonation (O_3), and ozonation combined with aerobic biodegradation, were performed. The real pharmaceutical wastewater presented a high concentration of organic matter (TOC: 803 mg C*L^{-1} and COD: 2775 mg O_2*L^{-1}), significant amoxicillin content (50 mg L^{-1}) and acute ecotoxicity (Aliivibrio fischeri aTU: 48.22).

The ozonation experiments were performed in a 1000 mL borosilicate glass bubble column reactor for 180 min at semi-batch conditions, in which the ozone-containing gas was continuously sparged through a cylindrical porous-stone diffuser, at ambient temperature (25 ˚C ± 6). The reactor was connected to an O_3 generator and an O_2 concentrator from air (Figure 4).

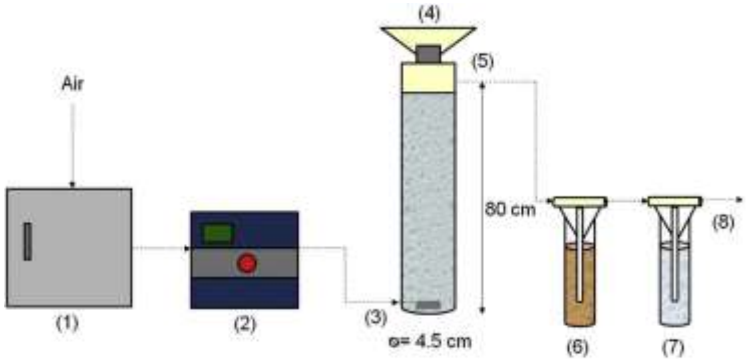

Fig. 4 - Ozonation experimental setup:

(1) O_2 concentrator, (2) O_3 generator, (3) O_3 inlet, (4) wastewater load, (5) O_3 outlet, (6) KI solution, (7) KI solution (security trap), (8) off-gas

For the conditions tested, the surface response of TOC removal by ozonation (regarding pH and the oxygen flow rate), show that increase in the oxygen flow increased the level of TOC removal. The mass balance results showed that the reaction system was not able to utilize all the produced ozone. The largest part of the supplied ozone (>50%) was lost in the outlet gas stream, as shown in Figure 5.

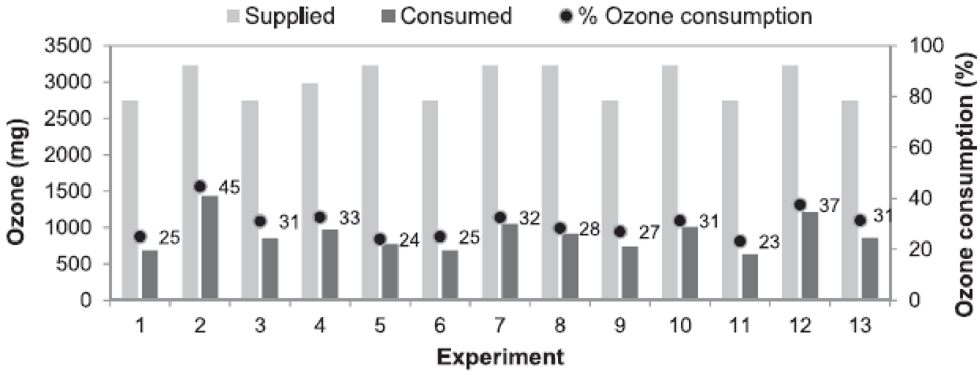

Fig. 5 - Ozone consumption for each ozonation experiment performed:

Total O_3 supplied (mg O_3 e light grey bars), total O_3 consumed (mg O_3 e dark grey bars), and percentage of O_3 consumption (percentage O_3 e black dots)

Ozonation alone at the optimum condition could achieve 46% of TOC removal; however, the combination of aerobic biodegradation and ozonation was able to improve the degradation of the practically all of the organic matter present. More than 98% of the original wastewater COD and TOC were removed, and removal of more than 99% of colour and amoxicillin was achieved. Moreover, the ecotoxicity of the final wastewater had also decreased in comparison with the ozonation treatment alone. The ozonation process reduced approximately 62% of the original toxicity, whereas the combined treatment removed 90%. A summary of these comparisons is presented in Figure 6.

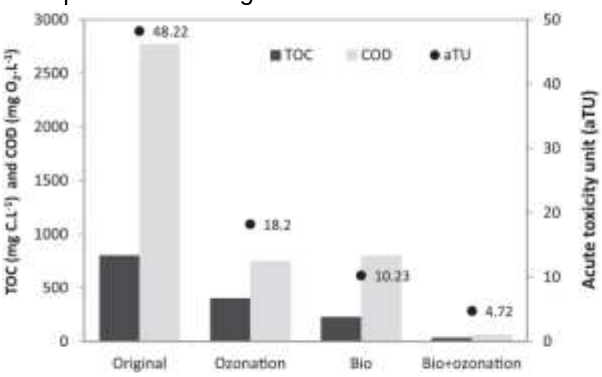

Fig. 6 - Comparison of TOC (mg C*L-1), COD (mg O2*L-1) and the Aliivibrio fischeri acute toxicity unit (aTU) of the original wastewater, relevant to treatment by ozonation alone, biodegradation alone and by the multistage system

In the effort to improve the efficiency and cost effectiveness of wastewater treatment, combining aerobic biodegradation with ozonation in a multistage treatment system has emerged as a feasible option.

In their study, *Zhang et al. (2018*) analyzed the performance of catalytic microbubble (MB) ozonation using a commercial granular activated carbon (AC) as catalyst in synthetic acid red 3R wastewater treatment. The performance of catalytic MB ozonation treatment was investigated and compared with MB ozonation alone and coarse bubble (CB) ozonation under the same conditions, including ozone mass transfer, decolorization, TOC removal, ozone reaction efficiency and ozone utilization efficiency. The experimental apparatus is shown in Figure 7. A sealed reactor with a diameter of 200 mm and a height of 500 mm was used and its work volume was 10 L with a water height of 318 mm. An ozone generator (Guanyu, China) was used to produce ozone from oxygen.

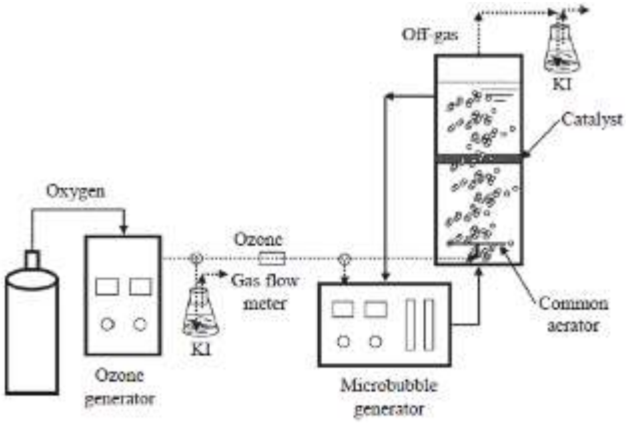

Fig. 7 - Experimental apparatus

The decolorization efficiencies of acid red 3R wastewater over time during CB ozonation and MB ozonation with and without AC are shown in Figure 8. The completed decolorization with the decolorization efficiency of more than 99% was realized after 15 min and 25 min in MB ozonation with and without AC, respectively.

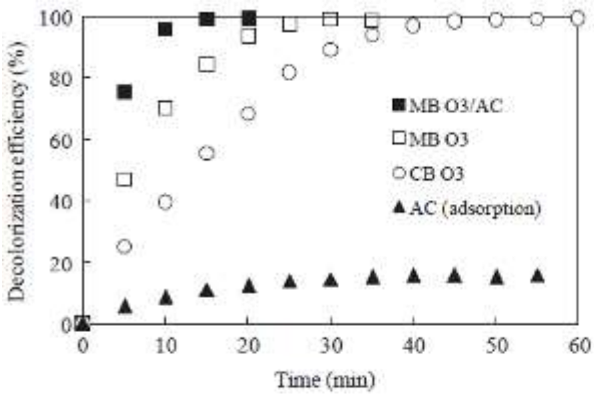

Fig. 8 - Decolorization efficiency of acid red 3R wastewater

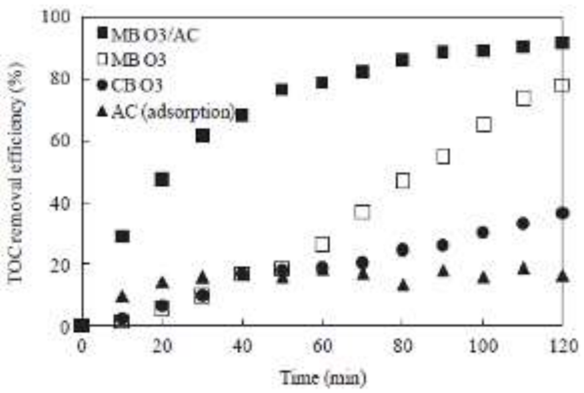

Fig. 9 - TOC removal efficiency of acid red 3R wastewater

The TOC removal efficiencies over time in CB ozonation and MB ozonation with and without AC are shown in Fig. 9. As expected, the TOC removal was efficient during the initial treatment period in catalytic MB ozonation with AC. Its TOC removal efficiency reached 78.2% after 60 min treatment and finally 91.2% after 120 min treatment, which was 18.6% higher than that in MB ozonation alone.

The comparison of these performances indicated that catalytic MB ozonation was considerably more efficient than CB ozonation and MB ozonation alone. The performance of catalytic microbubble (MB) ozonation using a commercial granular activated carbon (AC) as catalyst in synthetic acid red 3R wastewater treatment was more efficient than that of coarse bubble (CB) and MB ozonation alone. Therefore, the catalytic MB ozonation with commercial granular AC was a promising solution for wastewater treatment by ozonation process.

CONCLUSION

Disinfection is considered to be the primary mechanism for the inactivation/destruction of pathogenic organisms to prevent the spread of waterborne diseases to downstream users and the environment.

Ozone treatment has the ability to achieve higher levels of disinfection than either chlorine or UV, however, the capital costs as well as maintenance expenditures are not competitive with available alternatives. Due to its high oxidation potential, bactericidal properties, ease of on-site generation from air or oxygen, and ease of destruction to form ordinary oxygen, ozone has become widely used in a large number of applications, the most representative being the wastewater treatment field.

The MicroSparge™ technology for measurement of dissolved ozone concentration currently is being applied to a wide range of waters to determine the limitations of the technique with respect of loadings of organic compounds and particulate matter. In the effort to improve the efficiency and cost effectiveness of wastewater treatment, combining aerobic biodegradation with ozonation in a multistage treatment system has emerged as a feasible option. The comparison of these performances indicated that catalytic microbubble ozonation was considerably more efficient than coarse bubble ozonation and microbubble ozonation alone. Therefore, the catalytic microbubble ozonation with commercial granular activated carbon was a promising solution for wastewater treatment by ozonation process.

ACKNOWLEDGEMENT

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INHIBITORY EFFECT OF ESSENTIAL OILS ON COMMON FUNGAL PHYTOPATHOGENS *FUSARIUM* AND *ALTERNARIA*
/
EFECTUL INHIBITOR AL ULEIURILOR ESENTIALE ASUPRA FUNGILOR FITOPATOGENI COMUNI FUSARIUM SI ALTERNARIA

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Keywords: *essential oil, phytopathogens, Fusarium, Alternaria*

ABSTRACT

Medicinal and aromatic plants produce secondary metabolites for defense and adapt to environmental factors. One of the most studied active compounds in plants are the essential oils, used for a long time in pharmacy, cosmetics, aromatherapy, and in the fight against crop parasites. The paper highlights the antifungal action of volatile oils of mint, thyme, sage and cloves against two phytopathogenic molds, Fusarium and Alternaria. The calculation of growth rate and percent inhibition has shown that essential oils of thyme and cloves have the most powerful effect on the growth of fungal colonies.

REZUMAT

Plantele medicinale și aromatice produc o serie de metaboliți secundari cu rol de apărare și adaptare la factorii de mediu. Unii din cei mai studiați compuși activi din plante sunt uleiurile esentiale, utilizate de multă vreme în farmacie, cosmetică, aromaterapie și în lupta împotriva paraziților plantelor de cultură. Lucrarea arata acțiunea antifungică a uleiurilor volatile de mentă, cimbru, salvie și cuișoare asupra mucegaiurilor fitopatogene Fusarium și Alternaria. Calculul vitezei de creștere și al procentului de inhibiție au demonstrat că uleiurile esențiale de cimbru și cuișoare au cel mai puternic efect asupra creșterii coloniilor fungice.

INTRODUCTION

Persistent application of pesticides often leads to accumulation in the environment and to the development of resistance in various organisms. These chemicals frequently degrade slowly and have the potential to bio-accumulate across the food chain and in top predators. Cancer and neuronal damage at genomic and proteomic levels have been linked to exposure to pesticides in humans. These negative effects encourage search for new sources of biopesticides that are more "environmentally-friendly" to the environment and human health. Many plant or fungal compounds have significant biological activity associated with the presence of secondary metabolites (*Cespedes et al., 2015*).

Cereals constitute a staple food for all over the world as well as the main source of animal feed. For decades, various agricultural practices have been applied to protect crops from molds and their mycotoxins. However, the current approaches dealing with the fungal phytopathogens were based on the use of chemical agents that are reported to be acutely and chronically hazardous to humans, animals and ecosystems. Within the context of the ''organic farming" and the sustainable development concern, alternative practices have to be developed, notably the biological solutions that maintain the quality and the abundance of crops with respecting the ecosystems and human and animal health (*Nguyen et al., 2017*). During storage, fruits and vegetables are often subject to varying levels of microbial decay, mainly due to pathogenic fungi, which usually infect the host through wounds sustained during harvest, handling and/or processing (*Lagrouh et al., 2017*).

The therapeutic virtues of aromatic essences have been known since antiquity. However, interest in the scientific study of the power of aromatic and medicinal plants has only increased in recent years, with the aim of seeking alternatives to chemicals that present risks to human health and to the environment.

Recently, many researchers have demonstrated that essential oils, due to their low toxicity and environmental effects and wide public acceptance, should be used as a promising alternative to synthetic fungicides (*El Ouadi et al., 2017*).

Secondary metabolism of plants is responsible for the synthesis of numerous bioactive substances, which provide protection against insects, pathogens and limit the growth of other plants species. Essential oils and plant extracts contain a multitude of bioactive substances, including alkaloids, cyanogenic glycosides, glucosinolates, lipids, phenolics, terpenes, polyacetylenes and polythienyls (*Borges et al., 2018).*

Essential oils are volatile secondary metabolites and are produced by plants as signals in several interactions among other organisms, such as fungi and other plants. They have an important role in defense mechanisms against pathogens and pests, and in the interactions between plants, because they can inhibit and/or stimulate germination and development of other plants *(Ferdeș M., 2018*). Search for essential oils that present antimicrobial activity is increasing, since they possess desirable characteristics such as fast degradation and low toxicity to non-target insects and animals besides they presented minimal impact on the environment and humans (*Tomazonia et al. 2018*).

The most common scenario in plant pathology research is to use extracts and oils in their raw state for managing fungi, bacteria and nematodes. In controlled conditions, extracts and essential oils from diverse plant species have shown efficiency in inhibiting plant pathogens. However, the promising results obtained in laboratory or greenhouse are usually not observed in the field, with few exceptions. Degradation and volatilization of bioactive compounds are the major factors that reduce the efficiency of plant-based products under field conditions. Consequently, the potential suitability of certain plant material for use in agriculture ends up being underestimated due to losses of bioactive substances. One option to avoid these drawbacks is to formulate bioactive plant products using polymers, plasticizers, stabilizers and biodegradable antioxidants. Polymers, emulsifying agents, surfactants, solvents, stabilizers, defoamers and other components are used to ensure the stability, adherence and controlled release of the bioactive compounds, depending on the type of formulation (*Borges et al., 2018)*.

Several plant-derived compounds have been reported as defense mechanisms, activated upon pathogen attack. Among such mechanisms, the antimicrobial peptides (AMPs) have been described as being able to kill or slow the growth of infecting microorganisms and help to develop plant adaptive immunity. In this field, AMPs provide innate immunity by the rapid formation of a "first defense line" against phytopathogens. Hundreds of different antimicrobial proteins and peptides encoded within the genomes of plants have been described, and plant seeds have been used as a target for identification of plant AMPs (*Ferdeș M., 2018; Mandal et al., 2013*).

An example of agro-industrial by-products of high potentials are olive mill wastewaters (OMW) which are generated during the olive oil extraction by the traditional milling and press processes. Recently, any researchers tried to take advantage from the phytotoxic and antimicrobial properties of OMW by using it in agriculture as biopesticide for crops protection (*El-Abbassi et al., 2017*). Another antifungal compound from plants is an enzyme, the urease. Ureases are widespread in plants, fungi and bacteria but are not synthesized by animals. Plant and fungal ureases are usually trimers or hexamers of a single type of polypeptide chain with ~90 kDa, while bacterial ureases are multimers of two or three subunits complexes (*Carlini C.R., 2016*).

The aim of this paper is to analyze the potential of essential oils of mint, thyme, sage, and cloves to inhibit the growth of fungal phytopathogens *Alternaria alternata* and *Fusarium oxysporum* in crop plants.

MATERIAL AND METHOD

Fungal strains and culture media

The effect of essential oils have been tested using two fungal strains, commonly found in plant cultures, namely *Alternaria alternata* and *Fusarium oxysporum* from the Laboratory of Microbiology, Faculty of Biotechnical Systems Engineering. These fungi are well known for their spreading and the effects they produce on crop plants.

The two strains were cultivated onto potato dextrose agar, in tubes, at 25 °C, for about 7 days and preserved at 4 °C until use. The growth rate was evaluated by measurement of diameters of colonies in Petri dishes, on potato-dextrose agar, at 25 °C.

Antimicrobial vapor assay

Four essential oils (mint, thyme, sage, cloves) commercially available, were used to test the inhibitory effect on the fungal phytopathogens *Fusarium* and *Alternaria*. Each Petri dish containing culture media was inoculated with 2 µL containing a suspension of $10^8 mL^{-1}$ fungal spores. Volumes of 5, 10 and 20 µL of essential oils were pipetted on the inside of the Petri dish cover. The dishes were tightly closed with adhesive tape and incubated at 25 °C for 9 days. The diameter of fungal colony was measured after 3, 6, and 9 days, with a ruler.

Radial growth rate and inhibition ratio

In order to estimate the radial growth rate of fungal colonies, the maximum diameter of colonies was measured and the ratio diameter/time was calculated.

The inhibition ratio was estimated using the formula:

$$Inhibition\ ratio = \frac{C-S}{C} \times 100 \qquad (1)$$

where C is the diameter of mold colony in control plate and S is the diameter of the fungal colony grown in experiment plate containing the essential oil.

RESULTS

The experimental data of the growth of fungal colonies are shown in Figures 1 and 2. The measurement of colony diameters after 3, 6, and 9 days at 25 °C shows that the control colony is always larger than the colonies grown in the presence of essential oils. As expected, it was observed that the larger the volume of essential oil, the smaller the diameter of fungal colony. In the Petri dishes containing 20 µL of mint, thyme and cloves volatile oil, the colonies of *Alternaria* were almost completely inhibited (diameters less than 1 cm). The essential oil of sage seemed to have the weakest effect on fungal growth in cultures of *Alternaria alternata*.

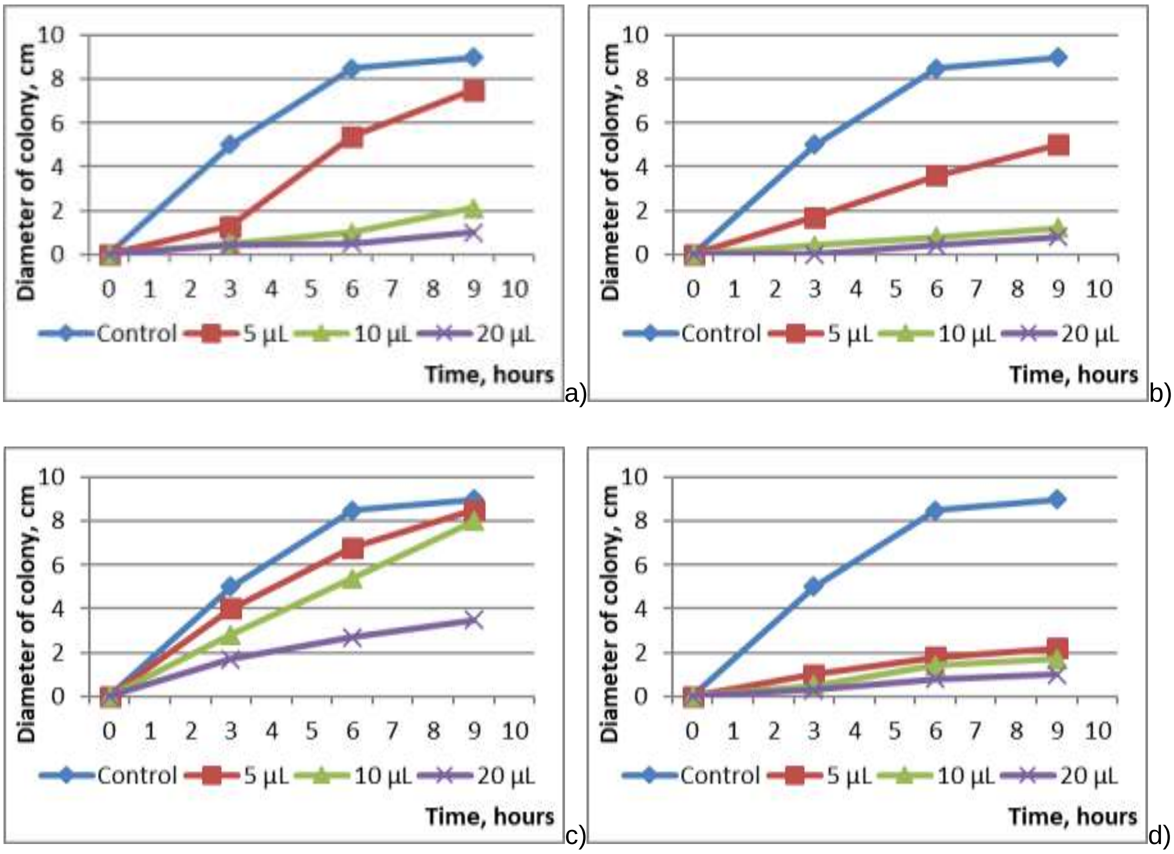

Fig. 1 - Variation of colony diameter in cultures of *Alternaria alternata* in cultures with a) mint, b) thyme, c) sage, d) cloves.

In the cultures of *Fusarium oxysporum*, the inhibitory effect of essential oils of thyme and cloves is even greater than in the case of *Alternaria*. Volumes of 10 and 20 µL of volatile oils caused a marked inhibition of fungal growth. The mint and sage have shown a lower effect on colony growth in the cultures of *Fusarium*, as can be seen in Figure 2.

For both fungal strains of phytopathogens, the appearance of colonies varies depending on the type of oil and volume added. Concomitantly with inhibition of growth, the absence of sporulation occurs and the fungal mycelium remains white.

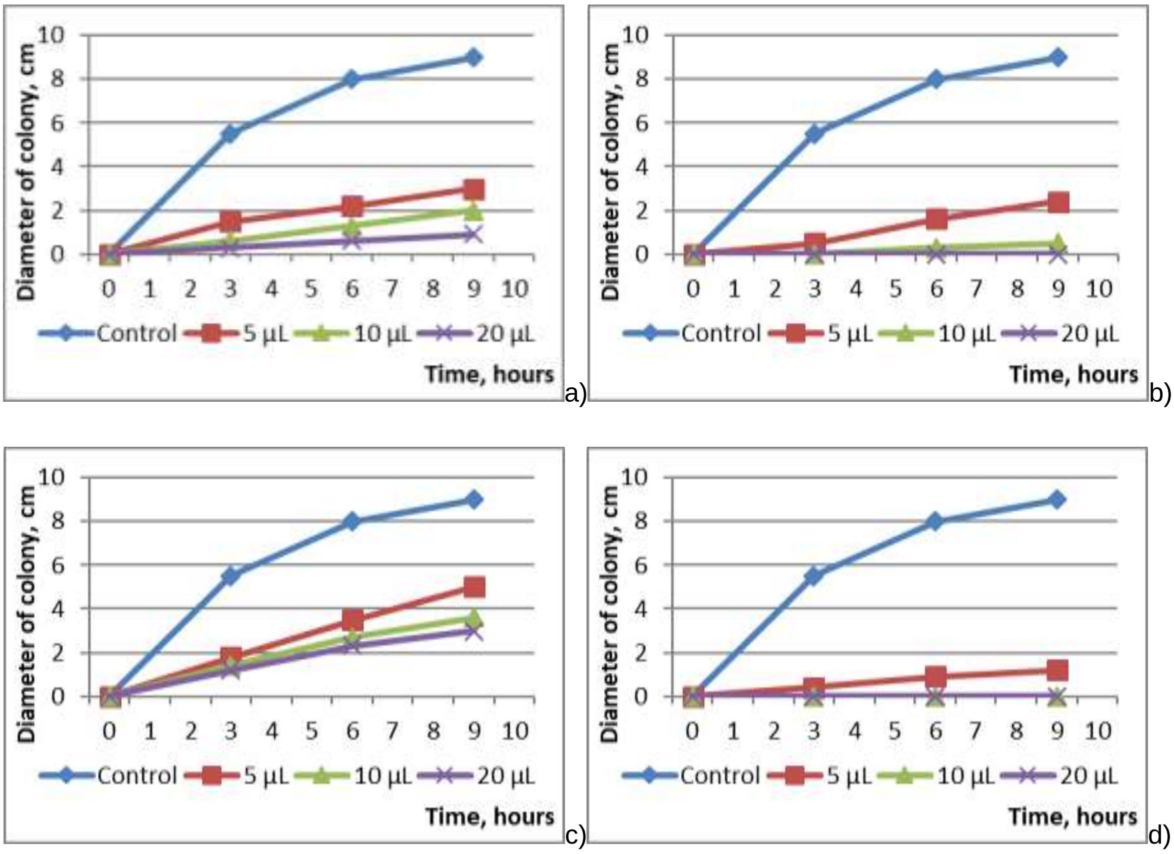

Fig. 2 - Variation of colony diameter in cultures of *Fusarium oxysporum* in cultures with a) mint, b) thyme, c) sage, d) cloves.

The radial growth rates for each fungal colony are shown in Table 1. For control plates, the growth rate was 0.42 mm·h^{-1} for *Alternaria* and 0.41 mm·h^{-1} for *Fusarium*. Essential oil vapors have determined lower growth rates, depending on the plant type and the added volume. In the Petri dishes containing volumes of 20 µL of thyme and cloves oil, the growth inhibition was total.

Table 1

The average growth rate for fungal colonies

Alternaria alternata	**Volume of essential oil, µL**			
	0	**5**	**10**	**20**
	Growth rate, mm·h^{-1}			
Mint	0.42	0.35	0.1	0.05
Thyme	0.42	0.23	0.05	0.04
Sage	0.42	0.39	0.37	0.16
Cloves	0.42	0.1	0.08	0.05
Fusarium oxysporum				
Mint	0.41	0.14	0.09	0.04
Thyme	0.41	0.11	0.02	0
Sage	0.41	0.23	0.17	0.14
Cloves	0.41	0.06	0	0

The antimicrobial activity of essential oils is based on the hydrophobicity, disturbance of the cytoplasmic membrane, disruption of the electron flow, active transport, and coagulation of cell contents. Other mechanisms include disturbances of the pH gradient and the electric potential of the proton motive force. The great effect of essential oils is due to the lipophilic nature of the hydrocarbon skeleton and hydrophilic nature of functional groups (*Ferdeș M., 2018*).

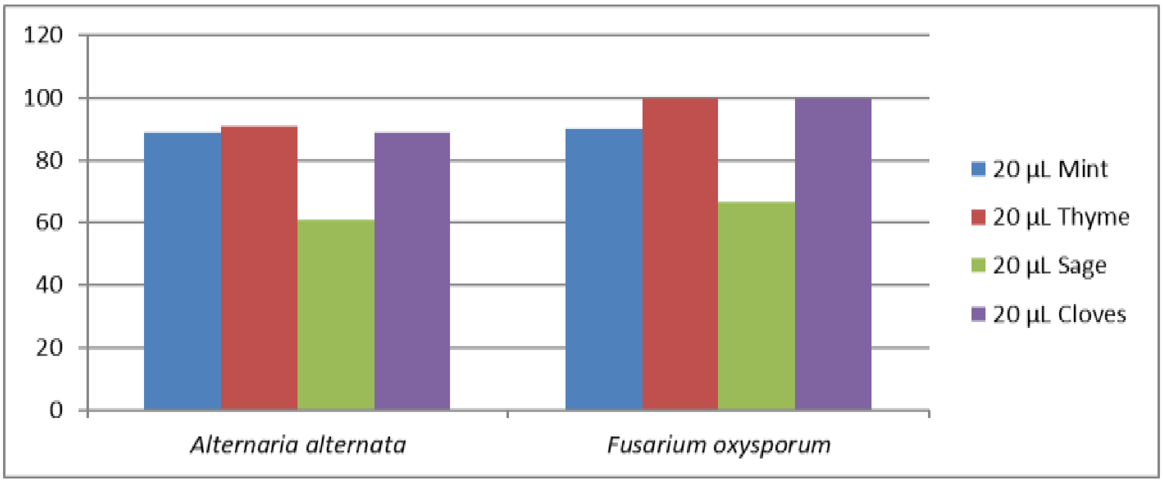

Fig. 3 - Inhibition ratio of essential oils in cultures of *Alternaria alternata* and *Fusarium oxysporum*

The essential oils cause different percents of inhibition ratio of mold colonies, as seen in Figure 3. The highest values of inhibition were recorded in the case of thyme and cloves oils, but *Fusarium oxisporum* seems to be more sensitive than *Alternaria alternata* in the same conditions.

Similar results have been obtained for *Citrus reticulata Blanco* essential oil against phytopathogens from North East India (*Chutia et al., 2009*), and for the essential oils of *Aloysia citrodora*, *Eucalyptus staigeriana*, *Cinnamomum camphora* and *Foeniculum vulgare* on fungal tomato pathogen *Stemphylium solani* (*Tomazonia et al., 2018*). Essential oils from different native Mexican aromatic plants have been screened for activity against a diverse set of fungal phytopathogens, and antifungal activity of varying intensities has been reported for EO from *Eupatorium glabratum, Chrysanctinia mexicana, Hesperozygis marifolia,* and other Mexican plants (*Calvo-Irabien et al., 2018*).

The largest group of plant pathogens is fungi belonging mainly to *Ascomycetes* and *Basidiomycetes* classes. These pathogens have developed sophisticated ways to penetrate plant surface, effectively - specialized infection structures and a repertoire of enzymes able to digest the external layers of the host plant (*Lazniewska J. et al., 2012*).

CONCLUSIONS

The inhibitory effect of four essential oils – mint, thyme, sage, cloves – has been tested against two fungal phytopathogens, *Alternaria alternata* and *Fusarium oxysporum*.

The measurement of colony diameters after 3, 6, and 9 days at 25 °C shows that the control colonies are larger than the colonies grown in the presence of essential oils. The growth rate of fungal colonies depends on the type and the volume of essential oil added in the culture.

For both *Alternaria alternata* and *Fusarium oxysporum,* the strongest inhibition effect was recorded for the thyme and cloves, while the sage had the weakest action on the growth of fungi.

The highest values of inhibition ratio were recorded in the case of thyme and cloves oils, but *Fusarium oxisporum* seems to be more sensitive than *Alternaria alternata* in the same conditions.

The great effect of essential oils is due to the lipophilic nature of the hydrocarbon skeleton and hydrophilic nature of functional groups. The most active molecules are the phenolic compounds, following in order by aldehydes, ketones, alcohols, ethers and hydrocarbons, that interfere with the cell membrane and with the enzymes involved in energy production.

In view of the results obtained, it can be concluded that essential plant oils can be used alone or in combinations to reduce the incidence of phytopathogens in crop plants.

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FINISHED ANALYSIS OF DENTAL FREQUENCIES
/
ANALIZA CU ELEMENT FINIT A FREZELOR DENTARE

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Keywords: *finite element, dental cutter, stressed cuttings*

ABSTRACT

Determining the optimal values of the parameters of the cutting process is a difficult operation, because there are multiple phenomena in the process (plastic deformations, external and internal friction, material creep, material relaxation, thermal phenomena, wear of cutting tools, modification of the cutting environment, etc.), in a very difficult interdependence described by mathematical functions. The utility of cutting tools consists in their participation in the process of generating the surfaces of a piece, by simultaneously or sequentially removing the layers of material that make up the machining addition.
The wide variety of machining processes involves the existence of different cutting tools, but whose active part contains, in principle, the same geometrical elements.

REZUMAT

Determinarea valorilor optime ale parametrilor procesului de așchiere reprezintă o operație dificilă, deoarece în cadrul procesului au loc multiple fenomene (deformații plastice, frecare exterioară și interioară, ecruisarea materialului, relaxarea materialului, fenomene termice, uzura sculelor așchietoare, modificarea mediului de așchiere etc.), într-o interdependență foarte greu de descris prin funcții matematice. Utilitatea sculelor așchietoare constă în participarea acestora la procesul de generare a suprafețelor unei piese, prin îndepărtarea simultană sau succesivă a straturilor de material ce alcătuiesc adaosul de prelucrare. Marea varietate a procedeelor de prelucrare prin așchiere presupune existența unor scule așchietoare de construcții diferite, dar a căror parte activă conține,în principial, aceleași elemente geometrice.

INTRODUCTION

In order for a dental cutter to be manufactured in optimum conditions, it is necessary for the designer to be subjected to modeling, simulation and analysis processes before making these cutting tools (*Ivan, 2011; Abele et. al., 2008*).

The Finite Element Method is a numerical method that can be used to accurately determine complex engineering problems. At present, the finite element method is considered to be one of the best methods for efficiently solving a wide variety of practical problems involving partial differential equations (*Paraian, 2008; Campomanes, 2003*).

The essence of the finite element method is to mesh a domain or region into sub domains or sub-regions (finite elements). This means replacing a domain having infinity of degrees of freedom with a system having a finite number of degrees of freedom. Elements are considered to be interconnected at specific points called "nodes" or nodal points (*Gradisek, 2005; Landers, 2002*).

The shape, dimensions, number and configuration of the elements are chosen so that the simulated field is as close as possible to the original range, with the highest accuracy, without unduly increasing the effort of the computer to calculate the solution (*Străjescu, 1983; Lupulescu, 2000*).

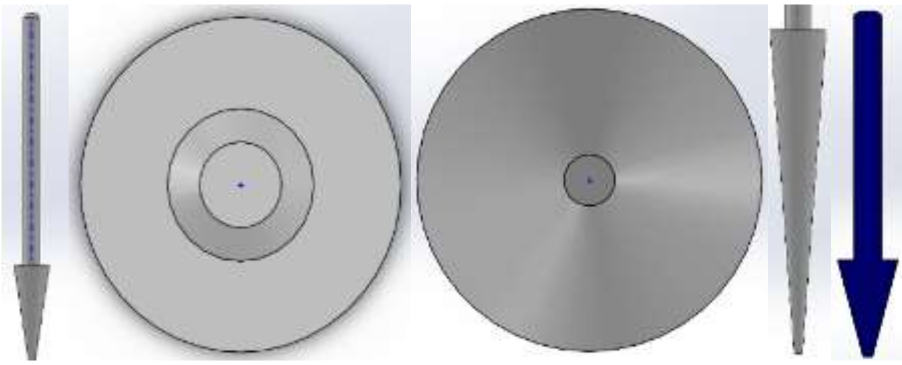
The purpose of this 3D numerical simulation with finite element study was to study the behavior of a dental cutter, subjected to the stresses that arise during operation (*Stelian, 2010; Dragoș, 2003*).

MATERIAL AND METHOD

In the first stage of this study, the three-dimensional geometric model of the dental cutter, made by Micro Diamond Technologies, was carried out. For this purpose, an ASUS K55V laptop has been used, which includes a 2.5 GHz Intel Core i5-3210M processor, an NVIDIA GeForce GT 630M video card with 2 Gb of memory, the laptop's RAM of 8 Gb . 3D modeling was accomplished with Solid Works Premium 2016 S.P. 0.0.

The three-dimensional modeling of the dental cutter was done in the "Parts" module of the design program, in the figure are presented different views of the obtained models and the interface of the Solid Works program.

The material from which the cutters are made is a nickel-chromium alloy having the following composition: 77.95% nickel, 12.6% chromium, 5% molybdenum, 2.9% aluminum, 1.95% beryllium, 0.35% titanium.



a. b. c. d. e.

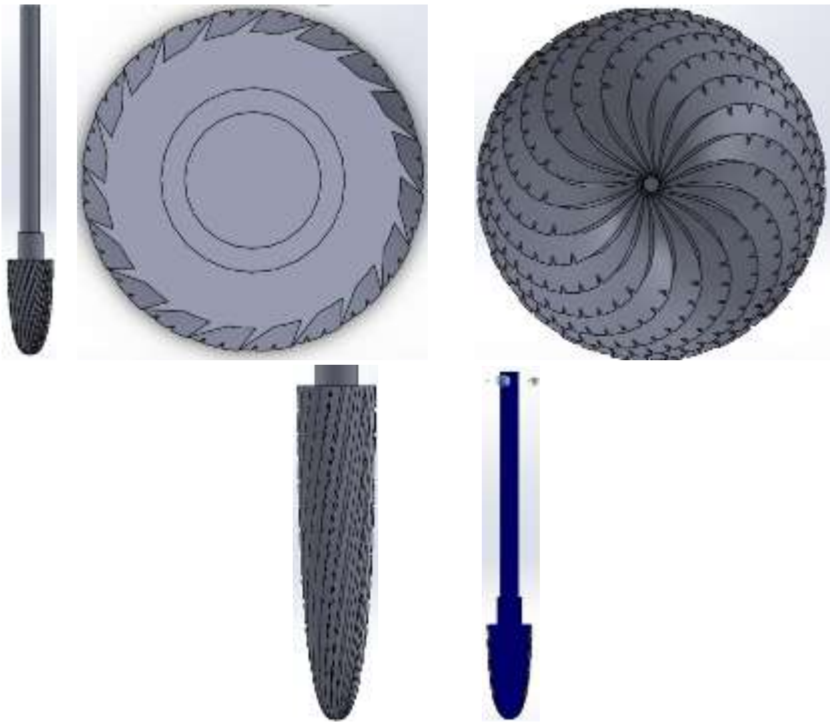
Fig. 1 - Three-dimensional modeling of three types of dental cutters

a. Front view, b. Top view, c. Bottom view, d. Detail on the milling area, e. longitudinal section

RESULTS

After this step was taken, the next step was to introduce the 2D geometric model of each longitudinal section cutter in the Simulation module of the Solid Works design program. In this regard, the following simplifications of the process where made:

- The analysis was carried out in the plane of deformation of the geometric model made for each pattern of milling;
- Each cutter is embedded at the end of the milling area where it receives the motion from the pneumatically actuated micro motor;
- It is assumed that a pressure of 1MPa is applied to the external area of each milling area of each milling machine;
- It has also been considered that each milling machine is driven in rotation at a speed of 30,000 rpm (ω = 3141,6 rad / s).



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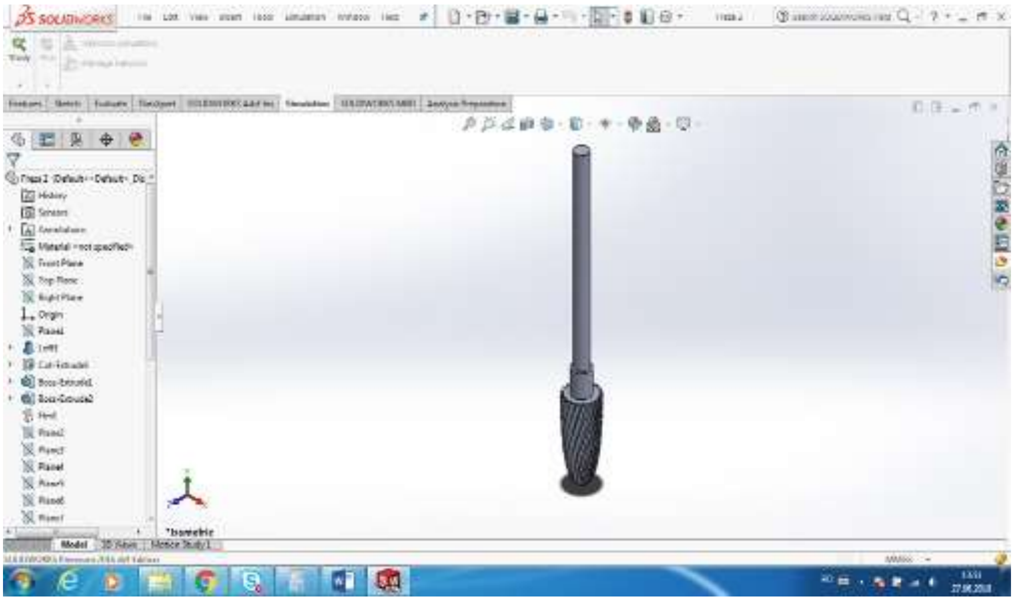

Fig. 2- Views of the dental model

a. Front view, b. Top view, c. Bottom view, d. Detail on the milling area, e. Longitudinal section, f. Isometric view of the milling cutter, and interface of the software used

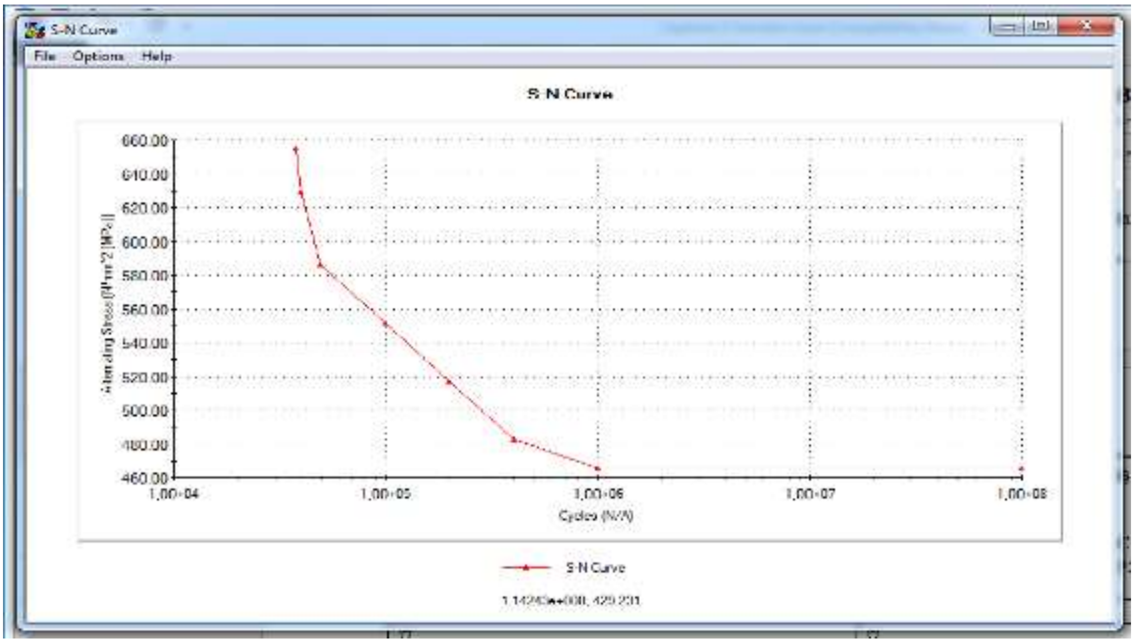

Fig. 3 - The fatigue curve of the nickel-chromium alloy used to make the other milling patterns

After applying these assumptions to the geometric model of the three cutters, the view from the front of the cutters is shown in Figure 4.

Fig. 4 - The front plan for the geometric model of the three studied mills , after applying simplifying assumptions

After performing the simulation, the program recorded in its own database the values of all requests that act on the three cutting patterns. The finite element mesh model of the three cuts is shown in Figure 5. After meshing the finite element network, the simulation was run, the results of which are shown in Appendix 1: Fret 1, 2 or 3_uset_Buna-Static 1-1.

Fig. 5 - Finite Element Displacement of the Geometric Model

Following the simulation, the design program provided the graphical results; the geometric model is divided into areas of a certain color, each area comprising the region of the geometric model in which the analyzed size has the value specified in the chromatic legend on the right side of the screen.

For molded and analyzed dental modeling models, the results from simulation in Solid Works are presented below. Thus, in Figure 6 are presented the values of displacements occurring in the cutters during the previously defined stresses.

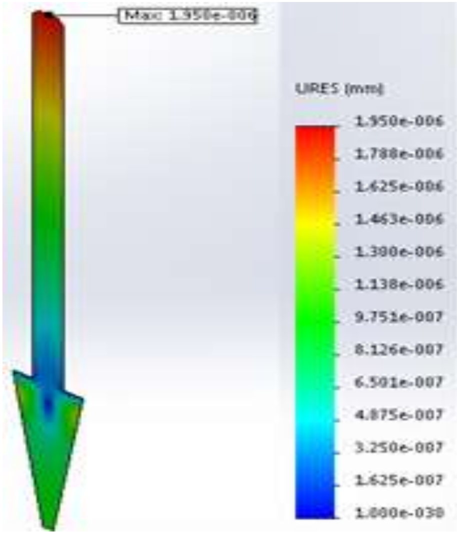

Fig. 6 -The values of the displacements appeared in the third models of analyzed dental cuttings

Analyzing these data, it can be observed that the largest displacements of the nodes in the worm structure occur either in the dental cutter micro motor gripping area its maximum value being $1.95 \cdot 10^{-6}$ mm.

Figure 7 shows the values of the equivalent stresses in the three stressed cuttings under tension, stresses calculated by the von Misses criterion.

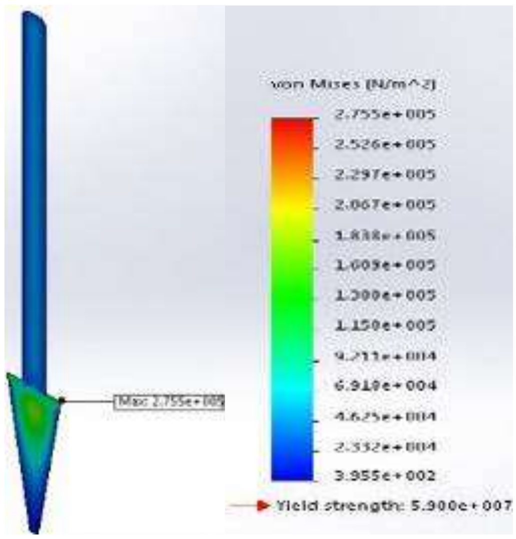

Fig. 7- The values of the stresses equaled by the von Misses criterion in the three analyzed dental cut patterns

Analyzing fFgure 7, it can be seen that in the structure of the dental cutters there appears a stress concentrating point located in the milling area, the values of the von Misses equivalent stresses created at this point being 2.76 $\cdot 10^5$ Pa. Taking abstraction from this point, it can be seen that the maximum stress in the milling area of the three dental cuts is around $4 \cdot 10^4$ Pa.

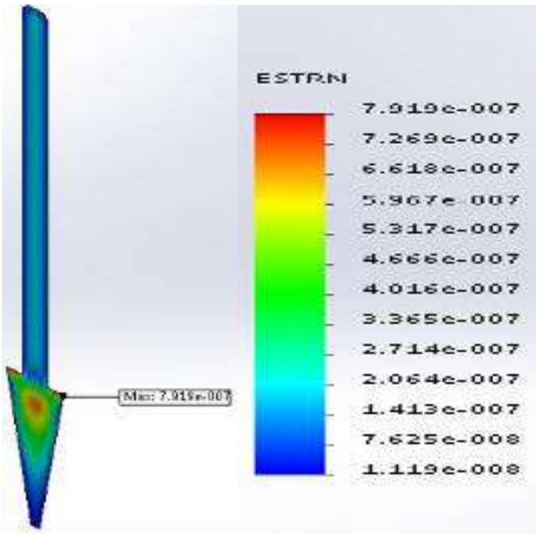

Fig.8. Equivalent deformation values occurring in the three analyzed dental cuttings

Analyzing Figure 8, we can observe the values of the equivalent deformations occurring in the three mills following the stress they are subjected to. Thus, the maximum equivalent deformation occurs at the same stress concentrator point, the deformation value being $7.9 \cdot 10^{-7}$, whereas the minimum equivalent deformations for the three dental cuts have values below 2.19 10^{-9}.

CONCLUSIONS

• In order to process the dental cutters in optimal conditions it is necessary that the designer's model be subjected to modeling, simulation and analysis processes before making these cutting tools.

• The shape, dimensions, number and configuration of the elements are chosen so that the simulated field is as close as possible to the original field, with the highest accuracy

• The aim of this 3D numerical simulation study was to study the structure behavior of three types of dental cutters, subject to the stresses that arise during operation.

• The next step was to insert the 2D geometric model of each longitudinal section cutter into the Simulation module of the Solid Works design program.

• Analyzing these data, one can notice that the largest displacements of the worms in the worm structure occur either in the denture micromotor gripping area, its maximum value being $1.95 \cdot 10^{-6}$ mm for the dental cutter model 1, $5.75 \cdot 10^{-5}$ mm .

• It can be seen that in the dental cutter structure there appears a stress concentrating point located in the milling area, the Von Mises equivalent stress values created at this point being $2.76 \cdot 10^5$ Pa for model 1, $7 \cdot 10^5$ Pa.Taking this point away, it can be seen that the maximum stress in the milling area of the three dental cuttings is around 4.10^4 Pa

• The maximum equivalent deformation occurs at the same stress concentrator point, the deformation value being $7.9 \cdot 10^{-7}$, while the minimum equivalent deformations for the three dental cuts have values below $2.19 \cdot 10^{-9}$.

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CONSTRUCTIVE SOLUTIONS FOR DISTILLATION INSTALLATIONS FOR OBTAINING ALCOHOL
/
SOLUȚII CONSTRUCTIVE PRIVIND INSTALATIILE DE DISTILARE PENTRU OBȚINERE DE ALCOOL BRUT

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Keywords: *distillation installations, periodic operation, continuous operation, raw alcohol.*

ABSTRACT
This paper presents a synthesis regarding the constructive solutions of distillation plants for the production of raw alcohol. The notion of alcohol originates in the Arabic words of (article) and cohol (subtle work). Typically, the alcool produced by the industry is called alcohol, thus meaning a mixture of alcohol, water and other elements, ethylene alcohol (the scientific name) being the main component: 95-96.6% by volume. Worldwide, the highest amount of raw alcohol (spirits) is obtained by fermentation, the raw materials commonly used in the order of their weight are: molasses, potatoes, cereals (especially corn), sugar beet, sugar cane, etc.

REZUMAT
Lucrarea prezintă o sinteză în ceea ce privește soluțiile constructive de instalații de distilare pentru obținerea de alcool brut. Noțiunea de alcool își are originea în cuvintele arabe al (articol) și cohol (lucru subtil). Uzual, alcolul produs pe cale industrială este denumit spirt, prin aceasta înțelegându-se un amestec de alcool, apă și alte elemente, alcoolul etilic (denumirea stiințifică) fiind component principal: 95-96,6 % volum. Pe plan mondial, cea mai mare cantitate de alcool brut (spirt) se obține prin fermentație, materiile prime frecvent folosite, în ordinea ponderii lor, fiind: melasa, cartofii, cerealele (îndeosebi porumbul), sfecla de zahar, trestia de zahar, etc.

INTRODUCTION
Raw alcohol (spirit) has many uses in various industries, so in the food industry it is used for the preparation of alcoholic beverages and vinegar, in the pharmaceutical industry for the preparation of certain substances (chloroform, ethers, etc.), in the chemical industry for the manufacture of synthetic rubber and dissolving, and in medicine as a disinfectant. Mixed with gasoline is used as fuel, (*Aruna et all., 2019*). Useful substances they contain, raw materials used in the raw alcohol industry are classified as: raw materials containing alcohol (wine, yeast, marc, fruit wine), raw materials containing fermentable sugar (sugar beet, cane sugar, molasses, sorghum, etc.), raw materials containing starch (potato and potato flour, corn, wheat, rye, oats, barley, millet, chestnut, etc.), sponges, spruce waste, bisulphates produced from cellulose production), raw materials containing inulin or lichenin (topinambur tubers, gehergin and chicory roots containing inulin).

After their construction and mode of operation, distillation plants are divided into two groups:
- distillation systems with periodic operation;
- Continuous distillation equipment.

Distillation plants with periodic operation. During the first period of development of the spirit industry (until the end of the 17th century), distillation apparatuses with periodic functioning were used. These are nothing more than alambics, which are still used in the present to obtain the fruit of fruit tart or wine distillate from which the cognac is produced.

Alabaster construction is very simple, as shown in Figure 1. An Alambic consists of a boiler 1 made of copper, the lid 2, the loading mouth 3, the dome 4, the furnace 5, the cooling coil 6 and the cooler 7.

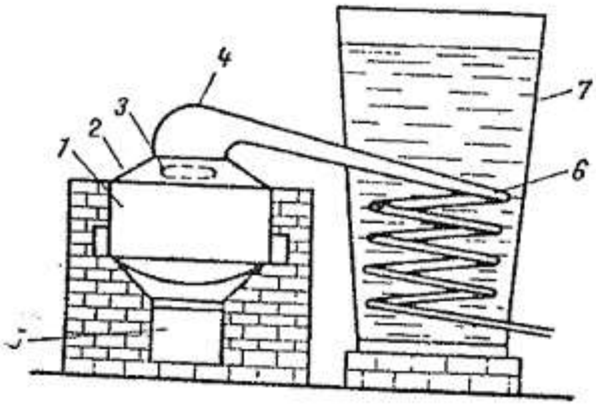

Fig. 1 - Alembic (*Apostol L., 1969*)

The building material used is copper. By the loading mouth 3 the alcoholic material being subjected to distillation (botot of fruit, wine or wine yeast) is introduced. After the cover is closed, the boiler is boiled with a fire or a steam, in which the bottom of the boiler has a shirt. By boiling alcoholic liquor, alcohol and other volatile components are vaporized. In dome 4, the vapor is partially condensed. Alool vapors continue to penetrate through cooling coils in the racito, and the liquid is trapped at the outlet, (*Audilakshmi et all, 2019*). A single distillation can not achieve a desired concentration and therefore about 4 to 5 successive distillates of distillates must be made in order to achieve the desired alcoholic strength.

MATERIAL AND METHOD

Distillation plants with continuous operation. In the raw alcool industry in our country we use exclusively distillation systems with continuous operation. They are made of copper or cast iron. Figure 2 shows the scheme of a continuous distillation plant consisting of the following apparatuses: pump 1 for feeding the distillation column with the fermented plate; the distillation column of fermented lamellar; borot 3 regulator; the deflector 4; condenser - cooler 5; filter and control lantern 6; the measuring device (control) of the quantity of alcohol produced 7. To understand the operation of the distillation plant the following is a brief presentation of the construction, the role and the functioning of each particle of the installation.

Fermented plamen pump. For filling the distillation columns, special construction feed pumps are used, aspirate the flame from the fermentation line and refold it at some height at the feed point of the column. In the spirit industry, the most widespread are steam or electric piston pumps. These pumps, also known as plunger pumps, have the advantage of regulating the flow of the plate by changing steam (steam driven) or changing the stroke of the piston. Important in the operation of this pump is the fact that it can ensure a uniform flow, and therefore a constant flow of the plamade, a safe adjustment, with the possibility of aspirating the liquid and from levels below the floor, i.e from the fermentation plaque collectors (*Apostol L., 1969*).

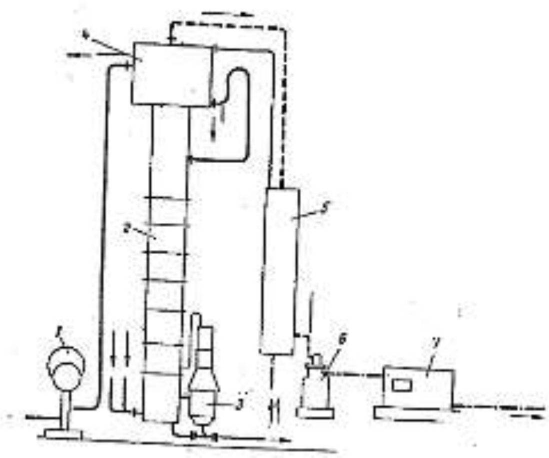

Fig. 2 - Scheme of the continuous-mode dislocation facility (*Apostol L., 1969*)

In recent times, electric actuation of the flame pumps has also been applied by means of trapezoidal belts or gears. The advantage of electric drive is that the pumps work uniformly, no longer dependent on steam pressure. The modern ones are electrically driven horizontal piston pumps that also show safe operation.

The continuous operation distillation column is the main part of the distillation plant by means of which the flame distillation is carried out. All other appliances that have been shown in the installation layout are the annexes to the distillation column. Columns or distillation apparatuses are mostly made of copper, and rarely cast iron is no longer used for their construction because they are very fast because of the fermentation of the fermented plaques. Figure 3 shows the log section of distillation columns.

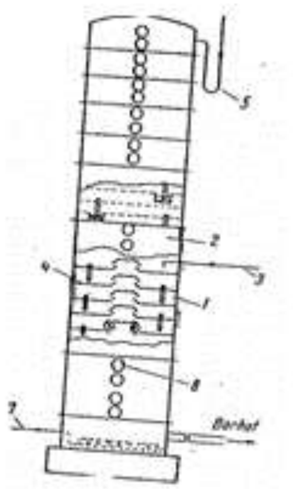

Fig. 3 - Diagram of the distillation column, (*Apostol L., 1969*)

From a constructive point of view, a distillation column has the following components:

- column 1 of flame or flame exhaustion column which is the bottom of the appliance, from the feed tray to the foundation;
- column 2 of lute or concentration, which is the top of the gap, from the feed tray to the point of coupling of the column with the deflector;
- the connection 3 for introducing the flame onto the boiler feed tray;
- the flap column 4, which is the first tray at the top of the firing column and which connects the boiling column with the concentrate;
- the patch 5 of the phlegm of the deflector in the column of concentration, when it is not mounted on the column;
- the connection 6 for the output of the bore in the column, which connects with the borhot regulator;
- the steam introduction pipe 7 into the distillation column;
- the viewfinder 8, which is mounted on each strand of the strand to observe the level of the flame and its movement during operation.

To understand how the plant works, it is necessary to know more about the construction of the distillation column and the phenomena that occur inside it during operation. The boiling column 1 is composed of: column segments of the same diameter and identical in terms of construction. These segments are connected to one another by a screw flange across the circumference. Each segment has 2 to 4 cups in its interior, the role of which will be described in the following. The first segment at the base of the column is 700 - 800 mm high and has no trays. In this segment, steam is introduced into the column through a perforated serpentine and through it is removed the borot (the dealcoholised plate) from the column. By assembling the segments described above a boiling column is obtained which has 12 to 16 compartments separated by the plates. The diameter of the boiling column is variable depending on the projected capacity of the distillation plant, ranging from 850 mm to the small columns and 1400 mm to the high capacity columns. The distance between the tiles is 250 - 300 mm or higher (large columns), (*Deidre et all., 2012; Apostol, 1969*). From a constructive point of view, of the way of operation and efficiency, the trays are two slats: trays with simple iron lines and double boiler trays.

Figure 4 presents a longitudinal and transverse section a tray segment with tray and a simple boiling line. The tiles are made of copper sheets. The parts of a simple boiling pan are the following: In the segment 1 of the column 1, the tray 2 is mounted, which has the bell 3, the overflow pipe 4 and the steam patch 5.

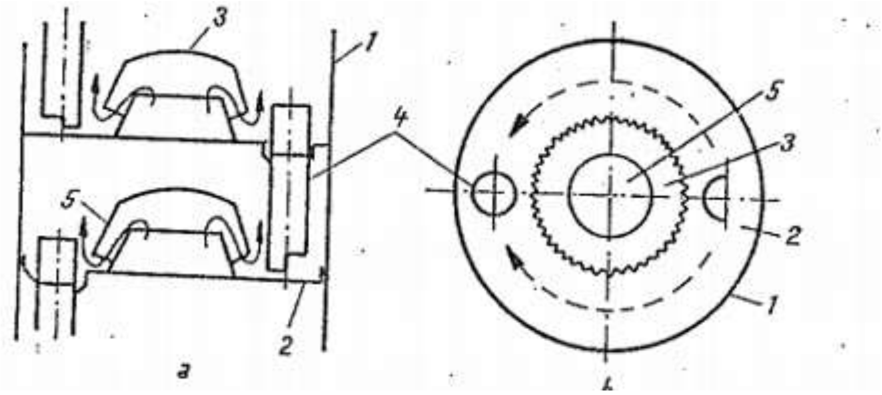

Fig. 4 - Simple boiling thalers (*Apostol L., 1969*)
a-longitudinal section, b-cross section

In principle, the trays are made as follows: Cut a copper disk with a diameter of more than 5 cm above the diameter of the column. At the center of the tray there is a hole, whose edges bend upwards, forming a neck through which the steam penetrates and which does not let the liquid drain from the tray. The pallet neck is covered with a bell made of copper sheets that fixes itself so that its edge is 300 mm away from the tray. Also, a hole in the copper plate is made, in which an overflow pipe is mounted, the upper end of which is 55-60 mm above the level of the bottom plate. The plate forming the distillation tray bends round about, forming a 2.5 cm margin, which is fixed by riveting the column casing and water mowing.

The mode of operation of the simple baking tray is the following. The steam introduced at the bottom of the column (in the last segment) penetrates through the neck of the pan. The bell's bell has its edges dipped in the flame forcing the steam to penetrate into it, heating the firing point. The lighter volatile alcohol is entrained from the vaporous liquid and goes to the next tray where phenimen is repeated.

Thus, from one taler to another, vapor is becoming more and more concentrated in alcohol. The circulation of the plame is done as follows: The fermented plamea preheated in the four-stroke petheler. Between this food tray and the first tray of the concentration column, a space of about 50 cm is left. The plate reached on the feed tray can not leak through the steam penetration hole because the maximum height of the liquid layer is below the neck, being regulated by the overflow pipe. When the level of the flame exceeds the upper edge of the overflow pipe, the flame leaks through it on the next plate. The overflow pipe on the upper plate has the lower part dipped in the plate on the immediately lower tray, because the vapor does not penetrate through it and thus prevents the circulation of the plame. In its downward direction, the plaque suffers a de-alcoholisation on each taler, so that in the lower segment of the column it no longer contains alcohol, being finally eliminated as a borhot from the column. Thus, knowing the phenomena that occur on the plates, it results in the distillation column there is a countercurrent circulation of the flame vapor. As the vapor advances to the top of the column, it increases its alcohol concentration and lowers its temperature, while the flask loses its alcohol to the bottom of the column, until its exhaustion and its temperature increases, (*Kersenbrock L., 1979, Reddy et al., 2005*).

RESULTS

Borhot regulator. This device automatically adjusts the burst output in the column so that its level at the column level is constant. As illustrated in Figure 5, the borhot regulator is composed of a cylindrical vessel 1 in which there is found a float 2 crossed by a shaft 3 which exits through the lid of the vessel outwards with a handle and at the lower end terminates with a pin 4 which closes the pipe 5 through which the borehole in the regulator is evacuated.

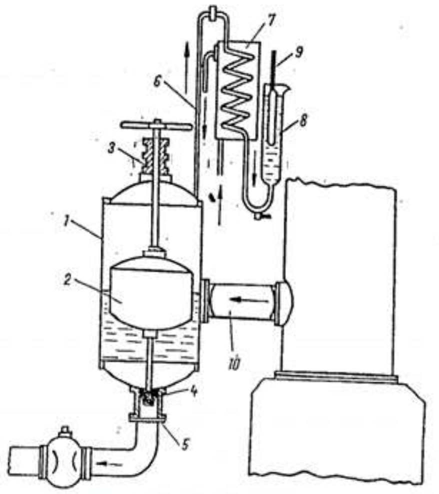

Fig. 5 - Borhot regulator (*Apostol L., 1969*)

A conduit 6 is also mounted on the regulator cover, through which the internal vapor enters. They are condensed in the cooler 7 and the condensate enters the control tube 8 in which the alcohol meter 9 is permanently located. The regulator is in communication with the distillation column through the conduit 10.

The mode of operation is as follows: When the collar level increases, the pressure of the fluid column increases. In this case, a higher boron flow is evacuated which raises the float. In turn, the float opens the exhaust pipe at the bottom of the regulator. If the burrow level in the column decreases, the drain also decreases and as a result the float descends by partially or completely closing the outlet of the borot controller. The role of the adjacent vapor capture and cooling installation in the regulator is to periodically control the test tube if the evacuated borehole does not contain alcohol. Through the pipeline that connects to the borhot regulator, called the lutex pipe, the vapor penetrates the coil coil where it condenses. In the control tubes is always an alcoholometer with gradients from 0 to 3 degrees of alcohol, which indicates the alcoholic strength of the condenser.

Alcoholic vapors that appear as boiling columns are not so rich in alcohol that, after condensation, the liquor obtained has the alcoholic strength of raw spirit (80%). The alcohol vapor concentration increases with the concentration column. Its normal operation can be ensured by the continuous flow of alcohol. This condition can be done with the help of the clamp. The throttle is a heat exchanger, which besides the function of feeding the alcoholic spill column, and the role of concentrating in addition to the alcohol vapors that come out of the column, so that after they leave the deflector by condensation, they can give a coarse alcohol of the appropriate alcoholic strength.

Partial condensation of alcoholic vapors in the deflector is achieved by moderate cooling, so that vapor remaining uncondensed contains a larger proportion of the more volatile components and those which condense a larger proportion of less volatile components. Partial condensation of a vapor mixture is called defragmation, and the alcoholic liquid that returns from the deflector in the column is called reflux or phlegm. The cooling of the alcohol vapors entering the deflector is done with water or with the fermented flame before being introduced into the column, or combined with water and flame. The partial or, in some cases, total cooling of the fermenter flapper has a double advantage, (*Zhenglin L., 2014*).

On the one hand, the cooling water economy is achieved, and on the other hand the steam economy, because by passing through the deflector the plate is preheated before it reaches the feed tray, thus decreasing the thermal stress of the column. Also, by heating the flame, avoid foaming before inserting it into the column. In the case of cold plams there is an abundant foam (especially potato plaques), which can reach the deflector, condenser and even in the alcoholic meter.

In order for a deflector to work in optimal conditions, it must meet the following conditions:

- the vapors and coolant in the coil's spirals have to flow opposite each other;
- the reflux has to move from the cold side to the warmer side and to the countercurrent to the steam;
- The reflux must be in a more intimate contact with alcoholic vapors.

By following these principles, reflux comes into contact with hotter vapors that continue to extract alcohol by enriching the vapor. The deflector has a function similar to that of the concentration column, thus contributing to the decrease of the plate count. The capacity of the deflector must be correlated with that of the distillation column. In the case of undersized derailleurs, the necessary amount of phlegm can not be achieved and, consequently, the raw alcohol obtained has a low alcohol concentration. When the derailleur is oversized, it is very difficult to regulate the flow of the cooling agent to determine the optimal amount of reflux that returns to the column. The characteristic size of the deflector is the cooling surface that can be 20 to 40 m2 in relation to the capacity of the distillation column. The types of deflectors used in the spirit industry are as follows: Tube clamps, which are shown in the longitudinal section in Figure 6.

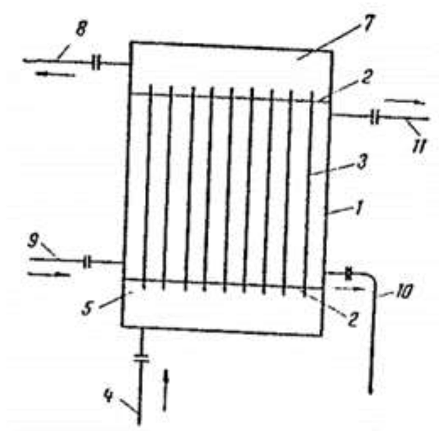

Fig. 6 - Marc regulator (*Apostol L., 1969*).

In the casing 1 of the cylindrical shaped derailleur made of iron sheet, a copper plate 2 is mounted at the upper and lower part, where copper cooling pipes are fixed by means of torsion. Cooling water enters the connection 4, in the the lower cooling chamber 5 passes through the copper pipes and through the upper cooling chamber 7 the outlet 8 is removed from the deflector. Alcohol vapors penetrate through the connection 9 into the space between the cooling pipes. The condensate returns to the column through connection 10, the uncondensed vapor leaves the derailleur through the connection 11 and is guided through the connecting pipe to the condenser of the cooler.

The condensers are like heat exchangers that have a double action, namely the total condensation of the alcoholic vapors coming in the deflector and cooling at the desired temperature of the obtained alcohol. The main types of capacitors are the following: the tubular capacitor, the coil capacitor and the combined condenser (with pipes and coil).

In Figure 7 shown in a longitudinal section a coil with a coil having the water inlet connections 1 and outlet 2, the connection 3 for entering the alcoholic vapors in the deflector, the cooling coils 4 and the connection 5 for the outlet of the spirits from the convector. This type of cooler is used in low-capacity distillation plants.

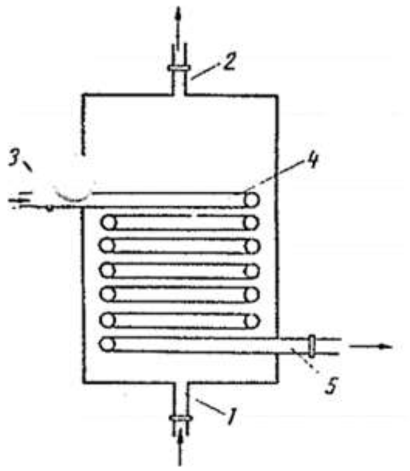

Fig. 7 - Condenser with serpentine (*Apostol L., 1969*).

In Figure 8, a condenser with pipes and coils is shown in the longitudinal section. Alcohol vapors penetrate into the first part of the convector (with pipes) through the connection 1, in which it condenses. The condensate then passes through the connection 2 into the cooling coil 3 of the lower half of the convector in which it cools and then exits it through the connection 4 by going to the control lamp. The cooling water enters the lower part through the connection 5, then enters the upper half pipes 6, passes into the collector chamber 7 and exits the connection 8, going through the connecting pipe to the deflector. At each of the condensers described above, a vent pipe 9 is mounted on the filter duct which connects to the filter, which has the role of venting the air and carbon dioxide passing through the column, as well as the vapor spirits condensable.

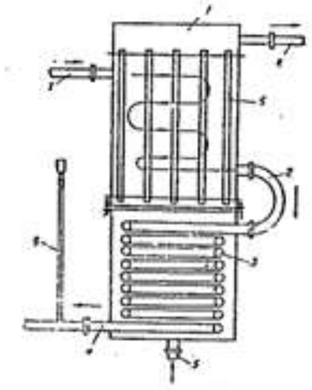

Fig. 8 - Combined condenser (with sepentine and pipes) (*Apostol L., 1969*)

Filter spirit and control lantern. The filter serves to retain impurities from the spirits, preventing their patronage in controllers (recorders of alcohol production), which are very sensitive and can be degraded. Figure 9 shows a filter-lantern assembly of coltrol. The control filter and lantern is in fact a single appliance, the control lamp being mounted on the filter 1, through the connection 2 from which it enters the discharge cup 3 of the lantern 4, which is a glass bell. In the beaker 3 is located the alcoholmeter 5 for controlling the spirits alcohol concentration and the thermometer 6 for controlling its temperature. From the beaker 3, the crude alcohol flows through the orifice 7 and the conduit 8 to the bottom of the filter. Moving from a small section to a much larger, the spirits get a quiet upward movement. Under these conditions, the macanic impurities in the spirt due to their higher specific weight are deposited on the circular discs 9 made of the sheet, which are placed in the filter one above the other. Each board rests on the next, on the 10th leg.

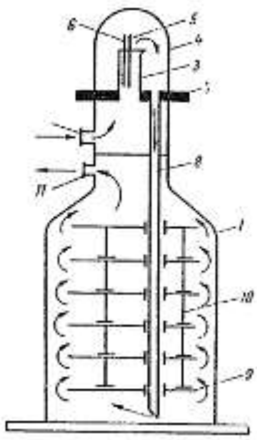

Fig. 9 - Crude alcohol filter (*Apostol L., 1969*)

CONCLUSIONS

By distillation, alcohol and other volatile vapors are extracted from the plate by heat. The vapors are condensed through the water cooler and brought into liquid state. By distillation, on the one hand, the alcohol is separated with other volatile substances, and the other remains a residue which is called borhot.

From a physical point of view, the fermented plaque is a solution in which several substances are dissolved. In terms of their distillation behavior, some are volatile (distillable) and others are fixed (undetectable), the solvent being water, which is itself a distillable substance. In addition to the existing solubilized solutions, fermented platelets also contain suspension elements, some of which are derived from the raw material, such as cereal shells, potatoes, sugar sorghum, topinambur etc., coagulated cell protoplasm residues, low amounts of fat, insoluble mineral substances (phosphates and hydrates of heavy metals from water used as raw material.

In addition to these suspension elements, there are also: yeast cells that caused fermentation, lactic bacteria when acidification was done with them or lactic bacteria, infected. The main volatile-distillable substances in the flame are: ethyl alcohol, higher alcohols (amyl, propyl, butyl), acetic aldehyde, volatile acetic acids, acetone-derived bacteria.

ACKNOWLEDGEMENT

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RESEARCH ON THE EXTRACTION METHODS OF GRAPE SEED OIL / *CERCETĂRI PRIVIND METODELE DE EXTRACȚIE A ULEIULUI DIN SEMINȚE DE STRUGURI*

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Keywords: *CO_2 extraction, grape seed oil, SFE, cold pressed oil*

ABSTRACT

This study focuses on the most effective ways to extract grape seed oil. Grape seed oil is a by-product of the wine industry due to the need to reduce the amount of waste, but at the same time it has been found that this oil is an excellent ingredient in cosmetics because it is easily absorbed by the skin and has properties that help wounds heal faster. The extraction method affects the quality of the oil through the applied pressure and temperatures. Suitable methods for extracting grape seed oil are: cold pressing, classic solvent extraction, CO_2 supercritical fluid extraction.

REZUMAT

Acest studiu este concentrat pe modalitățile cele mai eficiente de extragere a uleiului din semințe de struguri. Uleiul din semințe de struguri este un subprodus ce rezultă din industra vinicolă din necesitatea de a reduce cantitatea de deșeuri, dar în același timp s-a constatat că acest ulei este un ingredient excelent în produsele cosmetice deoarece este ușor absorbit de piele și are proprietăți ce ajută la vindecarea mai rapidă a rănilor. Metoda de extracție afectează calitatea uleiului prin presiunea și temperaturile aplicate. Metodele adecvate pentru extragerea uleiului din semințe de struguri sunt: presarea la rece, extracția cu solvent clasic, extracția cu fluid supercritic CO_2.

INTRODUCTION

There is a growing interest in the extraction of seeds and plants oil, as it has been found by studies that this oil brings a supply of vitamins and minerals that help maintain health and many more. Today, it is important to maintain a natural characteristic of oil components during extraction irrespective of the technology used (*Mohammad and Iffat, 2016*).

Grape seed oil is an excellent cosmetic ingredient for skin moisture control. The texture of the oil is light, so it is easily absorbed by the skin and will not leave a surplus of oil on it. According to an independent study published in Radical and Free Medicine Biology, grape seed oil can accelerate the healing process of wounds on human skin and can also be valuable for curing any acne problem. It is rich in vitamin E, linoleic acid, omega fatty acid and antioxidants. Its antioxidant properties are essential for minimizing skin aging. Oil can be beneficial for reducing the appearance of wrinkles as it provides moisture and protection against free radicals. As the University of Maryland Medical Centre states, grape seed oil is able to increase the amount of antioxidant in the blood and maintain the existence of collagen and elastin (*Evangelia et. al.*). On the other hand, grape seed oil plays an important role in treating diseases such as: arthritis, inflammatory diseases, hair loss, diabetes, eczema, dementia, Alzheimer's, divisions, a weak immune system and hypertension, and those with an increased cancer risk and other chronic diseases [*Evangelia et. al.; Mohammad and Iffat, 2016; Victor R. P., 2016).* The structure of grape seeds contains 8% -20% oil (dry basis). Oil production depends on the extraction technique, the solvent type and the exploitation conditions used, the variety of varieties and the environmental factors during the harvest year. In the state of Rio Grande do Sul, Brazil, three varieties of V. vinifera (Moscato Giallo, Merlot and Cabernet Sauvignon) and two of V. labrusca (Bordeaux and Isabel) harvested between 2005 and 2006 for their grape seed oil content were analysed. The highest oil content was obtained from the Bordeaux variety (15.4%) in 2005 and from the Merlot grape variety (14.7%) in 2006 (*Garavaglia et. al., 2016*).

To obtain grape seed oil, there are several technologies that can be used. The chosen technology used depends on the nature and content of the raw materials oil, but also on the complexity of the technology chosen, the technology's production capacity, the cost of the technology involved and the quality of the oil obtained (*Beerens and Eijck, 2010*).

In Figure 1 a diagram presenting the most recent extraction methods used to obtain the oil is displayed. Out of all of these, the most effective for grape seed oil extraction are solvent extraction, mechanical extraction and supercritical fluid extraction CO_2.

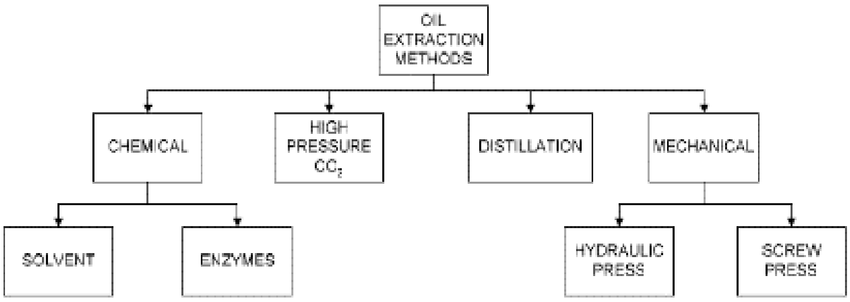

Fig. 1 – Oil extraction methods (*Ardebili et. al., 2012*)

MATERIAL AND METHOD

Grape seed oil can be extracted through traditional methods such as mechanical pressing or chemical solvents. In recent years, more modern methods of oil extraction have been developed, and these include extraction with supercritical CO2 fluid and ultrasonic extraction. This study aims to determine which of these a higher yielding method is.

Mechanical extrusion by pressing

Mechanical extraction is the oldest known method for obtaining oil from oilseeds, which is based on the mechanical compression of these seeds. Two well-known mechanisms can be used for this compression: hydraulic press and screw press.

The mechanical pressing of oil products involves the separation of oil from the oil mixture (liquid-solid mixture) under the action of external compressive forces that originate in machines called presses. The main machines used for mechanical pressing are hydraulic presses and screw presses (*Beerens and Eijck, 2010; Sari P., 2006*). Currently, the most efficient and most used oil extraction presses are those with a wicking system.

During the pressing process, the press is fed with oil seed by means of a feed hopper. The seeds are transported and crushed by a worm screw in a rotating motion, in the direction of a restriction, called a nozzle. As the press feed area is filled with seeds, the first step of the compression process is the rotation and breaking of the oleaginous material, as well as the displacement and removal of air from the gaps in the material. After removing the air from the oleaginous material, the seeds begin to withstand resistance to the applied force, (*Owolarafe et. al., 2007*). The continuous transport of the material causes the pressure to rise until the restriction imposed by the exhaust head is exceeded. This pressure leads to the removal of seed oil. Pressure values in a screw press vary between 40 and 350 bar (4-35 MPa), depending on the type of press and the type of oilseed.

A combined friction and pressure force developed inside the pressing chamber leads to the breakage of the cell walls and the removal of the oil in the liquid-solid mixture in the pressing chamber. The separated oil is removed from the press chamber through the holes along it. The compressed solid material, called clod, is discharged simultaneously through the nozzle located at the end of the pressing chamber (*Singh and Bargale, 2000*).

A low capacity screw press model is shown in Figure 2.

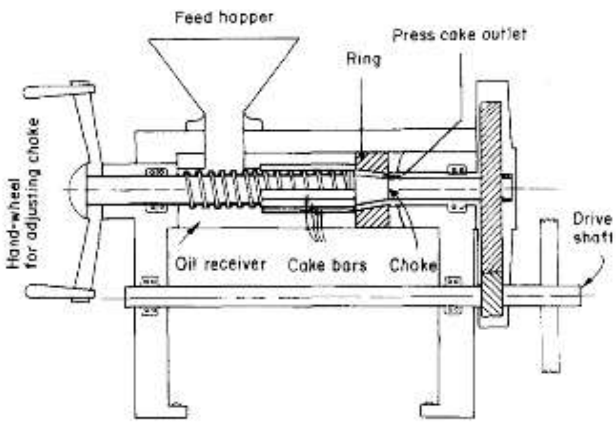

Fig. 2 – Screw press *(Khan and Hanna, 1983)*

Classic solvent extraction

Solvent extraction is the process of separating the liquid from a liquid-solid mixture using a solvent (pentane, hexane, heptane or octane) (*Yan et. al., 2005*). This method involves mixing the solvent with the milled oleaginous material (the grinding operation is required to increase the contact surface between the seed and the solvent which in turn increases the amount of oil extracted) and roasting (roasting destroys the cellular tissues and thus penetrating the solvent more easily into the material), after which the oil-solvent mixture called the crucible is heated to a temperature above 100 °C to separate the oil (*Bargale, 1997*). Using the solvent extraction method, about 98% of the oleaginous material's oil is extracted.

Choosing a solvent must take into account a number of factors, in particular the solvent extraction capacity, solvent effects on oil properties, process safety, solvent volatility and stability, and economic considerations (*Akinoso et. al.*).

The most used solvent is hexane because of its ease of evaporation and because of it leaving no unusual smells or residual taste. There are two types of hexane: normal, also known as n-hexane; and commercially known as extraction quality hexane. The N-hexane is pure and boils at 69 °C, while extraction grade hexane is not pure. Hexane is also one of 189 dangerous air pollutants, encouraging research to look for alternative solvent for oil extraction. Examples of alternative solvents studied are halogenated solvents, water as solvent, enzyme assisted aqueous extraction, acetone as solvent, alcohols as solvents and supercritical solvents (*Williams, 2005*).

The ability to extract oil from oil seeds depends on the nature of the oil, the nature of the solvent, the temperature and the contact time between the solvent and the grain mass, the thickness of the flake and the conditions for seed pre-treatment.

In Figure 3 is the scheme for obtaining the oil by the chemical solvent extraction method.

One of the disadvantages of conventional techniques is due to the temperature used in the process of obtaining oils which undergo chemical changes (hydrolysis, isomerization, oxidation) because of the high temperatures applied. The quality of the extracted oils is therefore extremely poor, especially if the extraction time is long. It is important that the extraction methods can maintain the chemical composition of the oils and the natural proportion to the original state. As economy, competitiveness, ecology, sustainability, high efficiency and good quality become key words of modern industrial production, the development of essential oil extraction techniques has never been interrupted. Strictly speaking, conventional techniques are not the only way to extract. New techniques follow the concept of extraction and ecological principles to obtain natural extracts of a quality similar to or better than official methods. New extraction techniques should also reduce extraction time, energy consumption, solvent use, and CO_2 emissions.

Traditional methods of extracting essential oils have been discussed and they are the most widely used on a commercial scale.

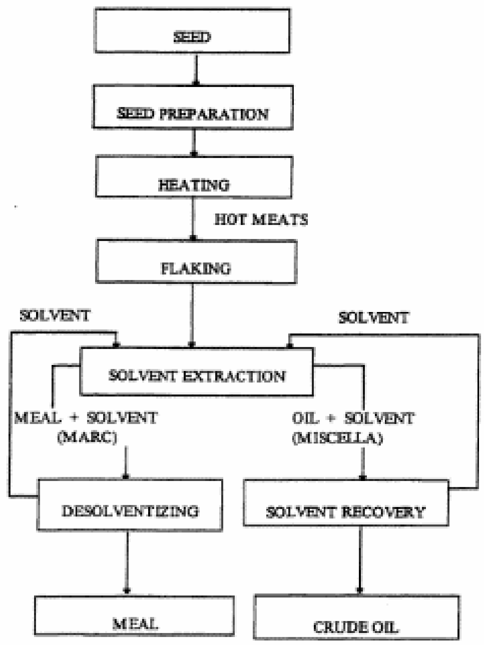

Fig. 3 – Oil extraction with solvent methods (*Bargale, 1997*)

Extraction with supercritical fluid CO_2

Concerns about environmental protection have given a new perspective to chemistry, accused of producing a large number of toxic waste. In the field of extraction, where large quantities of organic solvents are used, their quantity should be reduced and some should even be replaced. A non-polluting alternative is considered to apply supercritical fluid extraction.

The critical point of a pure substance is defined as the highest temperature and pressure at which the substance exists in liquid-vapour equilibrium. At higher temperatures and pressures than this point a homogeneous fluid is called supercritical fluid. These aspects can be seen on the phase diagram of any substance, the diagram shown in Figure 4. In the triple point three phases coexist. The co-existence curve of the gas-liquid phases is the boiling curve. Moving up on the boiling curve by increasing both pressure and temperature, the fluid becomes less dense due to thermal expansion and gases denser due to increased pressure (*Stoica et. al., 2007*). Finally, the densities of the two phases converge to the same value, becoming the same, the difference between gas and liquid disappears and the boiling curve ends at the critical point.

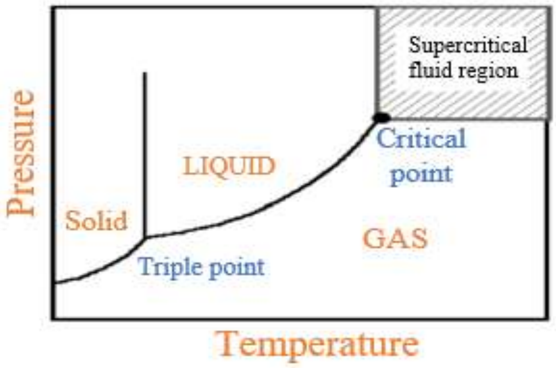

Fig. 4 – Phase diagram (*Stoica et. al., 2007*)

The solubility capacity of supercritical gases increases in proportion to the increase in pressure and density. What makes supercritical fluids as attractive solvents is that gas density becomes much higher at high pressures, while viscosity and diffusivity have values close to those at atmospheric pressure. These properties make the mobility and solvability of supercritical fluids unique.

The most used supercritical fluid is CO_2. The critical point of carbon dioxide is characterized by a pressure of 73.8 bar and a temperature of 31.1^{0}C (*Stoica et. al., 2007*).

A supercritical CO_2 extraction process contains two main steps (*Stoica et. al., 2007*):

- supercritical fluid extraction;
- CO_2 recovery and recirculation, when it is advantageous.

In Figure 5 is presented a pilot setup showing a supercritical fluid extraction. Even if it has a very low capacity (<10 kg), it contains all the elements that appear in industrial plants of this type. Its essential components are: the extraction and separation vessels, the condenser and the high pressure pump. Carbon dioxide is stored at its vapor pressure in the condenser as a near critical fluid.

The physical state of carbon dioxide in the extraction-separation steps is determined by the pressure and temperature in the two vessels. The temperature is controlled by means of a thermostatic fluid flowing through the shell of each vessel and the pressure is maintained by the pressure valves. Parameters such as temperature, pressure and flow rate are always measured at the strategic points of the plant. When an extraction process takes place, the plant material is fed into the extraction vessel, which is first purged with CO_2 to remove the air from the system. The extraction starts by pumping liquid carbon dioxide through a heat exchanger into the extraction vessel. The flow rate, which is regulated by the pump, is maintained at a low value so that the residence time in the extraction vessel is sufficient to achieve the balance.

The resulting solution then passes into the separating vessel where release conditions of the extracted components are achieved by varying the pressure and temperature conditions. The carbon dioxide which is at this time in gaseous state then passes to the condenser to get cooled and where it is condensed and converted into a liquid state (*Stoica et. al., 2007*). Such a plant, operating between 2-10 L, is useful when it is necessary to extract small amounts of material.

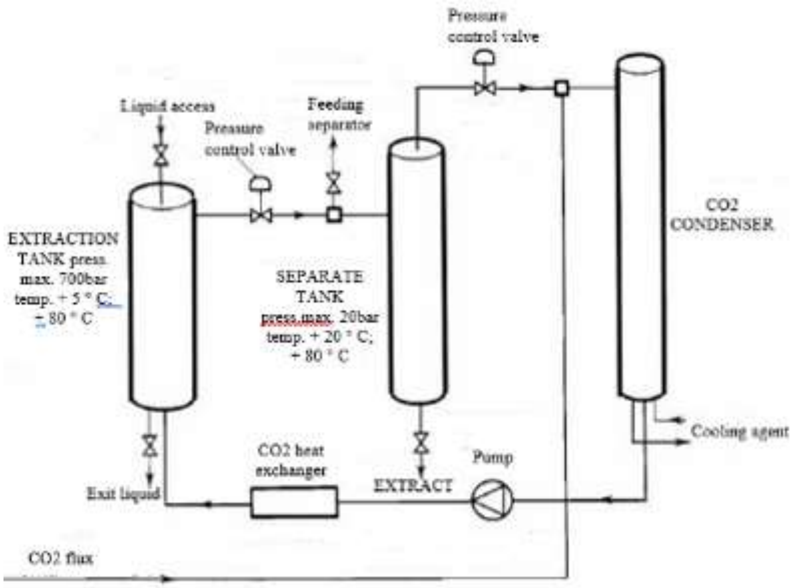

Fig. 5 – Supercritical fluid extraction pilot plant (*Stoica et. al., 2007*)

RESULTS

With regard to the three processes described above: solvent extraction, supercritical CO_2 and mechanical extraction these three can be compared and evaluated taking into account three main parameters: economic yield, impact on the environment and the quantity of oil obtained.

Today, the most commonly used process in the trade is solvent extraction. This process has the advantage of a high oil yield (over 98%) and the development of the technology needed for this industry. However, the use of chemical solvents remains the biggest disadvantage, as it is necessary to refine the oil obtained before it is used, there is the possibility of toxicity as well as the danger of explosion due to the use of solvent [6]. During the oil extraction process, the used solvent should be monitored so that there is no loss in order to prevent damage to the environment and to avoid additional costs with it. Although there is a wide range of equipment, they have a high cost, which is a big investment. Another serious problem is removal of solvent from vegetable oil, ensuring adequate levels that do not harm human health. In addition to oil, a co-solvent extraction co-product is also obtained, which can be used to obtain other products or can be used as such. If necessary, one more step can be taken by removing the solvent from the smear so that it can be used. This process is not recommended for oilseed oil with high oil content in its composition. The energy consumed to operate a solvent extraction plant is high and requires a skilled workforce to cope with this complex operation.

Solvent extraction is a quantitatively efficient method for extracting grape seed oil because the grape seed oil content is relatively small and such a plant has a good oil yield. However, nowadays, emphasis is placed on the quality of the products, and due to the chemical solvents used, the obtained product has a lower quality than that obtained by mechanical pressing.

The supercritical CO_2 extraction method is a relatively new way of obtaining the oil and is therefore not widely used. It has the advantage of presenting a pure oil without the solvent being used. The yield of oil obtained is close to that obtained by chemical solvent extraction and the quality is close to that obtained by mechanical pressing. For this method, studies are still being done to optimize the process and reduce costs. Also, the energy consumed to operate the equipment is high, and the complexity of the system requires skilled labour. Another drawback is the fact that the plant does not allow the continuation of the flow in a continuous way for large volumes of seeds. However, new research and developments in equipment design and government regulations on the use of hexane may make this trading system possible in the near future (*King, 1997*).

Even if the investment costs are high, it remains the most efficient method for obtaining grape seed oil, because it can obtain a qualitative product in terms of composition, the quantum of the oil is higher than in the case of mechanical pressing.

Mechanical methods are the oldest methods of oil extraction. The big advantage of these methods is the non-use of chemicals, producing a high quality raw oil and ready for consumption in some cases. Other important advantages are the low cost of equipment acquisition, low energy consumption for operations than other methods, low impact on the environment, and the workforce needed does not require to be qualified. In spite of the advantages it presents economically, the method is not profitable. Even if plants have lower costs than chemical processes, the oil yield is low and the oil content in the ore is high.

CONCLUSIONS

Grape seed oil is of particular importance for human health as well as for the development of new products. It can be produced from several technological, chemical and mechanical processes.

The solvent extraction technology is still the most widely used and the higher oil process, and due to the use of chemicals that affect the environment and human health, new technologies such as supercritical extraction have been researched. Methods that are not as new as supercritical extraction, such as screw press, require optimization of the process so that it produces more oil with high quality at a lower cost.

An extraction process should provide economic and environmental benefits to become a future technology.

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STATIC PRESSURE DISTRIBUTION IN THE SOIL UNDER THE WHEEL OF A SPRAYING MACHINE
/
DISTRIBUȚIA STATICA A PRESIUNII IN SOL SUB ROATA UNEI MAȘINI DE STROPIT

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Keywords: *soil, compaction, pressure, mesh sensor, Hidropuls*

ABSTRACT
Current farming practices using heavy machinery are associated with soil compaction. The paper presents the results of tests aiming to determine in field the contact area and pressure distribution in the contact area between MSL machinery (for the precise application of the phytosanitary treatments in orchards) and the agricultural soil, respectively the determination in laboratory, on Hidropuls, of pressure distribution at 0 - 45 cm deep into the soil under the wheel of the MSL machine. The tank of the machine was loaded with 750 litres of water (wheel load 9.81 kN) and tire inflation pressures were 100, 150 and 200 kN.

REZUMAT
Practicile agricole actuale care utilizează mașini grele sunt asociate cu compactarea solului. Lucrarea prezintă rezultatele unor teste care au constat în determinarea în câmp a ariei suprafeței de contact și distribuției presiunii în pata de contact dintre roata mașinii MSL (pentru aplicarea cu precizie ridicată a tratamentelor fitosanitare în plantații pomicole) și solul agricol, respectiv în determinarea în laborator, pe Hidropuls, a distribuției presiunii pe adâncimea 0 – 45 cm în sol, sub roata mașinii MSL. Rezervorul mașinii a fost încărcat cu 750 litri apă (încărcare pe roată 9.81 kN) iar presiunile în pneu au fost de 100, 150 și 200 kN.

INTRODUCTION
Several years ago, compaction would have been relatively shallow because farm equipment weighed less and many cover crops were grown in rotation (*Sivarajan et al, 2018*). Nowadays, the risk of soil compaction increases with the growth of farm operations and the drive for greater productivity causing farmers to use heavier machinery, with repeated passes, most often on soils with high moisture content. The heavier equipment used today for different agricultural practices increases the negative effects of artificial compaction both on agriculture and the environment. Preventive measures should be taken to avoid soil compaction because targeted amelioration of this type of degradation of soil is complex, costly and rarely long- lasting (*Rücknagel et al, 2015*).

Surface soil compaction takes place until a depth of 0.3 m or in the topsoil (soil tillage layer) and subsoil compaction takes place to depth under soil tillage layer. Soil compaction in cropping systems affects mostly the upper layer of soil (topsoil compaction) but it is also observed at certain depth (subsoil compaction) (*Nawaz et al, 2013*). The increase in the size and weight of agricultural machinery calls for accurate measurements of stresses applied by machinery in the tire-soil interface and in the soil profile (*Lamande et al, 2014*).

During compaction, stress distribution is influenced by factors such as tire inflation pressure, wheel load, tire–soil contact area, lug, tire stiffness (bias or ply), single or dual tire and soil conditions, e.g. soil type, soil texture and soil strength (*Schjonning et al, 2008*). In order to predict the stress in soil due to wheel pressure, the stress has to be determined on the soil and on the contact area. The shape and area of the tire footprint and the magnitude and distribution of stresses distributions have practical implications on the topsoil compaction. These factors are also decisive for the pressures reaching the subsoil, as well as the potential of improving our understanding of contact pressures propagation to the soil (*Cueto et al, 2016*).

The effect of surface stress distribution on soil stress decreases with increasing depth. The vertical stress in the upper subsoil (down to 1 m depth) depends on both soil contact stress and wheel load (*Nankali et al, 2012*). *Arvidsson and Keller (2007)* have found that tire inflation pressure has a great influence on contact pressure at the depth of 100 mm, but has a very low influence on the subsoil stresses (at 300 mm and deeper). When doubling the wheel load, the contact area increases by 30-40%, while at the doubling of the tire inflation pressure, the contact area drops by 70-80% (*Ekinci and Çarman, 2011*). *Way and Kishimoto (2004*) have shown that the stress in the contact area is not uniformly distributed and the maximum stress may be many times greater than tire inflation pressure. Most of the contact pressures researches were done in experimental conditions, because in field conditions, is difficult to measure and maintain the experimental parameters during testing. During agricultural works, using higher tire inflation pressure results in smaller footprint area, soil deformation increases and the pressure is distributed deeper into the soil (in this case, deep loosening is needed to alleviate the compaction). Using lower tire inflation pressure, tire deformation increases, footprint area increases, contact pressure decreases, soil deformation are smaller and the pressure is transmitted to shallower depths (*Ungureanu et al, 2018; Kenarsari et al, 2017*).

Quantitative understanding of stress transmission and deformation processes in arable soils remains limited. Yet such knowledge is essential for better predictions of effects of soil management practices such as agricultural field traffic on soil functioning (*Keller et al, 2013*). Strategies for prevention of soil compaction often rely on simulation models that are able to calculate stress propagation in soil profile for certain mechanical loading (agricultural machinery) and soil conditions (e.g. soil moisture), and may help farmers and advisors in planning and making decisions about specific traffic situations in the field (*Keller and Lamande, 2010*).

MATERIAL AND METHOD

A. In the first set of tests, carried out in the field, were determined the size of contact area and the distribution of contact pressure under the wheel of MSL spraying machine for precise application of the phytosanitary treatments in orchards. The tire is Danubiana Superfront Tractor, size 6.00-16, profile F-2. The total weight of the machinery with empty tank is 4.90 kN (2.45 kN wheel load). The tank was filled at with 750 litres of tap water litres (maximum capacity is 1000 litres) and then the load on each wheel was measured, resulting in a total of 9.81 kN wheel load. Tire inflation pressure varied to 100, 150 and 200 kPa. Contact pressure and the size of contact area were measured by mesh-type pressure sensor Tekscan Industrial Sensing coupled to the VersaTek Handle electronic data acquisition system (Figure 1) and to a laptop.

Fig. 1 – Field testing of the MSL spraying machine

B. The second set of tests was conducted in laboratory conditions, using a complex testing system that works in simulated and accelerated regime, Hidropuls type (Figure 2), which can simulate the static pressure at compression of the tires on the soil (stationary machinery). A container made of reinforced sheet with thickness of 3 mm was filled with soil (Figure 3).

Fig. 2 - Installation for testing in simulated and accelerated regime, Hidropuls type

Fig. 3 - Container filled with soil

Eight sensors for force measurement, Flexi Force Tekscan type W-B201-L (Figure 4) with the maximum domain of 10 N / 50.24 mm^2 and the diameter of contact button of 0.8 cm, were mounted in the container at depths of 5, 10, 15, 20, 30, 35, 40 and 45 cm. The connection between the laptop and force measurement sensors was achieved through an adaptation module, formed by amplifiers and analog-to-digital converter, coupled to a serial interface 4RS232 to coupling view (USB), an adaptation module (acquisition system) and laptop. A hydraulic cylinder with a force of 10 kN, close to the wheel load determined in field testing and some intermediate devices in the Hidropuls (Figure 5) were used to simulate the static compression pressure of the MSL wheel on the soil.

Fig. 4 – Flexi Force Tekscan type W-B201-L sensor

Fig. 5 – Stand for static compression pressure

RESULTS

The experimental data obtained from field testing of the MSL spraying machine are given in Table 1.

Table 1

Compaction characteristics under the wheel of MSL machinery in field testing

Wheel load Q [kN]	Tire inflation pressure p_i [kPa]	Size of contact area A [m^2]	Contact pressure p_c [kPa]
9.81	100	0.0619	159
	150	0.0546	180
	200	0.0539	182

Figure 6 shows the mapping of pressure distribution in the footprints obtained in field testing. It can be seen that at soil surface, for 9.81 kN wheel load and tire pressure ranging from 100 - 200 kPa, were obtained contact areas between 0.0539 - 0.0619 m^2 and the contact pressure ranged between 159 - 182 kPa.

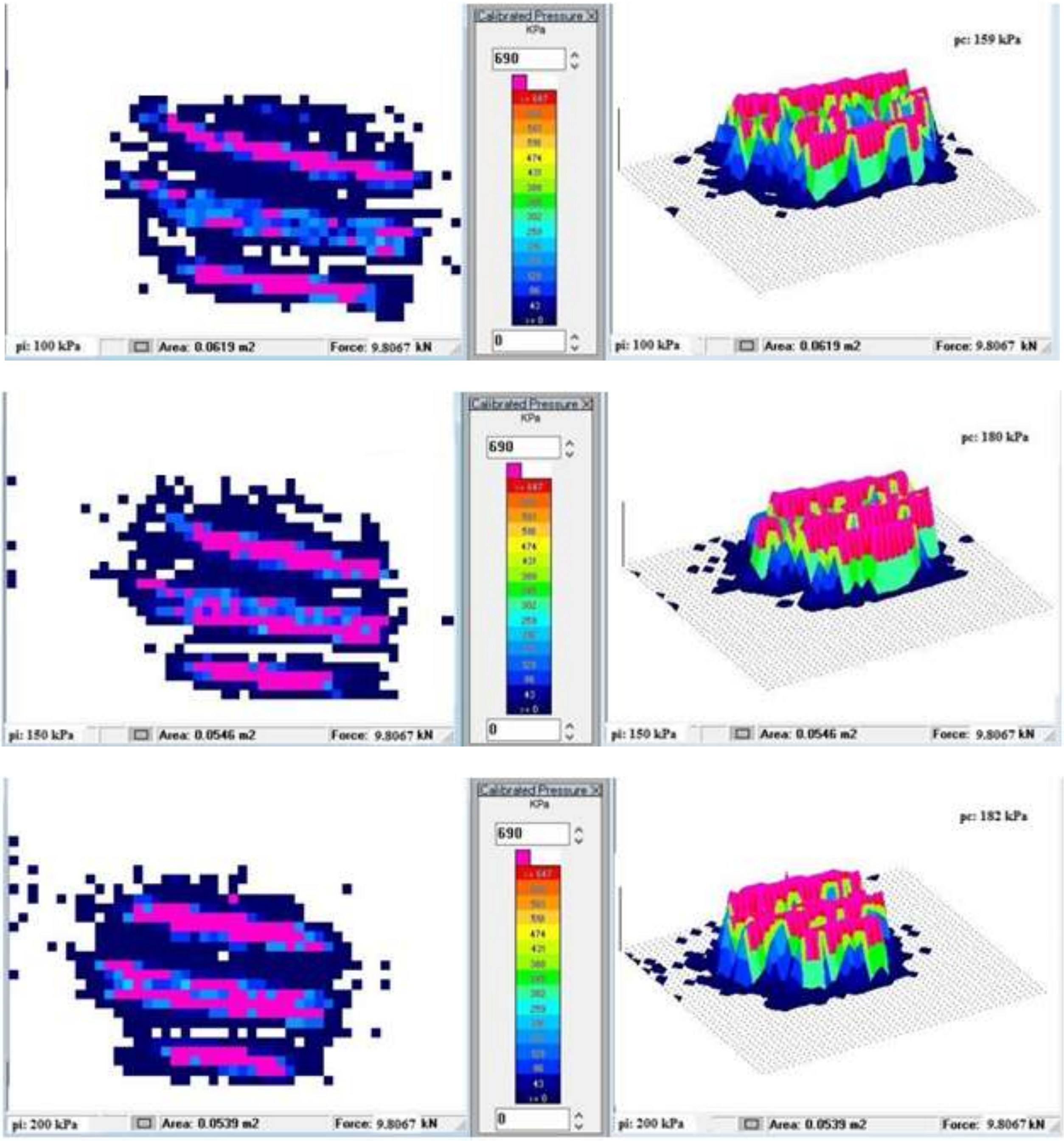

Fig. 6 – Field mapping of pressure distribution in the footprint between tire and soil

The shape of footprint tends to be rectangular at 100 kPa wheel load, but with increasing tire inflation pressure, it changes into an elliptical shape. Also, the maximum contact pressure values are recorded close to the tire's edges.

Referring to the results obtained in the second set of tests, pressure distribution was determined at eight soil depths where the force sensors were applied, in the direction of action of the compressing force (vertical direction). For each tire inflation pressure, three replication tests were made. Vertical stresses measured at each tire inflation pressure for one of the replicate measurements are presented next. In Table 2, the size of contact area at soil surface was recorded during field testing, using the mesh-type pressure sensor Flexi Force Tekscan. For depths between 5 – 45 cm, the size of contact area reffers to the surface of FlexiForce sensor in contact with the soil, which was computed as: $S = \pi \cdot R^2 = 3.14 \cdot 0.16 = 0.5024\ cm^2$.

To simulate the pressure applied by the wheel of the MSL machine, for each tire inflation pressure, a compressive force was progressively applied to the wheel by a hydraulic cylinder until it reached the value determined in real conditions (by weighing the machine after filling the tank with 750 litres of water) and determining the distribution on axles and on the wheels), when the forces were measured at each of the 8 depths using the Flexi Force Tekscan W-B201-L sensors. Thus, at tire inflation pressure of 100 kPa, the duration of load was 33.5 seconds, until the compressive force of 9842 N was reached; at tire inflation pressure of 150 kPa, the duration of load was 33.3 seconds, until the compressive force of 9828 N was reached, respectively at tire inflation pressure of 200 kPa, the duration of load was 39.7 seconds, until the compressive force of 9810 N was reached.

Table 2

Laboratory testing of static compression for the MSL spraying machine

Sensor no.	Depth of sensor [cm]	Compressing force [N]	Size of contact area [cm^2]	Presssure in the soil [N/cm^2]
Tire inflation pressure 100 kPa				
-	0	9842	619	15.9
1	5	19.3633	0.5024	38.5416
2	10	13.8288	0.5024	27.5255
3	15	19.7474	0.5024	39.3031
4	20	5.7194	0.5024	11.3842
5	30	10.3005	0.5024	20.5026
6	35	10.1156	0.5024	20.1346
7	40	10.8269	0.5024	21.5504
8	45	11.7232	0.5024	23.3344
Tire inflation pressure 150 kPa				
-	0	9828	546	18
1	5	23.2473	0.5024	46.2725
2	10	15.1613	0.5024	30.1777
3	15	22.0238	0.5024	43.8372
4	20	5.6389	0.5024	11.2240
5	30	10.1873	0.5024	20.2773
6	35	9.8149	0.5024	19.5360
7	40	10.9587	0.5024	21.8127
8	45	11.4109	0.5024	22.7128
Tire inflation pressure 200 kPa				
-	0	9810	539	18.2
1	5	23.7458	0.5024	47.2647
2	10	15.5888	0.5024	31.0287
3	15	22.9301	0.5024	45.6411
4	20	5.7703	0.5024	11.4855
5	30	10.4681	0.5024	20.8362
6	35	10.0451	0.5024	19.9942
7	40	10.7853	0.5024	21.4676
8	45	10.8004	0.5024	21.4976

Variation of pressure with soil depth under the wheel of MSL spraying machine, obtained in laboratory testing, is presented in Figure 7.

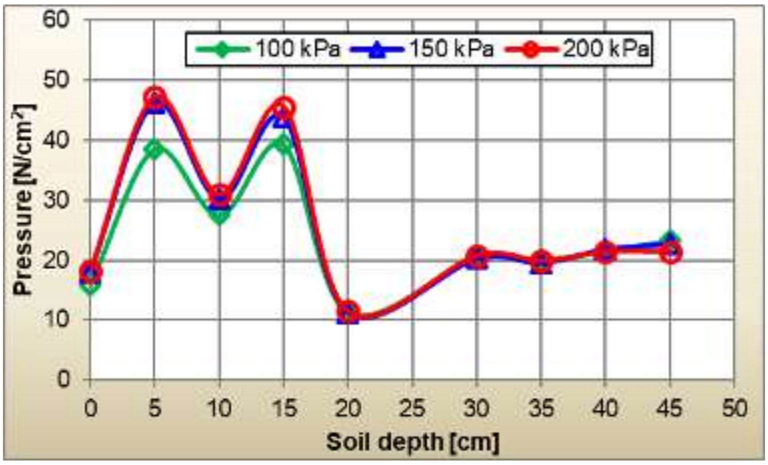

Fig. 7 - Variation of pressure with soil depth, under the wheel of the MSL machine, in laboratory conditions

It can be seen that for the tested tire inflation pressures, the variation curves follow a similar trend. The pressure applied to the soil tends to decrease suddenly as soil depth increases to 10 cm, and then rises to a depth of 15 cm, after which they follow a sharp downward curve to a depth of 30 cm, and then there is a slight increase at the maximum tested depth of 45 cm.

CONCLUSIONS

Soil compaction mainly depends on the compression applied on the soil surface by agricultural machines. Hence, contact pressure at the soil-machine interface can be measured as a good indicator of the potential compaction on agricultural soils.

We conclude that a traffic event in the tested conditions is likely to induce serious impacts on soil properties and functions to a depth of least 45 cm. Our results show that at 45 cm soil depth, wheel loads of 9.81 kN may induce vertical stresses around 233, 227 and 215 kPa, for tire inflation pressures of 100, 150 respectively 200 kPa. Maximum stresses in the tire-soil contact area were as high as 182 kPa.

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EXPERIMENTAL RESEARCH ON ENERGY CONSUMPTION IN BAKING BAGELS / *CERCETARI EXPERIMENTALE PRIVIND CONSUMUL DE ENERGIE LA COACEREA COVRIGILOR*

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Keywords: *bagels*, *baking*, *energy consumption*

ABSTRACT

The purpose of the article is to study electricity consumption in the baking process. The determination of the electrical energy consumed in the baking process was carried out, from the dough in the oven to the output of the finished product from the baking chamber. A Zanolli SYNTHESIS 06 40V E electric oven was used.

The results showed that the highest value of the electricity consumed was recorded for a dough containing 55% water and 10% sunflower oil, compared to a dough containing 45% water and 10% sunflower oil.

This study provides information on electricity consumption for baking different types of bagels that can be used by processors and bakery workers.

REZUMAT

Acest articol are scopul de a studia consumul de energie electrica in procesul de coacere a covrigilor. S-a realizat determinarea energiei electrice consumate in procesul de coacere, de la intrarea aluatului in cuptor pana la iesirea produsului finit din camera de coacere. S-a utilizat un cuptor electric Zanolli SYNTHESIS 06 40V E.

Rezultatele au aratat ca cea mai mare valoare a energiei electrice consumate a fost inregistrata pentru un aluat cu continut 55% apa si 10 % ulei de floarea soarelui, in comparatie cu un aluat cu continut 45% apa si 10 % ulei de floarea soarelui.

Acest studiu ofera informatii privind consumul de energie electrica pentru coacerea diferitelor tipuri de covrigi, care pot fi utilizate de procesatorii si lucratorii din panificatie.

INTRODUCTION

In the bakery industry, the baking process is a key step in obtaining finite quality products, both in texture, color and flavor. The qualities of the final product result from several reactions which happen during the heating process of baking, such as starch gelatinization, water evaporation, volume expansion, crust formation, etc. (*Therdthai et al., 2003; Gundu et al., 2012*). Many physical and chemical reactions that happen in this stage are only partially, understood undoubtedly the quality of the baked products is influenced by the cooking time, the temperature applied and the speed of application of the heat. (*Noël Haegens, 2018*). Baking temperature can affect the texture of the bread and the color of the shell. The color formation of bakery products is widely known as browning (*Sabovics et al., 2014*).

Besides the qualities of the finished products, important attention is paid to the energy consumption in the manufacturing process, especially for the energy consumption during the baking process, which represents 2/3 of the total energy consumption of the whole production unit. (*Zorn B., 2012*) The baking process is considered an intense process due to the evaporation of water from the dough, and for this reason baking is considered similar to the drying process. Both processes consuming a lot of energy compared to the processes of cooling, freezing and preservation, processes that require less energy (*Le Bail et al., 2010; Islam et al., 2015*).

In most cases, the cost of electricity exceeds the cost of other resources, such as the cost of raw material, human resources, or equipment maintenance (*Fadare, 2003*).

Stefan et al (2014). and *Constantin (2013*) have demonstrated that energy consumption research is treated even in units of wheat processing in flour, not just in units of processing of fine flour into finished products. This aspect indicates that energy consumption research is a topic of interest in the food industry.

MATERIAL AND METHOD

To perform the experiments, an electric oven, Zanolli SYNTHESIS 06 40V E, was used for baking different types of bagels and pizza (Figure 1). The oven is in the form of a tunnel with an opening at both ends. Inside the oven there is a metallic conveyor that the blank are baking directly. The travel speed of the conveyor belt can be changed from the control panel mounted on the oven. The travel time of the strip on the elongation of the baking chamber is even the baking time of the semi-finished products. It was found that in reality there is an additional 30 seconds longer than the one displayed on the oven.

a) b)

Fig. 1 - Views of the oven
a) overview; b) highlighting how hot air circulates in the baking chamber
1 - mobile hearth; 2 – carcase; 3 – control panel

The heat in the baking chamber is created by four heating elements, mounted two in the top and bottom of the oven (Figure 2). The hot air circulation in the baking chamber is provided by two 230 V fans mounted in the upper baking chamber.

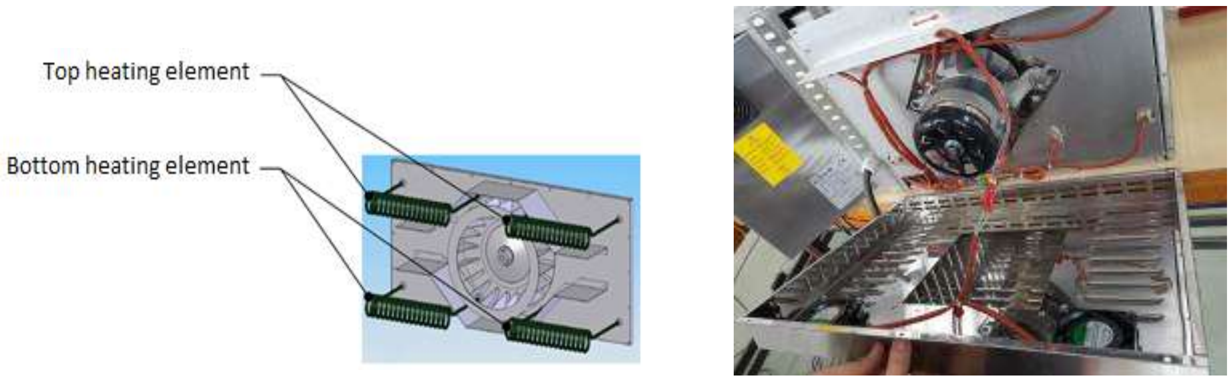

Fig. 2 - View oven heating elements Zanolly SYNTHESIS 06/40V E

A Power Fluke 434 three-phase ammeter was used to determine energy consumption, and Power Log Classic software was used to extract data and graphics recorded on the device. Measurement of the consumption was done by mounting an ampermetric clamp on the power cable of each electrical resistance: two at the bottom (L1- inlet, L3- outlet), and the third clamp was mounted only on a single resistance because the top two are triggering concurrently (L2). The conscription recorded on the L2 celesties was multiplied by two.

a) b)

Fig. 3 - a) clamping the pliers; b) Fluke 434 clamp meter phase

The data purchased by the appliance was for the baking of 40 pieces of bagels / experiment, ordered 4 times per 5 rows. Before the oven was loaded, data was obtained for emptying the aggregate (no dough). Because when the loading of the wind was made with the first 4 rolls of the row I there were no other covers in the oven, it was desired to process the experimental data for the rows of V rows. The time of entry and exit of the V row from the oven tunnel was noted.

The experiments were conducted for several types of bagels, and for several variations of the electric oven parameters.

The doughs was obtained from 3 kg of flour, 36 g of salt, 100 g of sugar, 15 g of yeast and different amounts of water and sunflower oil. Ingredients was blended for 2 minutes in Stage I and 10 minutes in Stage IIa of Spiral Army Mixing Model ITB 20 manufactured by Primasfood. After finishing the kneading process, the dough was divided into 100 g pieces, molded in the Breztel form and immersed in the rinse pot with a 10% sugar solution in the water. Bagels stayed in the sugar solution, heated to 85 °C, until they have picked up to the surface of the solution. During this stage the bagel table has changed, it increased from 100 g to 104.2 to 110.1 g. After picking up bagels surface solution, they were taken with a spatula and placed on mobile hearth oven, which was heated up to 230 °C.

The assortments of experienced bagels was:

- I – bagels with low amount of liquid in dough, which is 45% water and 10% oil. Paramaterial of the baking regime: 230 °C, baking time 10.30 minutes and resistance strength 100% of their total power (1800 W) for both the upper and lower ones.

- tip II - bagels with low amount of liquid in dough, which is 45% water and 10% oil. Paramaterial of the baking regime: 230 °C, baking time 10.30 minutes and resistance strength 100% of their total power (1800 W) for the upper ones and 80% of their total power (1800 W) for the lower ones.

- tip III – bagels with a larger amount of liquid in the dough, which is 55% water and 10% oil Paramaterii regime baking 230 °C, baking time 10.30 minutes and the power of resistances 100% of their power (1800 W) for the upper and 80% of their total power (1800 W) for the lower ones.

For recording data at idling were kept your settings for each program corresponding to each assortment of bagels baking.

RESULTS

Following the experimental determinations, the results presented in Table 1 and the graphs in Figures 4, 5 and 6, processed using Microsoft Excel.

Table 1

Experimental data recorded with FLUKE 434

Electrical resistance	Energy consumption [kWh]					
	Experiment 1		Experiment 2		Experiment 3	
	Bagels type I	Without bagels	Bagels type II	Without bagels	Bagels type III	Without bagels
L1	306.67	305	306.66	300	306.66	300
L2	293.34	160	293.34	160	346.66	160
L3	213.33	123.33	200	106.67	226.67	106.67
Total	813.34	588.33	800	566.67	879.99	566.67

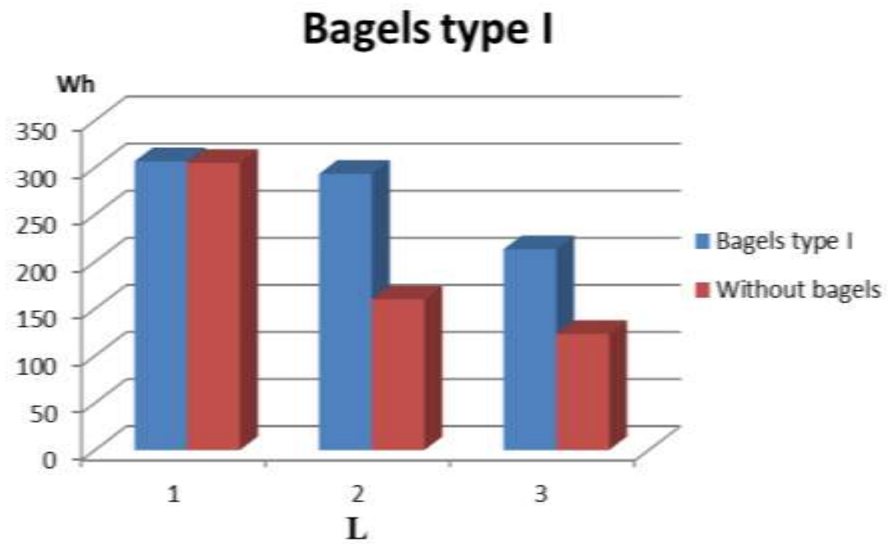

Fig. 4 - Energy variation in time of each heating element for baking bagels type I and idle for the same baking program

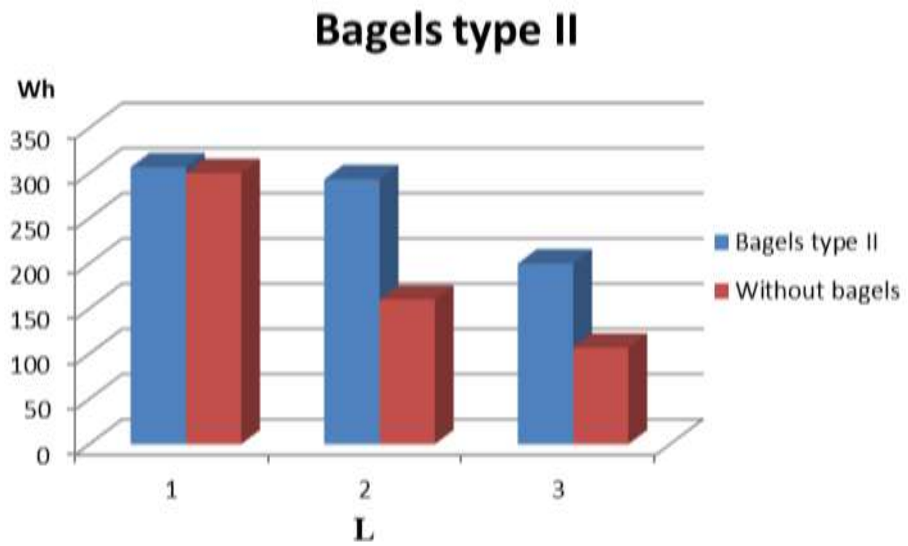

Fig. 5 - Energy variation in time of each heating element for baking bagels type II and idle for the same baking program

From the analysis of the data in Table 1 and the graphs of the data recorded for the first two types of bagels, shown in Figures 4 and 5, it can be directly observed that there is no significant difference in energy consumption for baking the same type of dough, but under different conditions. Also by analyzing the data in

Table 1 and the graphs of Figures 4 and 5, it can be noticed that even in the empty run of the aggregate, for the same baking conditions, there are no significant differences in energy consumption.

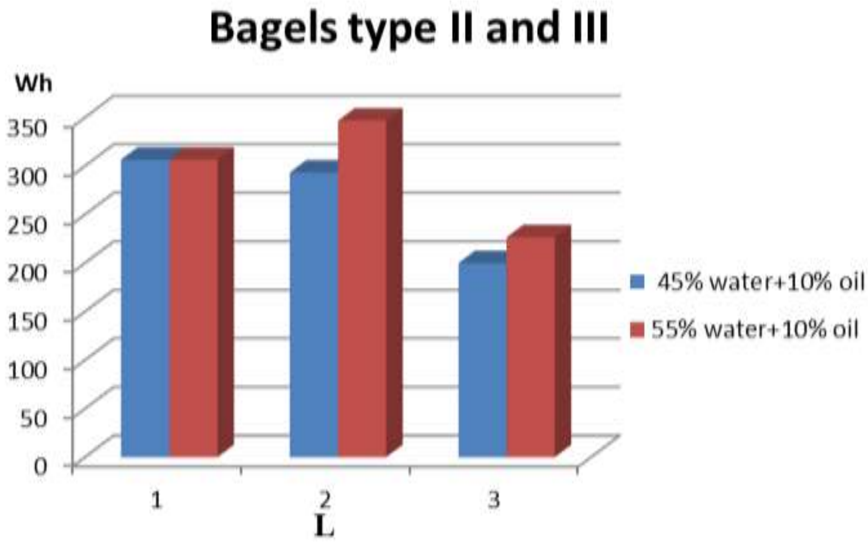

Fig. 6 - Energy variation in time of each heating element for baking types II and III of bagels

For samples II and III, energy consumption values vary within higher limits for upper heating elements (L2 = 293.34 Wh for semi-products with 45% water and 10% oil and L2 = 346.66 Wh for semi-products with 55% water and 10% oil) and lower heating element (L3 = 200 Wh for semi-finished products with 45% water and 10% oil and L3 = 226.67 for semi-products with 55% water and 10% oil) installed in the tunnel oven exit area. With regard to the energy consumption of the heating element L1 there were no variations for the baking of the two types of blanks products.

The reason why there is this difference in energy consumption at the two heating elements, set with the same baking parameters, could be that sample III contains a larger amount of water, which leads to an increase in energy consumption associated with the heat required to evaporate water from the blank.

CONCLUSIONS

The experiment was conducted to assess the energy consumption used to bake different types of bagels in different baking conditions.

In conclusion, it can be said that if a dough with an increased moisture content is inserted inside the baking chamber of the baking oven, the value of the consumed electric energy is increased. This increase occurs because electrical resistances are forced to produce more heat to help evaporate water from the dough pieces.

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ASSESSMENT OF THE STATUS OF THE ARGES RIVER NEAR BUCHAREST-ILFOV / *EVALUAREA STĂRII RÂULUI ARGEȘ ÎN ZONA BUCUREȘTI-ILFOV*

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Keywords: surface *water, quality assessment, aquatic ecosystem*

ABSTRACT

This paper presents the assessment of an aquatic ecosystem located in the Bucharest-Ilfov county. Water samples were taken from 6 points located on the banks of Arges River, in the proximity of 1 Decembrie commune. The main physicochemical indicators were evaluated. The results showed that the water quality falls in class of quality I and II, except for ammonia (quality class III).

REZUMAT

Această lucrare prezintă evaluarea unui ecosistem acvatic situat în zona București-Ilfov. Au fost prelevate probe de apă din 6 puncte de pe malurile râului Argeș, în apropierea localității 1 Decembrie, județul Ilfov. S-au evaluat principalii indicatori fizico-chimici. Rezultatele au arătat că râul se încadrează în clasele I și II de calitate, cu excepția azotului amoniacal (clasa III).

INTRODUCTION

Water is an essential resource and its protection and preservation is one of the issues that have gained an increased interest in the last decades. The assessment of the status of aquatic ecosystems has become of a paramount importance as the EU and subsequently the national regulations are more and more stringent. In this respect, a particular interest is given to high toxicity contaminants, such as heavy metals, due to their adverse effects on the environment and human health (*Deák et al., 2015; Nwamaka, 2013; Zeitoun, 2014*).

Nowadays, the quality of the aquatic ecosystem has been addressed widely in the literature. In Romania, the monitoring of metals in various aquatic ecosystems has been the subject of several available papers (*Anghel et al., 2016; Ilie et al., 2014, 2016, 2017; Ionescu et al., 2014, 2015a,b, 2016a,b, 2017; Radu et al., 2016*).

Among the surface water bodies located in Romania, the Arges River is one of the most important river basins, next to Danube, Olt and Mures, as it has an important role in water supply and energy production. Being an important water source for the regions nearby the course of Arges, an evaluation of the quality of ecosystem is thus a necessity (*Anghel et al., 2016; Ilie et al., 2014, 2016, 2017; Ionescu et al., 2014, 2015a, b, 2016a, b, 2017; Radu et al., 2016*).

This paper discusses the assessment of the quality of an aquatic ecosystem belonging to the Arges River basin that is located in the proximity of Bucharest, Romania.

MATERIAL AND METHOD

Water samples were collected from 6 points located on the bank of Argeș River, in the proximity of 1 Decembrie commune, Ilfov county. The points were located on both sides of the river, as shown in Figure 1. The length of the investigated river section was 2 km and the distance between the sampling points was 500 m.

Fig. 1 - The location of the sampling points

For the evaluation of water quality, the main physicochemical indicators enlisted by the in force legislation were determined. These indicators correspond to 6 main groups: thermal and acidification regime (temperature, *p*H), oxygen regime (biochemical oxygen demand - BOD_5, chemical oxygen demand – COD-Mn and COD-Cr), nutrients (ammonia, nitrites, nitrates, total nitrogen, total phosphorus, chlorophyll *a*), salinity (conductivity, chloride, sulphate, calcium, magnesium), toxic pollutants of natural origin (cadmium, chromium, copper, lead, cobalt, zinc, iron, manganese and sodium) and other chemically relevant indicators (phenolic index, MBAS).

RESULTS

The quality of water was assessed according to the MO 161/2006, which provides five quality classes. The results showed that most of the indicators fall in quality classes in I and II, except for ammonia (class III). Table 1 summarizes the fitting of the determined indicators in quality classes according to OM 161/2006.

The physicochemical analysis of the water samples showed the following aspects regarding the fitting in the quality classes provided by the MO161/2006: the values of the COD-Cr may fit the Arges River in the first and second class of quality (I-II); the values of the nutrients were relatively low, fitting the river in the first and second class of quality, one exception being registered in the case of ammonia whose values have fitted the river in the third quality class. Some others indicators have fitted the river in the first and second classes of quality, namely salinity, phenolic index and MBAS.

Table 1

Quality class of investigated section of Arges River, according to MO 161/2006

Physicochemical indicator		Sampling point					
		P1 MD	P1 MS	P2 MS	P3 MS	P4 MS	P5 MS
Oxygen regime	BOD_5	I	I	I	I	I	I
	COD-Mn	I	I	I	I	I	I
	COD-Cr	II	II	II	I	I	II
Nutrients	Ammonia	III	III	III	III	III	III
	Nitrites	II	II	II	II	II	II
	Nitrates	I	I	I	I	I	I
	Total nitrogen	II	II	II	II	II	II
	Total phosphorus	I	I	I	I	I	I
	Chlorophyll *a*	I	I	I	I	I	I
Salinity	Chloride	I	I	I	I	I	I
	Sulphate	I	I	I	I	I	I
	Magnesium	II	II	II	II	II	II
	Calcium	I	I	I	I	I	I
Toxic specific pollutants of natural origin	Cadmium	I	I	I	I	I	I
	Chromium	I	I	I	I	I	I
	Copper	I	I	I	I	I	I
	Lead	I	I	I	I	I	I
	Cobalt	I	I	I	I	I	I
	Zinc	I	I	I	I	I	I
	Iron	I	III	II	II	II	II
	Manganese	I	II	I	I	I	I
	Sodium	I	I	I	I	I	I
Other relevant indicators	Phenolic index	I	I	II	II	II	II
	MBAS	I	I	I	I	I	I

CONCLUSIONS

The quality of the Arges River near Bucharest-Ilfov was assessed and the main physicochemical indicators were monitored. The results showed that water is in quality classes I and II, except for ammonia (class III).

A more thorough and extensive monitoring of the quality of the Arges River ecosystem is required for a better assessment of its status.

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RESEARCH ON THE TREATMENT OF LIVESTOCK WASTEWATER BY OXIDATIVE DEGRADATION PROCESSES
/
CERCETĂRI PRIVIND EPURAREA APELOR UZATE REZULTATE DIN ZOOTEHNIE PRIN PROCESE DE DEGRADARE OXIDATIVĂ

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Keywords: *emerging pollutants, pathogenic microorganisms, UV / photocatalytic degradation, wastewater*

ABSTRACT
Wastewater resulting from livestock has a significant content of organic substances and nutrients (nitrogen and phosphorus) and thus is of interest for the fertigation of agricultural soils. In order to be recovered as such, wastewater should not have damaging potential on human health or on the environment. This paper presents the results on the treatment of wastewater resulting from cattle using UV and photocatalysis in the UV/ZnO system. The laboratory experiments showed high efficiencies for the removal of pollutants with toxic effect such as pharmaceuticals (clofibric acid) – over 90% and for the removal of pathogenic microorganisms (total coliforms) – over 99%.

REZUMAT
Apele uzate rezultate din zootehnie au un conținut important de substanțe organice și nutrienți (azot și fosfor), fapt pentru care prezintă interes în vederea utilizării la fertirigarea terenurilor agricole. Pentru a fi valorificate în acest sens, apele uzate nu trebuie să aibă potențial dăunător asupra sănătății umane sau a mediului înconjurător. Acest articol prezintă rezultatele unor cercetări privind tratarea apelor uzate rezultate de la creșterea bovinelor prin UV și fotocataliză în sistemul UV/ZnO. Experimentele efectuate la scară de laborator au evidențiat eficiențe superioare de îndepărtare a substanțelor poluante cu efect toxic de tipul produselor farmaceutice (acid clofibric) de peste 90% și a microorganismelor patogene (bacterii coliforme totale) de peste 99%.

INTRODUCTION
Water, characterised by its two main dimensions quantity and quality, is one of the most important and at the same time threatened environmental factors. The concept of *water management* is defined firstly at the level of water resources and involves the regularization and protection of natural stocks and secondly at user's level – as rational distribution of available water based on the existing potential vs. requirements.

Generally, the technical issue regarding water quality is to limit the discharged residues by applying optimum treatment processes which may lead to concentrations that do not exceed the self-cleaning potential of natural water so that the water resource could maintain the adequate quality for use development and aquatic fauna. After proper treatment, wastewater may be discharged in the environment or may be reused in different purposes (irrigation, other uses except drinking water purposes).

Zootechnics is an activity conducted by humans from ancient time and is meant to ensure the basic food products for humans; on secondary level, the residues from livestock were considered organic fertilisers adequate for crops and were reincorporated in the environment.

For its recovery in agriculture, wastewater should not show damaging potential on human health or on the environment. The ensuring of certain concentrations of toxic substances and pathogenic microorganisms is to be achieved (STAS 9450-1988). The quality of the resulting effluent used in agricultural purposes influences greatly the behaviour of the wastewater – soil – plant system. However, wastewater resulting from livestock has a significant content of organic substances and nutrients (nitrogen and phosphorus) that act as fertilisers for agricultural lands and represents an attractive source in this regard; thus it gained interest in this paper.

In the last decades, the diversification of the products for animal use has led to an increase in using of food supplements and of active pharmaceutical products (antibiotics, analgesics etc.). The detection of emerging pollutants in wastewaters have raised increased concerns regarding the potential adverse effects on human health and environment (*Ilie et al. 2017; Lishman et al. 2006*).

The manure and the effluents resulting from wastewater treatment plants represent the main sources for antibiotics in the environment and finally in drinking water, as few of them are equipped for the degradation of such pollutants (*Grenni et al., 2018*). Drinking water should not contain any chemicals of anthropogenic origin for numerous reasons; thus the prudent use of antibiotics and the restriction of their input into the aquatic environment is necessary (*Kummerer, 2009b*). Nevertheless, the available knowledge regarding the nature and the spreading of the impact of pharmaceutical products on the environment are still limited.

The use of advanced oxidation processes (AOPs) in wastewater treatment may ensure a high degree of removal of pollutants which show to be refractory to conventional treatment with HClO or with stronger oxidising agents such as H_2O_2 or O_3. Among the advanced oxidation techniques, the following are included: ozonisation at high pH values (over 8.5), O_3/H_2O_2 processes, photochemical processes using strong oxidising agents such as H_2O_2 and O_3 (H_2O_2/UV; O_3/UV; O_3/H_2O_2/UV), catalytic and photocatalytic techniques (*Ruppert et al., 1994*).

UV treatment is based on the primary mechanism of action of the UV radiation in killing the microorganisms by degrading the cell nucleic acids, particularly the deoxyribonucleic acid. The low pressure mercury vapour lamp emits approximately 92% of the light at the wavelength of 254 nm – optimum value for germicide action. Direct photolysis of organic pollutants is enhanced by light at λ = 290-400 nm. UV radiation itself is not efficient in the degradation of organic compounds, however when coupled with a catalyst it provides significant results (*Robescu et al., 2000*).

The catalytic oxidation in aqueous media may be conducted in homogenous phase, in the presence of soluble salts of transition metals with variable valence (Fe, Cu, Co, Mn, Cr etc.) or in heterogeneous phase using metal or transition metal oxides catalysts (Cu-Al_2O_3, Cu-TiO_2, CuO, CuO-Al_2O_3, CuO-ZnO-Al_2O_3, CuO-Cr_2O_3-Al_2O_3, NiO-Al_2O_3, Fe_2O_3/zeolite, MnO_2, V_2O_3/Al_2O_3, TiO_2 etc.) (*Oppenlander, 2003*).

The research depicted in this paper refers to the treatment of wastewater resulting from cattle farms for further use in fertigation of crops in arid or critical areas threatened by desertification. The procedures for wastewater disinfection using UV and photocatalysis in UV/ZnO system were investigated together with the optimum conditions for the exploitation of the clofibric acid (pharmaceutical product) in the water matrix.

Clofibric acid (ACL) is the active substance of lipid regulators, which act by reducing the production of serum triglycerides. Also, ACL is used widely as growth regulator for plant hormone auxin and has been employed as an efficient antiauxin for more than 5 decades in agricultural activities (*Popa et al., 2015*).

This xenobiotic compound is very persistent in the aquatic environment and remains unchanged within the conventional wastewater treatment plant (*Chen et al., 2002*). The available literature reports information regarding the assessment of the toxicity of clofibric acid using three estuarine organisms (an alga, a crustacean and a fish species). It has been noticed based on the examined indicators that no adverse effects occur, however the long term effects cannot be ruled out (*Tran et al., 2010*). Moreover, the possible mixing toxicity, the bioaccumulation and trophic transfer of this contaminant should be considered (*Rivera et al., 2011*).

MATERIAL AND METHOD

The experiments on wastewater treatment were conducted at laboratory scale on wastewater resulting from cattle. The analysis of physicochemical and bacteriological quality indicators of wastewater was performed using standardised methods, with conventional and instrumental methods: pH (SR EN ISO 10523-2012), conductivity (SR EN 27888-1997), COD (SR ISO 6060-1996), BOD (SR EN 1899/1-2002), total suspended solids (SR EN 872-2005), phosphorus (SR EN ISO 6878-2005), nitrogen (SR ISO 10048-2001), total coliforms and faecal coliforms (ISO 9308-1990), enterococci (SR EN ISO 7899/2-2002).

Recent advances in analytical chemistry methods have enabled the detection of contaminants concentration at low level in water. The concentration of ACL was determined using liquid chromatography as separation technique coupled with mass spectrometry for detection. The analysis was performed using

UHPLC ONLINE SPE - EQuan MAX LC-MS/MS TSQ Quantiva Triple-Stage Quadrupole Mass Spectrometer (SPE-UHPLC–MS/MS) – Thermo Fisher Scientific Modular liquid chromatograph.

For the assessment of the behaviour of clofibric acid (ACL), spiked samples were prepared by dissolving a known quantity of pollutant in the wastewater matrix. The photocatalytic degradation of ACL was conducted at laboratory scale in batch, in heterogenous phase, using ZnO nanoparticles.

RESULTS

Generally, wastewater management within a zootechnical farm involves its collection in tailing ponds, which allows also a local self-cleaning. Thus, the wastewater used in the experiments was initially subjected to a physical process for the separation of coarse matter and to aerobic/anaerobic biological processes. In the following, the analytically relevant wastewater quality indicators are pointed out.

The method proposed for the removal of pathogenic microorganisms is UV disinfection. The results obtained after 180 min exposure time are given in Table 1. A very good bactericidal efficiency of the disinfection process was observed, the degree of removal for all the monitored bacteriological indicators ranging between 99.7 – 99.9%.

Table 1

The efficiency of the UV treatment of wastewater (global quality parameters of wastewater)

Quality indicator	Unit	Influent Uv	Effluent UV	Efficiency (%)
pH	pH unit	8.4	8.3	-
Conductivity	mS/cm	3.5	3.4	-
COD-Cr	mg O_2/L	856	804	6.1
BOD_5	mg O_2/L	159	116	27.1
Total nitrogen	mg/L	203	201	1.0
Total phosphorous	mg/L	47	46	2.3
Total coliform bacteria	no/100 mL	9.200.000	230	99.9
Faecal coliform bacteria	no/100 mL	109.000	13	99.9
Enterococci	no/100 mL	80.000	237	99.7

The simulation at laboratory scale of the catalytic oxidation of clofibric acid (ACL) was performed at a concentration of 10 ppm and several tests employing increasing concentrations of catalyst established that the optimum dose of ZnO is 650 ppm. Comparative wastewater treatment tests were designed as follows: only UV, only catalyst, UV and catalyst. These preliminary experiments allowed the determination of the adsorption equilibrium on the surface of the catalyst and the minimisation of errors due to non-photocatalytic degradation.

The results showed that ACL showed no adsorption on the catalyst in the absence of UV and the irradiation of water without adding the catalyst does not potentiate the photocatalytic decomposition of ACL, which takes place at very low rate.

As seen in Figure 1, the removal of ACL had an efficiency in the range of 8-10% in the case of direct photolysis, while in the absence of UV the efficiency was lower than 1%. By comparison, the degradation of the pollutant using catalyst and UV radiation exceeded 90% efficiency after 120 minutes of treatment. Considering the results obtained for all the treatment systems, it may be stated that the high decomposition of the ACL observed in the UV/ZnO is a result of the photocatalytic reaction only.

CONCLUSIONS

The oxidation processes proposed in this paper come in addition to the existing treatment of wastewater resulting from zootechnical farms in view of their further use in the fertigation of agricultural land.

UV disinfection may represent an efficient method for the removal of pathogenic microorganisms from wastewater. At the wavelength of 264 nm, the UV destroys the DNA of the microorganisms and inhibit their further growth. Although the growth inhibition is acquired relatively fast, one of the drawbacks of this process is the absence of a remnant effect, which may favour the recontamination under the condition of long-term storage of wastewater and a more thorough investigation of this phenomenon is required.

The emerging pollutants from the class of pharmaceutical products are organic compounds that cannot be easily removed through the conventional wastewater treatment processes. These experiments have shown that the UV and the presence of an adequate catalyst are required for the efficient degradation of specific chemical compounds, such as clofibric acid.

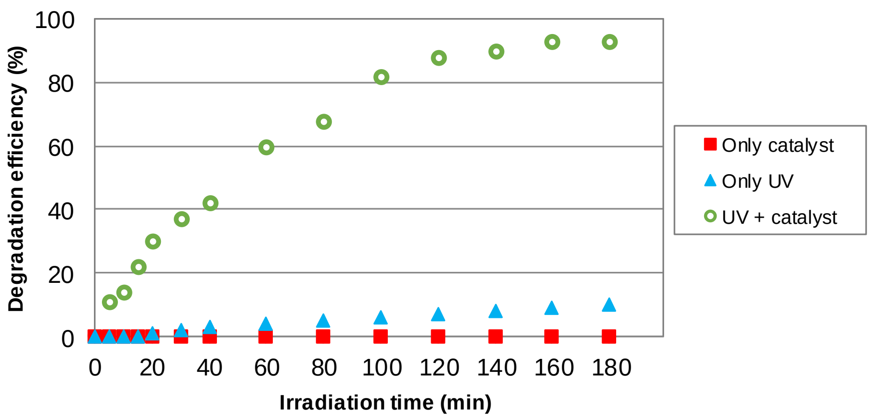

Fig. 1 – Comparative analysis of the efficiency obtained in wastewater treatment processes by UV and photocatalysis

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THE ECONOMIC PERFORMANCE OF ROMANIA IN THE YEARS 2015-2018 / *PERFORMANȚA ECONOMICĂ A ROMÂNIEI DIN ANII 2015-2018*

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Keywords: *money, function, sale, purchase*

ABSTRACT

Money is the general embodiment of public wealth - this explains the people's aspirations for their accumulation - something possible if the sale (M-B) is not followed by buying (B-M).This phenomenon (accumulation) is favored by the high liquidity of money, which also determines a convenient form of wealth preservation, although their rule, with rare exceptions, is not money-generating, which could be obtained if the money was kept in securities in the form of real estate, etc. Therefore, the money performs the function of treasury formation, accumulations and savings, when it is out of circulation and is in the commodity producers, ie the feasibility of this function results from the separation in space and time of the two acts - sale and purchase.

REZUMAT

Banii reprezintă întruchiparea generală a bogăției publice - aceasta explică aspirațiile populației pentru acumularea lor - ceva posibil dacă vânzarea (M-B) nu este urmată de cumpărarea (B-M). Acest fenomen (acumulare) este favorizat de lichiditatea ridicată a banilor de asemenea, determină o formă convenabilă de conservare a bogăției, cu toate că regula lor, cu excepții rare, nu este generatoare de bani, care ar putea fi obținută dacă banii au fost păstrați în valori imobiliare sub formă de bunuri imobile etc. Prin urmare, banii îndeplinesc funcția a acumulărilor și economiilor de trezorerie, atunci când este în afara circulației și este în producția de mărfuri, adică fezabilitatea acestei funcții rezultă din separarea în spațiu și timp a celor două acte - vânzare și cumpărare.

INTRODUCTION

The process of weighing pieces of metal for use as a means of payment for goods has ultimately been simplified by producing standardized metal fragments, which were the predecessors of today's coins.

The first coins were produced in the 7th century BC (*Burdekin R., 2004*). In Asia Minor, according to the NBR brochure on the occasion of the Euro Exhibition, which takes place from 10 March to 27 May 2011 at the NBR (*Bowen et al., 2003*).

This idea spread very quickly and, very soon, the ancient Greeks and later the Romans began to produce coins of silver and bronze. These early coins usually had a disc shape and contained a certain amount of metal that determines the value of the coin.

As a guarantee of value, the coins were engraved on the king's, the cities, or the country's issuing seal, therefore, people could rely on this guarantee, not having to weigh each coin before accepting it. Consequently, currencies have rapidly become a reliable and efficient means of exchange, which has greatly contributed to the development of antique trade (*Barro R.J., 2013*).

Coin inventory has solved many problems, but not all. Thus, when they wanted to buy expensive goods, people needed a large amount of coins that were difficult to carry, representing an easy target for thieves. The solution to this problem was provided by paper money (*Sidrauski M., 1967*).

The Chinese invented the paper and were the first to introduce the paper money concept because they did not have enough copper resources to beat the coins they needed (*Sărăcin and Pandia, 2007*).

In the eleventh century, Italian merchants began using valuable papers, called "bills", instead of large quantities of coins (*Klein P.A., 1985*). These included the details of the trade, including the names of the merchants.

MATERIAL AND METHOD

Money is the general embodiment of public wealth - this explains the people's aspirations for their accumulation - something possible if the sale (M-B) is not followed by buying (B-M).

This phenomenon (accumulation) is favored by the high liquidity of money, which also determines a convenient form of wealth preservation, although their rule, with rare exceptions, is not money-generating, which could be obtained if the money was kept in securities in the form of real estate, etc. Therefore, the money performs the function of treasury formation, accumulations and savings, when it is out of circulation and is in the commodity producers, ie the feasibility of this function results from the separation in space and time of the two acts - sale and purchase.

As a result of the inequality of the production cycles of the various commodities and the periods of their circulation (*Burdekin R. C.K., 2004*), of the seasonal nature of the production and sale of the goods, the potential buyers may not have cash in cash until the goods owner arrives on the market.

In such a situation, it becomes necessary to buy-sell the goods in credit, that is to say, a postponement of payments. In the given case, the money itself does not serve as a means of circulation, but rather as the debt securities that are expressed by them. When using them, money is the means of payment. The buying-selling process in credit can be read as follows:

C-M; M-B; B-C

Where:- C stands for debt (debt), for example, term commitments on bank loans or bills. As a means of payment, money appears as a link that completes the exchange process and as an independent achievement of value itself (*Barro Robert J., 2013*). As a means of payment, the money works not only when payments are made for the goods purchased in credit, but also during the amortization of money loans, the payment of land, taxes, and taxes.

RESULTS

Monetary money - is an indicator that designates all the money resources existing in a country's economy at a certain time, or as an average over a given period. It is a statistical indicator, which is quantified on the basis of the centralized balance sheet of the entire banking system in a country, after deducting the double operations between the banks. Money holders belong to both the banking and non-banking sectors. The banking sector of the economy is represented by commercial banks that hold reserves in the currency of the central bank (tickets and current account deposits) and the non-banking sector of the economy consists of economic agents and the population, who hold banknotes, metal coins and deposits in current accounts at commercial banks. It follows that the money table consists of a stock of bank claims, receivables in the possession of the currency users. In order to determine the level of money supply, account shall be taken of the funds available in the clients' accounts, plus the cash in circulation, respectively the liabilities of the commercial banks and those of the central bank.

From a statistical point of view, it is used for the measurement of the monetary mass, which allows for the calculation of monetary indicators and aggregates. The delimitation of the components of the money in circulation is made according to the following criteria, used in the international monetary statistics:

A. the sphere served by the money table;

B. the socio-economic nature of the currency holders;

C. the rotation and the degree of the various components of the money supply;

D. the degree of liquidity of the various components.

In a market economy, the prices of goods and services may change at any time. Some prices are rising, others are falling. There can be talk of inflation when there is a general increase in the prices of goods and services, not just specific items. Consequently, one euro can buy less, and one euro is worth less than the previous value.

When calculating the average price increase, a higher share of higher priced products - such as electricity - is attributed to cheaper products - such as sugar or postage stamps. Each household has its own consumption habits: some own a car and consume meat, others prefer exclusively the use of public transport or vegetarian food. The average consumption habits of households taken as a whole determine the share of different products and services in measuring inflation.

When calculating inflation, all goods and services consumed by households are taken into account, including: daily items (such as food, newspapers, petrol); durable goods (eg clothing, personal computers and washing machines); services (such as hairdressing, insurance and rental of housing).

Table 1

External and internal assetsnete

Period	M3					External assetsnete	Internal assetsnete	
	M2			M3 - M2	Total		Total	from which non-government credit
	M1	M2 - M1	Total					
milion lei, the end of the period								
2015	149 550.4	136575.9	286126.3	129.5	286 255.7	108 650.3	177 605.4	217 399.2
2016	179 980.2	134045.7	31426.0	108.6	314 134.6	139 669.1	174 465.5	220 100.6
2017	210 741.7	139732.1	350473.8	107.0	350 580.8	150 640.2	199 940.7	232 641.0
2017 T2	190 360.3	130720.6	321080.9	121.1	321 202.0	149 542.0	171 659.9	227 070.7
2017 T3	199 859.5	132161.5	332021.0	127.6	332 148.6	149 961.5	182 187.1	233 010.4
2017 T4	210 741.7	139732.1	350473.8	107.0	350 580.8	150 640.2	199 940.7	232 641.0
2018 T1	208 125.7	143029.4	351155.1	120.4	351 275.5	160 097.3	191 178.2	236 679.9
oct. 2017	202 052.2	134043.3	336095.5	127.8	336 223.3	155 437.8	180 785.5	233 783.4
nov. 2017	202 969.2	136471.8	339441.0	113.3	339 554.4	153 523.1	186 031.2	235 942.7
dec. 2017	210 741.7	139732.1	350473.8	107.0	350 580.8	150 640.2	199 940.7	232 641.0
ian. 2018	208 504.1	140466.4	348970.5	120.3	349 090.8	154 263.1	194 827.7	232 763.6
feb. 2018	210 656.1	141839.8	352495.9	121.1	352 617.0	161 718.1	190 898.9	233 326.3
mar. 2018	208 125.7	143029.4	351155.1	120.4	351 275.5	160 097.3	191 178.2	236 679.9

Table 2

Consumer price indices an inflation rate between 1971-2017

Year	Consumer price indices [%]	Inflation rate [%]	Year	Consumer price indices [%]	Inflation rate [%]
1971	100.6	0.6	1995	132.3	32.3
1972	100.0	0.0	1996	138.8	38.8
1973	100.7	0.7	1997	254.8	154.8
1974	101.1	1.1	1998	159.1	59.1
1975	100.2	0.2	1999	145.8	45.8
1976	100.6	0.6	2000	145.7	45.7
1977	100.6	0.6	2001	134.5	34.5
1978	101.6	1.6	2002	122.5	22.5
1979	102.0	2.0	2003	115.3	15.3
1980	102.1	2.1	2004	111.9	11.9
1981	103.1	3.1	2005	109.0	9.0
1982	117.8	17.8	2006	106.56	6.6
1983	104.1	4.1	2007	104.84	4.8
1984	101.1	1.1	2008	107.85	7.9
1985	100.8	0.8	2009	105.59	5.6
1986	101.0	1.0	2010	106.09	6.1
1987	100.9	0.9	2011	105.79	5.8
1988	102.2	2.2	2012	103.33	3.3
1989	101.1	1.1	2013	103.98	4.0
1990	105.1	5.1	2014	101.07	1.1
1991	270.2	170.2	2015	99.41	-0.6
1992	310.4	210.4	2016	98.45	-1.5
1993	356.1	256.1	2017	101.34	1.3
1994	236.7	136.7			

Cryptomoney or Cryptobond (*CryptoCurrency*) is a type of digital, virtual currency, a surrogate, non-bank currency used as a means of payment (eg Bitcoin, Ethereum, Bitcoin Cash, Ripple, Litecoin, Dogecoin). The name of cryptomonas indicates that this means of payment uses cryptography and is decentralized to control transactions and prevent double expense, a current problem for digital currencies. It is often the mistake of the virtual currency (*cryptomoneda*) to be considered an electronic currency.

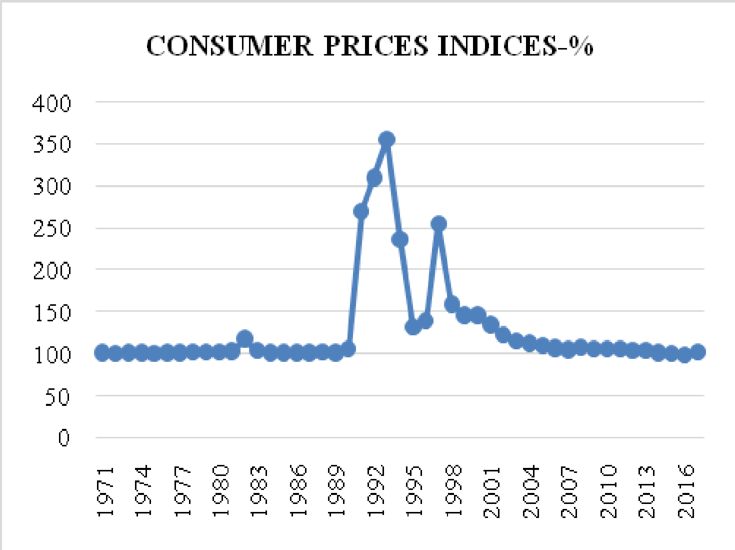

Fig. 1 - Evolution of consumer price indices an inflation rate between 1971-2017

According to the law, this is not electronic money. Thus, in Romania, art. 4 lit. f of Law 127/2011 on the issuance of electronic money, defines electronic money as "an electronically stored, including magnetic, monetary value, representing a receivable on the issuer, issued upon receipt of funds for the purpose of performing payment transactions and which is accepted by a person other than the issuer of electronic money.

In short, electronic money is the electronic version of banknotes and coins, which can be stored on an electronic payment device (e-money). It is usually used to make low-value electronic payments. The encryption market cap has been projected to reach $ 1 trillion by 2007.

Criptomones use proof-of-work protocols based on hashing algorithms. Most used are based on Bitcoin's SHA-256 algorithm, and the most used scrypt, with at least 480 confirmed implementations. Other algorithms that are used for proof-of-work include CryptoNight, Blake, X11, and combinations.

A digital wallet is generally the equivalent of a bank account: it allows receiving cryptomonads, storing and sending to other accounts. Wallets store the private password required to access the bitcoin address. Each user installs a software application that is a digital wallet, computer or mobile phone, or a web page. Using this digital wallet, the user can send or receive cryptomonodes from other users. Digital wallets can be dedicated for a single cryptomon (examples: Bitcoin, Etherium, Ripple, Litecoin), or they can be multimoded (Coinomi, CoinSpot, CoinVault, Cryptonator multi-cryptocurrency wallet, Exodus, Gatehub, Holy Transaction, Jaxx Wallet, UberPay Wallet.

Cryptomonade transactions are secured with cryptography between virtual wallets. Each virtual wallet will receive a "private key" resulting from cryptography. This private key prevents the alteration, alteration of the transaction by another person, making transactions extremely secure. Transactions are based on an alphanumeric address in the form of a string like 1FfmbHfnpaZjKFvyi1okTjJJusN455paPH derived from the public portion of one or more cryptographic keys generated free of charge.

A cryptographic key is an algorithm that requires two individual keys, one secret and one public key linked by algorithm. In order to benefit from cryptomones sent to an address, the user sends a digitally signed message with payment together with the associated private key. Cryptomoneda can be bought but also created. The process of creating the coin is called "mining". Network participants are known as miners.

They check, dated transactions, and share them in a public database called block chain. There are specialized nodes that validate transactions and blocks and connect them between transaction points. There are more than 700 cryptomonas available for trade in online markets, but only about 20 of them have had market capitalization of over $ 10 million.

Table 3

Type of currency in world

Currency	Cod	Date of establishment	Fondator	Function hash	Web page
Bitcoin	BTC	2009	Satoshi Nakamoto	SHA256	bitcoin.org
Ethereum	ETH	2013	VitalikButerin	Dagger Hashimoto	ethereum.org
Bytecoin	BCN	2012	Bytecoin Core Team	CryptoNight	bytecoin.org
Ripple	XRP	2012	Chris Larsen / Jed McCaleb	ECDSA	ripple.com
Litecoin	LTC	2011	Charles Lee	Scrypt	litecoin.org
Monero	XMR	2014	Monero Core Team	CryptoNight	getmonero.org
Ethereum Classic	ETC	2015	VitalikButerin	Dagger-Hashimoto	ethereum.org
Dash	DASH	2014	Evan Duffield / Kyle Hagan	X11	dash.org
MaidSafeCoin	MAID	2014	David Irvine		maidsafe.net
Augur	REP	2014	augurproject	Smart contract	augur.net
Steemit	STEEM	2016	steemit	SHA-256	steemit.com
NEM	XEM	2015	NemProject	blockchain	nem.io
Iconomi	ICN	2015		Smart contract	iconomi.net
Factom	FCT	2014	Paul Snow		factom.org
Waves	WAVES	2016		blockchain	wavesplatform.com
Golem	GNT				https://golem.network
Dogecoin	DOGE	2013	Jackson Palmer / Billy Markus	Scrypt	dogecoin.com
Zcash	ZEC	2016	Zooko Wilcox	Equihash	https://z.cash
DigixDAO	DGD	2015		Smart contract	https://digix.io
Ardor	ARDR				ardorplatform.org
Stellar Lumens	XLM	2014	Jed McCaleb		stellar.org
Lisk	LSK	2016	Max Kordek	DPOS	lisk.io
Tether	USDT	2014		blockchain	tether.to
ShadowCash	SDC	2014	sdcoin	Scrypt	shadowproject.io
GameCredits	GAME	2014	Sergey Sholom	Scrypt	gamecredits.com

CONCLUSIONS

"With your pocket full of money, you are wise, beautiful and you play even better," says an old Jewish proverb. It is perhaps one of the most suggestive aspects of the importance given to money, which is reflected in its long evolution. Before we learn to manage and then multiply them, we need to know them. Many may say: what is known here, that even a 2-3 year old child knows them.

Really? Is that really right? The simple fact that we know what it means we know them? What am I? What is their role? When did they come in? Why did they appear? How did they evolve? Money is worth? If so, who gives them the "value"? Will they still exist in the present form in the future? Money has never existed in its present form. They have been in a continuous process of transformation, like everything in this world, a process that obviously will continue in the future.

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SOME ASPECTS REGARDING THE ACTIVE PACKAGING OF FOOD PRODUCTS / *UNELE ASPECTE PRIVIND AMBALAREA ACTIVĂ A PRODUSELOR ALIMENTARE*

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Keywords: *food products, active packaging, scavengers, absorbers, emitters*

ABSTRACT

Prolonging the shelf life of food and always maintaining the original packaging conditions involves specific packaging methods and systems. Active packaging is defined as a modern packaging technique through which it constantly and actively changes both the permeability properties of the packaging materials, as well as the gas concentration in the free space of the packaging. More, active packaging involves oxygen and moisture absorption agents, regulators of ethylene or carbon dioxide, as well as adding antioxidant or antimicrobial compounds to the packaging environment, as well as other substances to improve the flavour and taste of foods. The most important advantage resulting from the use of active packaging is reducing food waste due to the prolongation of their shelf life. Improved packaging technologies are needed in this context, but also knowledge of operating mechanisms and the efficiency of active packaging methods.

REZUMAT

Prelungirea valabilității produselor alimentare și menținerea în permanență a condițiilor inițiale din ambalaj presupune metode și sisteme specifice de ambalare. Ambalarea activă este definită ca o tehnică modernă de ambalare prin care se modifică în mod constant și activ atât proprietățile de permeabilitate ale materialelor de ambalare, cât și concentrația gazelor din spațiul liber al ambalajului. Mai mult, ambalajele active presupun agenți de absorbție a oxigenului și a umidității, regulatori de etilenă sau de dioxid de carbon, precum și adăugarea în mediul de ambalare a unor compuși antioxidanți sau antimicrobieni, precum și a altor substanțe de îmbunătățire a aromei și gustului produselor alimentare. Cel mai important avantaj care rezultă din utilizarea ambalajelor active este reducerea pierderilor de produse alimentare datorită prelungirii duratei lor de valabilitate. În acest context sunt necesare tehnologii îmbunătățite de ambalare, dar și cunoașterea mecanismelor de funcționare și a eficienței metodelor de ambalare activă.

INTRODUCTION

Packaging materials are selected, in general, to avoid unwanted interactions with food. Usually, packaging is intended to protect food from the outside environment, to provide some convenience to purchase, but also to communicate to consumers about food information inside the packaging. On most of the usual packaging systems it is desirable to be avoided: the migration of components of the packaging material into the product, the absorption of the product components into the packaging material, high permeability to moisture, vapours and gases, as well as light, (*Sung et al., 2013*).

Active packaging is a solution in which packaging, product and environment interact. These are the systems that (as a result of chemical, physical and biological activities) actively modifies the conditions of packaged products, causes an extension of their durability and shelf life and guarantees or improves significantly microbiological safety and / or sensory properties, while maintaining quality (*Wyrwa and Barska, 2017*).

New packaging systems are called active or intelligent packaging, when they are able to capture oxygen, to absorb or release carbon dioxide, moisture in packaging or ethylene, but also to ensure temperature control and possibly compensate for temperature changes. More, smart packaging must be able to transmit food quality information at any time (*Bastarrachea et al., 2015; Ahmed et al., 2017; Vasile et al., 2017*). It is remarkable, so, the tendency to develop packaging with an active role on the packaging environment or food. The positive action consists in prolonging the freshness and stability of packaged products (*Mihindukulasuriya and Lim, 2014*). The packaging of this conception can be divided into two categories:

- sachets inserted inside the packaging;

- films where the active principles are incorporated into the structure of a single packaging material.

A special category is the capsules (closing systems) with an active role. There are several types of active principles that are incorporated into the structure of active role bags that are placed inside the packaging, (*Utto et al,, 2005; Vartiainen, 2017*).

Active packaging is defined as a packaging technique which constantly and actively modifies both the permeability properties of the packaging materials, as well as the concentration in volatile compounds and gases in the free space of the packaging or adding antioxidant compounds, antimicrobials or other substances to improve the flavour and taste of foods (*Mitelut, 2012*). It concerns the incorporation of certain additives into the packaging foil or in the packaging containers in order to maintain and extend the shelf life of the product. So, active packaging also fulfils a role other than providing an inert barrier to the exterior of the product (*Vartiainen, 2017; Vasile et al,, 2017*).

MATERIAL AND METHOD

Active packaging is based on the use of absorbent or generating materials. These packages can also be called interactive packaging.

Intelligent packaging is a developing technology that uses the packet communication function, while *active packaging* focuses on the protection function and aims to increase the shelf life, to maintain and improve the acceptability of quality and packaged food.

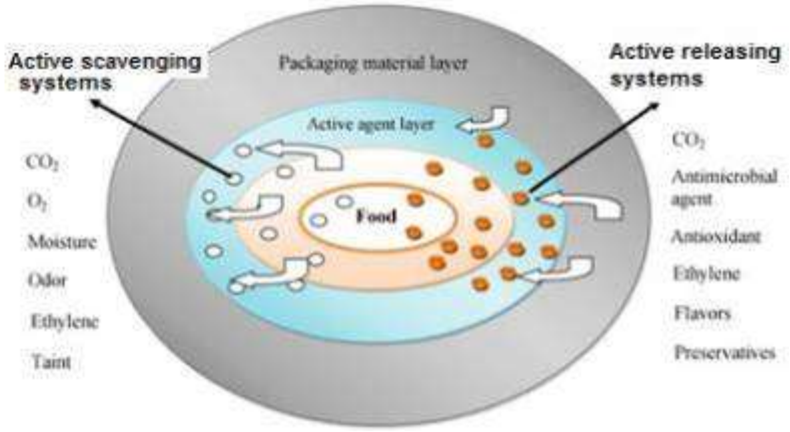


Fig. 1 – Packaging functions including its advanced packaging systems, active and intelligent packaging (a) (*Mihindukulasuriya*) **and active scavenging and releasing systems used in meat industry (b)** *(Ahmed)*

Active packs have, usually, active functions beyond inert passive isolation and product protection. Intelligent packaging involves, usually, the ability to sense or measure an attribute of the product, the inner atmosphere of the packaging or the transport environment. This information can be communicated to users or trigger active packaging functions.

In active packaging can be used, usually *(Vasile et al., 2017; Utto et al., 2005*):

- systems that retain / eliminate food-derived compounds – absorbers (of humidity, oxygen, carbon dioxide, unpleasant odours, undesirable substances);
- systems that release compounds in food – generators (of oxygen, antimicrobial agents, antioxidants, functional compounds, flavours)
- other active systems (microwave susceptors - microwave oven cover, self-heating and self-cooling).

Packing materials added with active agents are obtained by enclosing the mass of the package, usually in the last inner layer in contact with the packaged product, of some absorbent substances, neutralizing, with a certain composition. These materials are interactive because they react with the food to increase consistency and improve product quality (*Vartiainen, 2017)*.

An ideal material for antimicrobial packaging must meet the following conditions: have a restricted spectrum activity; be active at low concentrations; not to have adverse sensory effects; to be cheap; to accept the national or international service for consumer protection (OPC).

Antimicrobial packaging materials can be: organic acids; bacteriocins; isothiocyanates; metal ions; gas emitters. Antifungal agents can be mentioned: parabens; benzoate; sorbates; imazalil on packs of cheese, fresh produce and bread. The problems raised by these packaging materials are: thermal stability, efficacy under cold distribution conditions and regulations in force (*Prasad and Kochha, 2014*).

Bacteriocins are both bacteriostatic compounds, and bactericides, especially at low pH, but they are microbial-specific, with relatively low activity for fresh meat. Allyl isothiocyanate is a horseradish compound, both bacteriostatically, as well as bactericidal, but it has intense flavour even at very low doses (*Mitelut, 2012*).

Chlorine dioxide is an antimicrobial gas released from a chlorine compound, by exposure to moisture. The main advantages: works at a distance; is one of the few antimicrobials for packaging that do not require direct contact with the food and the surface of the packaging.

RESULTS

Oxygen control in packaging food products

While gas packaging is used to slow down or inhibit changes that may occur in the presence of air in the packaging, aerobic deterioration of products can occur due to the residual oxygen concentration of the packaging. This is due, mainly, factors such as:

- the permeability to oxygen of the material from which the packaging is made,
- the ability of the food to hold air,
- inappropriate sealing (passing the air through the poorly glued edges of the packaging),
- inappropriate gas discharge or leakage.

Using an absorbent of O_2 for the absorption of residual oxygen from the sealed package and of the one who penetrates continuously through the packaging material from the external environment could improve the quality of horticultural products. Existing oxygen absorption technologies use the following concepts: oxidation of iron powders, oxidation of ascorbic acid, oxidation of a photosensitive dye, enzymatic oxidation, ferrous salts, unsaturated fatty acids (oleic acid and linoleic acid), liquid rice extract containing oxygen scavenger or yeast immobilized on a solid material (*Floros et al., 1997; Ozdemir and Floros, 2004*).

So, oxygen absorbents can be defined as being “a category of chemical compounds introduced into modified atmosphere packaging (not in the product) to change the atmosphere in the packaging”.

The absorber holds the oxygen inside and, until the packaging is opened, maintains a lower oxygen concentration 0.1% (even 0.01%). Oxygen-absorbent bags or oxygen-absorbent food sheets contain components that can be used in the food industry.

Advantages of oxygen absorption are related, firstly, by the fact that: it does not impart specific taste or smell; does not allow the mixing of flavours; makes it possible to reduce the amount of preservatives and antioxidants used; the method does not change the natural state of the food, (*Utto et al, 2005; Yeh et al, 2008*).

Oxygen removal is necessary because its presence negatively influences the preservation of food allowing the development of microorganisms, chemical degradation (rancidity, loss of colour and nutrients, browning) and physiological changes (continuing breathing) (*Gaikwad, 2018*).

Factors influencing the choice of the type and size of the absorbent are related to the nature of the food, product dimensions, quantity of O_2 dissolved in food, the desired storage life, initial level of O_2 in the free space of the package, permeability to O_2 of the packaging material (*Ozdemir and Floros, 2004)*.

Lately, has gained an increased interest in the use of plastic materials to remove oxygen from the packaging by incorporating in their mass microcapsules containing iron filings, potassium acetate or sodium sulphite. The iron filler is used to provide a large reaction area, which proceeds as follows (*Ramos et al., 2015; Cirillo et al., 2018*):

$$Fe \rightarrow Fe^{2+} + 2e^-$$
$$1/2O_2 + H_2O + 2e^- \rightarrow 2OH^-$$
$$Fe^{2+} + 2OH^- \rightarrow Fe(OH)_2$$
$$Fe(OH)_2 + 1/4O_2 + 1/2\ H_2O \rightarrow Fe(OH)_3$$
$$Fe + 3/4O_2 + 3/2H_2O \rightarrow Fe(OH)_3$$

There are countless manufacturers of oxygen scavengers, of which one can remember: Mitsubishi Gas Chemical (with absorbers Ageless), Toppan Printing (Freshilizer) Toagosei Chem. Ind. (Vitalon) Nippon Soda (Seaqul), Finetec (Sanso-cut), Toyo Seikan Kaisha (Oxyguard), from Japonia, Dessicare (O-Buster), Multisorb technologies (FreshMax), Amoco Chemicals (Amosorb), W.R. Grace (PureSeal), from USA, Ciba Specialty Chemicals (Shelfplus), from Switzerland CSIRO/Southcorp Packaging (Zero), from Australia, Standa Industrie (ATCO and Oxycap), from France) and more, most of them using as active substances the iron filing embedded in sacks, but also in labels or plastic packaging material (film, cylinders or alveolar plates) (*Utto et al, 2005*).


Oxygen absorbers have the advantage of not imparting specific taste or smell, do not allow the mixing of flavours, make it possible to reduce the amount of preservatives and antioxidants used, and the method does not change the natural state of the food.

Carbon dioxide control

Although the increase in carbon dioxide around certain horticultural products reduces breathing, delaying senescence and growth of fungi, excessive levels of CO_2 may induce fermentative metabolism or cause physiological disorders. So, both absorbers of CO_2, as well as carbon dioxide generators could be beneficial for extending the shelf life of fresh fruit and vegetables (*Utto et al, 2005*).

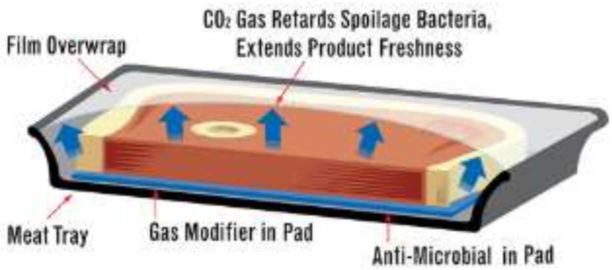
Transmitters / Absorbers of CO_2 have the role of delaying the growth of aerobic microorganisms and thus reduce the processes of breathing and senescence when there is a high level of carbon dioxide in the fruit packaging space. They are based on the reaction of sodium bicarbonate and the hydratants, such as acidified water, in order to produce carbon dioxide. The absorption reaction a CO_2 of calcium hydroxide, at a high level of reaction form calcium carbonate:

$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$$

Incorporation of active absorption ingredients of CO_2 (soda lime, magnesium oxide and activated charcoal) in an active packaging system include their deposition on the surface of the packaging material or the introduction of active material into sachets (*Utto et al, 2005*).

Production characteristics of CO_2 and the desired environmental conditions in the food packaging must be established and adapted to the thermodynamic and kinetic properties of the absorbent of CO_2, often in combination with the gas transfer mode through the layers of the packaging material (*Lee, 2016*).

High levels of CO_2 causes changes in product taste, so a generator of CO_2 is only useful in certain applications, such as fresh meat, poultry, fish and cheese. The lack of oxygen is insufficient to delay the growth of fungi and bacteria at ambient temperatures. That's why, oxygen absorption must be combined with the generation of CO_2 for better quality packaged products. Because of permeability of CO_2 is 3 to 5 times greater than off O_2 in most plastic films, it must be produced continuously to maintain the desired concentration in the package (*Prasad and Kochha, 2014*). The emitters of CO_2 have a bacteriostatic effect in food.



Packages that only absorb CO_2 are rare, the active substance being used in combination with other types of gas absorbers or generators capable of maintaining the qualities of the food.

Ethylene absorbents

Commercial ethylene absorption systems are made as separate elements (sachets) or are integrated into the packaging material. The active substance is, in general, potassium permanganate as a fine powder or zeolite. Flexible packaging materials, such as low density polyethylene (LDPE) and linear low density polyethylene (LLDPE) when impregnated with potassium permanganate, they become ethylene collectors. Fresh vegetables and fruits, such as mango, tomatoes, bananas, papaya, has a longer storage period when are packaged in such ethylene adsorption films. Chemical reagent, embedded in the packaging film, capture ethylene produced by ripening fruits or vegetables. The reaction is irreversible and small amounts of absorbent substances are required to remove ethylene at the concentrations at which it is produced. Potassium permanganate ($KMnO_4$) oxidizes C_2H_4 in a series of reactions with acetaldehyde and acetic acid formation, which, in turn, is further oxidized with the formation of CO_2 and H_2O (*Sahurkar and Pawar, 2018*):

$$3C_2H_4 + 2KMnO_4 + H_2O \rightarrow 2MnO_2 + CH_3CHO + 2KOH$$

$$CH_3CHO + 2KMnO_4 + H_2O \rightarrow 3CH_3COOH + 2MnO_2 + 2KOH$$

$$3CH_3COOH + 8KMnO_4 \rightarrow 6CO_2 + 8MnO_2 + H_2O$$

and respectively: $3C_2H_4 + 12KMnO_4 \rightarrow 12MnO_2 + 12KOH + 6CO_2$

When put into the pouch, the active substance is impregnated on an inactive substrate (inert), such as silica gel or activated carbon, because $KMnO_4$ is toxic.

Table 1

Examples of active and intelligent packaging systems (*after Svensson, 2004*)

System	Form	Reagent	Function	Application
O_2–absorbent	Sachet, label, cap or film	Ferrous compounds Metallic salts Organometallic compounds Pd/Pt catalysis Glucose oxide / Ethanol oxide	Inhibit lipid oxidation, mould growth, discolouration	Fats, oils, nuts bakery products, roasted coffee, meat, cheese, dried fruit, beverages etc.
CO_2-absorbent	Sachet or film	CaOH + NaOH or KOH	Adsorb produced CO_2 to prevent swelling of the package	Roasted coffee and cheese
Ethylene-absorbent	Sachet or film	Aluminium oxide + potassium permanganate Chrystobalite Activated carbon Zeolite	Control ripening of fruits and vegetables	Fruit and vegetables
Odour-absorbent	Film	Polyethylene imine Ascorbic acid and iron salt (ferrous sulphate) dispersed in plastic	Preserve smell and taste Remove off-odours	Adsorb aldehydes from oxidation of fats and oils Remove amine or sulphur-compounds from fish in domestic refrigerators
Moisture-adsorbent	Sachet or film	Glycerol Polyvinyl alcohol Clay Silica gel	Control moisture content	Dry foods, meat and vegetables
Antimicrobial	Sachet or film	Nisin Chitosan Horeradish derivative Ceramic compounds (e.g. silver zeolite and zinc oxide)	Prevent microbial growth	Fish, fresh fruits, cheese, meat, bread
Antioxidants	Film	BHT BHA Vitamin C or E	Prevent lipid oxidation	Cereals, wine
CO_2-emitters		Ascorbic acid Ferrous carbonate+metal halide	Control ripening of vegetables	Vegetables
Ethanol-emitters	Sachet	Ethanol adsorbed in silica powder (release ethanol in response to water adsorption)	Prevent microbial growth and staling	Bakery products and semi-dry fish

The functionality of an absorber depends, also, of specific needs. In some cases, it may be necessary not only to remove volatile hydrocarbons, but also to retain water molecules, in which case an adsorbent must be constructed so as not to dehydrate the packed product too much.

There are packaging that can be degraded by the effect of corrosion caused by volatile hydrocarbons released from the product. In such cases, the absorbent must ensure proper humidity inside the packaging, as well as the absorption of oxygen and volatile hydrocarbons.

The packing strategy must consider both the product and its biochemistry, as well as the delivery system, the required shelf life, in essence, the entire lifecycle of the product from manufacture to use. Although absorbents are introduced, most often, in packaging close to the end of the packing process, the choice of the absorber working strategy cannot be chosen later, but from the beginning, together with the determination of the packaging method of the packaged product.

CONCLUSIONS

Active packaging refers to the incorporation of certain additives into packaging film or in packaging containers to maintain and extend the shelf life of the product. Packaging can be called assets when they fulfil a desired role in preserving food, other than providing an inactive external barrier.

Active packaging includes additives or agents to improve freshness who are able to capture oxygen, adsorbing carbon dioxide, moisture, ethylene and / or flavorings, releasing ethanol, sorbates, antioxidants and / or other preservatives.

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POPCORN DAKOTA BLACK - ALTERNATIVE FOR SMALL FARMERS
/
PORUMBUL POPCORN DAKOTA BLACK - ALTERNATIVĂ PENTRU MICII FERMIERI

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Keywords: *consumption, capitalization, expansion, popcorn*

ABSTRACT

After the wheat culture, the corn is on the second place as the most important cereal plant, having the benefits resulted from grains consumption and being a medicinal remedy for certain diseases or for the completion of the necessary essential amino-acids for our organism. The importance of capitalization of corn grains Zea Dakota Black, and their commercialization of this hybrid.

The paper presents the crop technology of the pop corn crop on the sandy soil from the western part of Oltenia, its importance as a food crop, determination on expansion degree at different moistures and temperatures for the wide consumption capitalization.

REZUMAT

După cultura grâului, porumbul se află pe locul al doilea ca cea mai importantă plantă de cereale, având beneficiile rezultate din consumul de boabe și fiind un remediu pentru anumite boli sau pentru completarea aminoacizilor esențiali necesari pentru organismul nostru. Importanţa valorificării boabelor de porumb Zea Mays Dakota Black, şi comercializarea lor, a condus la cercetarea amănunţită a acestui hibrid.

Lucrarea prezintă tehnologia culturilor de recoltare a porumbului popcorn pe solul nisipos din partea de vest a Olteniei, importanța sa în cultura alimentară, determinarea gradului de expandare la diferite umidități și temperaturi pentru valorificarea consumului larg.

INTRODUCTION

The popcorn was discovered by Amerindians in the pre-Columbian era. The year 1948 marks the discovery of the popcorn, with an existence of 5600 years. In 1885, the first commercial machine for producing popcorn is created (*Pîrvulescu et al., 2008*).

By their content in some active principles like phytosterols, mineral salts, saponins, vitamins C, E, K and volatile oil, the corn grains have a pharmacological action, being a good diuretic, energetic and bland, consumed in the form of various products, accessible for humans (*Pîrșan et al., 2006*).

Proteins are essential constituents of the body in their turn being formed of the essential amino acids, cannot be produced by the organism and must be brought by food in various combinations and non-essential amino acids a body which can be produced, and caloric needs can be filled from vegetable or animal food with complete and incomplete biological values (*Manea, 2009; Pandia O., 2006*).

The percentage of protein in corn grain can range from 10.8% to 20% and fat percentage from 4.7% to 15%, this is an important factor for studying all amino acids present in the grain, but mainly corn caryopses are followed containing more lysine and tryptophan by diversifying more hybrids.

Lysine, is an essential amino acid that is found in almost all proteins in the body, having a major role in increasing the molecular weight and calcium absorption, hindering the elimination of urine, so, lysine prevents osteoporosis, positively influence the central nervous system, it helps the collagen production and participating in the production of enzymes, antibodies and proteins (*Hera C., 1972*).

By eating foods of plant and animal origin, those amino acids can be found naturally on corn seeds which are rich in lysine and can cover the daily equipment of lysine for the body (*Ailincăi B., 2008; Sărăcin I., 2008)*.

Because most essential amino acids are in different quantities in the food composition of a group where some nutrient factors are in large quantities, while others are in small quantity or missing, therefore in order to have a balanced diet it is necessary to eat food from different groups.

Thus, in this paper, we study two of these essential amino acids taken from corn grains, besides other existing therein and required for the daily ratio supplement of amino acids useful to humans, such as tryptophan and methionine (*Goian et al., 2000; Rusu et al., 2005*).

Due to its high contents in fiber, corn regulates bowel movement, prevents constipation, leading to occurrence of colorectal cancer. Rich in polyunsaturated fatty acids, corn oil stops the growth of blood cholesterol, being a good diuretic and permanent consumption can prevent water retention in the body.

MATERIAL AND METHOD

The results presented in this work are acquired by research effectuated within country Olt, Izbiceni village, where the evert co variety Dakota Black of crop was studied. Within this co variety the beans are yellow- orange, shining, little, and have the bean's apex rounded.

The endosperm has corneous texture (glassy), excepting a small region around the embryo, and MMB is of 70-81 grams, 50.000 plants/ha were sowed on a sandy soil, using a non-irrigated system, resulting a production of 820 kg beans/ ha.

Studied parameters:
Parameter **A**: sowed plant;
1 – Fundulea 625 popcorn
Parameter **B**: fertilizer dose;
1 – Using the reserve that exists in the soil
Parameter **C**: irrigation system;
1 – Non-irrigated system

RESULTS

Before establishing the corn culture, soil analyses were made for each variant. Because of the unfavorable conditions during the studied year, an 820 kg/ha production was obtained, without using chemical fertilizers and within a non-irrigated system.

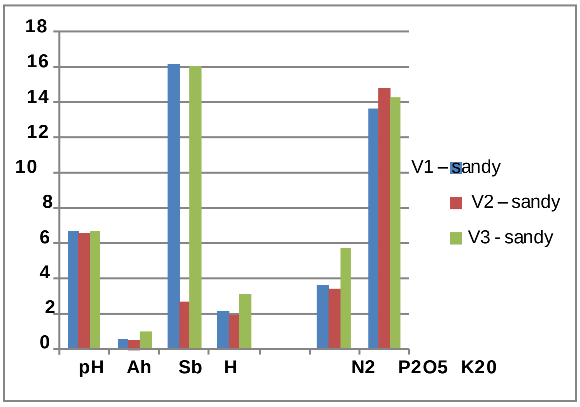
Table 1

Characteristics of the soils where the experiments took place

Soil type	pH [%]	Ah Me/100 [g/soil]	Sb Me/100 [g/soil]	H [%]	N2 [%]	P2O5 Mg/100 [g/soil]	K2O Mg/100 [g/soil]
V1.sandy	6.73	0.57	16.21	2.20	0.055	3.8	13.7
V2.sandy	6.66	0.49	2.8	1.96	0.056	3.5	14.9
V3.sandy	6.71	1.04	16.12	3.16	0.052	5.9	14.4

Source: authors

Analysis of expansion within the laboratory



Source: authors

Fig. 1 - Characteristics of the soils where the experiments took place

After the maize beans were ingathered (100 beans), they were subjected to determinations of expandability at 60°C and 23% humidity. In this way it is performed the first determination, using gas flame, and, after a period of 3 minutes, it results: 34 very well expanded beans, 32 medium expanded beans and 37 unexpanded beans. If the exposure time increases the beans are burnt.

The determination is taken again but an electric stove is used this time. The expansion period is of 5 minutes and the results are the following: 65 expanded beans, 17 medium expanded beans and 21 unexpanded beans. For the ingathered beans in these humidity conditions which return to consumption, a slower and longer heating (5 minutes), but:

Table 2

The expansion results of popcorn beans depending on Humidity (H) and Temperature (T)

Quantity	H [%]	T [°C]	Time of exposure	Source of heating	Degree of expansion		
					Very well	Medium	Unexpanded
100 beans	23%	60°C	3 minutes	Gas flame	34	32	37
100 beans	23%	60°C	5 minutes	Electric stove	65	17	21

Source: authors

Source: authors

Fig. 2 - Variety Dakota Black of crop studied

For acquiring better results, it is recommended that the corn cobs are ingathered when they reach their physiological maturity and the humidity of beans is of 11.9%. The same determinations are effectuated, using an electric stove and the following results are obtained:

For a quantity of 100 beans at 11.9% humidity, using gas flame, after a period of 2 minute, the following results are obtained: 88 very well expanded beans, 12 medium expanded beans and 2 unexpanded beans.

The determination is repeated, but this time an electric stove is used and the following type of beans are obtained: 79 very well expanded beans, 11 medium expanded beans and 10 unexpanded beans.

Table 3

The expansion results of popcorn beans depending on Humidity (H) and Temperature (T)

Quantity	H [%]	T [°C]	Time of exposure	Source of heating	Degree of expansion		
					Very well	Medium	Unexpanded
100 beans	11.9%	60°C	2 minutes	Gas flame	88	12	2
100 beans	11.9%	60°C	3 minutes	Electric stove	79	11	10

Source: authors

The same determinations are effectuated, using an electric stove and the following results are obtained: For a quantity of 100 beans at 11.9% humidity, using gas flame, after a period of 2 minute, the following results are obtained: 88 very well expanded beans, 10 medium expanded beans and 2 unexpanded beans.

The determination is repeated, but this time an electric stove is used and the following type of beans are obtained: 79 very well expanded beans, 11 medium expanded beans and 10 unexpanded beans.

CONCLUSIONS

Using the popcorn on a large scale in order to obtain financial advantages.

For acquiring better and more economical results, the maize ingathering and preserving until it reaches the value of 13% humidity within beans production.

The use of natural gas or other high caloric power sources as a source of expansion. In order to obtain a better result, it is recommendable to use a certain dose of fertilizers and an irrigated crop system.

Determination of differentiated protein content and amino acids existing in corn grains, lead to establishing the biological value of the protein in the two hybrids that are recommended for planting being representative for the high protein content.

It is recommended for the popcorn to be consumed safely, without fat additions which can become harmful for the human body. The home-made popcorn frequent consumption contributes to the improvement of the health status by preventing some heart and vascular diseases, because of the presence of an anti-oxidant in these grains.

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THE QUALITY OF WELDED JOINTS FROM STEEL OL 52.4 AND THEIR BEHAVIOR WHEN EXPLOITING
/
CALITATEA ÎMBINĂRILOR SUDATE DIN OȚEL OL 52.4 K ȘI COMPORTAMENTUL LOR LA EXPLOATARE

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Keywords: *steel, proprieties of melted material, characteristics of welded, hardness analysis*

ABSTRACT
In the paper we present the analysis of the hardness (HV_{10}) in more directions in transverse area of the joint, in the thermal-influenced area (TIA), in the basic metal (BM) and in weld, but we also analyze the embrittlement and stub- cracking effect and the angle at static bending.

The hardness analysis of melted material and also the study of embrittlement and stub-cracking effect and the analysis of static bending angle under constant load offer very important information over the quality of welded joints and their behavior when exploiting them.

REZUMAT
În lucrare prezentăm analiza durității (HV10) în mai multe direcții în zona transversală a articulației, în zona cu influență termică (TIA), în metalul de bază (BM) și în sudură, dar analizăm și fragilitatea efectul de crăpare și unghiul la îndoire statică.

Analiza durității materialului topit și, de asemenea, studiul efectului de fragilitate și crăpăturilor și analiza unghiului static de încovoiere sub sarcină constantă oferă informații foarte importante asupra calității îmbinărilor sudate și a comportamentului lor atunci când sunt exploatate.

INTRODUCTION
The execution of the welded metallic constructions aggregates appeared on industrial scale first for road and railway bridges and then to maritime vessels. The damages that appeared proved the ignorance and lack of mastery of some technological aspects and also the usage of materials with inappropriate proprieties for the aimed purpose.

The frequent fragile breaks determined the necessity of studies over the causes of damages, especially at the weld of complex metallic constructions. Among the factors that influence the life span of welded constructions there are reminded: the choice of materials and technological welding processes, chemical com- position, thermal influence area *(Dobrotă D., 2014)*.

Growing life span for welded constructions is possible by constructive improvements and optimization of weld parameters so that metallographic structures are more homogenous in welded joint *(Bayrakte E., 2004; Parhi et al., 2007)*. Generally, the metallic welded constructions present more deteriorations in the jointing area compared to other areas of the constructions and all of these are determined by the proprieties and the inhomogeneous structure in welded jointing area.

For welded structures the execution temperature generates conditions for certain types of degradations by breaking because of the inhomogeneous metallographic structures obtained during the application of different types of weld. The life span of welded constructions is very influenced by the evolution of material proprieties from their structure and these proprieties are much influenced by the structural constituents of material from the welded joint *(Lippold J., 2005)*.

The steels for general purposes for constructions gained a large usage in making welded constructions of great importance compared with the carbon steel because of their characteristics which allow an appropriate behavior at combined requests, respectively mechanical with corrosive environment *(Ansi Z49, 2005; Pokorny et al.,2015)*.

Making metallic constructions from steel OL 52.4k is often met, but these kind of welded constructions are indicated to be used especially for making very requested equipments.

In practice, it is very important to know the proprieties of melted material from the welded jointing because of the strong requests to that they are exposed. In terms of technological exploitations of certain welded constructions, the breaks or failures by breaking are the result of an uneven metallographic structure for welded jointing or the expansion of dimensions of a flaw appeared during welding process *(Narayanan S., 2005)*.

The welded constructions became more and more used in the last two decades because of their advantages compared with other structures obtained by other technological processes, but the technological making process of some products in welded construction in its specific character presents also a series of disadvantages that arise mostly from the operation with materials in liquid state *(Chang B., 2001).*

The life span of these metallic constructions is very influenced by the evolution of dimensions and deformations suffered by it. Thus an important analysis that must be made refers to deformation evolution that can appear at welded metallic constructions, but also to the establishment of the main causes that determine the appearance of these deformations, mainly related to the proprieties of the melted material from the welded jointing *(Bayraktar E., 2004; Chivu O., 2013).*

MATERIAL AND METHOD

Choosing welding processes and addition material is related firstly to project provisions of the sub-ensemble and to the technical conditions that the executor disposes. Generally, the manual welding procedure with wrapped electrode is the most used for heavy aggregates and high gauge made from profiles, tin and other mechanical-processed elements, but in the last decades the MAG (metal active gas) procedure extended considerably for welding steel.

The joint formation is made from addition metal and part of the basic melted metal, resulting in a chemical composition formed by mutual diffusion of the two components.

The electrical arch is a concentrated source of energy, emitted in the form of electrons on the conductive space between electrode and bath, caused by ionization. The released temperatures owed to Joule - Lentz effect reach approximately 3000 °C and the stream density is approximately 100 A/mm^2.

The research was made to establish the main proprieties of melted material from a welded joint made from steel OL 52.4k so that superior characteristic for welded joint are obtained.

The usage of this type of steel is indicated at the manufacture of resistance elements (beams, poles, sections, sleepers, consoles etc.). Making welded joints from tins 10 mm thick was taken into account in the experimental research. The welding joints technology from steel OL 52.4k recommends that until the thickness becomes 10 mm the basic material should not be overheated, because the linear welding energy makes an overheat that is sufficient to the operations.

The mechanical characteristics were established to obtain the desired results in the research and they are presented in Table 1 and the chemical composition is presented in Table 2.

Table 1

Mechanical characteristics of steel OL 52.4k

R_m / MPa	R_{02}/ MPa	z / %	A / %	K_{CV} 20^0 C / J	K_{CV} 0^0 C / J	K_{CV} -20^0 C / J
568	402	23	31	79	64	52

Table 2

Chemical composition of steel OL52.4k / wt. %

C	Mn	Si	S	P	Al
0.217	1.6583	0.053	0.025	0.021	0.011

RESULTS

The relation for calculating the equivalent carbon is the starting point to establish the main proprieties of melted material C.

$$C_e = C \cdot Y + \frac{Mn}{6} + \frac{Si}{2} + \frac{Ni}{40} + \frac{Cr}{5} + \frac{Mo}{4} + \frac{V}{14} \quad (1)$$

In this relation the last four terms can be excluded because in steel for low-alloyed construction for welded structures that do not contain nickel, chrome, molybdenum and vanadium from which steel OL 52.4k takes part, where Y is the thickness of the tin (as a basic material, being represented in mm).

The information about melted metal proprieties in joint area can be obtained by measuring hardness (HV) along some directions, in the transverse joint area, in the thermal-influenced area (TIA), in the basic metal (BM) and in weld, after metallic bath solidified.

The maximum hardness (H^M) in the thermal-influenced area (TIA) must be under 350 units (HV^{10}). The calculus of maximum allowed hardness is made with the empirically determined (relation 2).

$$H_m = 660 \cdot \left(C + \frac{Si}{24} + \frac{Mn}{6} + \frac{Ni}{40} + \frac{Cr}{5} + \frac{Mo}{4} + \frac{V}{14}\right) + 40 \quad (2)$$

When the parenthesis from (relation 2) represents the equivalent carbon, the restrained (relation 3) results by replacement.

$$H_m = 660 \cdot C_e + 40 \quad (3)$$

The tendency of cracking because of the thermal influence and accumulated gases in addition material (AM) is correlated with the (relation 4).

$$H_m \le 350\ (HV10) \quad (4)$$

The qualities requested to the joint for reducing the risk of embrittlement are different from those of basic metal (BM) because it does not contain always flaws capable to become crack primers, as in the case of addition material (AM) at solidification because of the dif- fusion, precipitation and cooling phenomena which are hard control in the whole cord mass.

The attempts made for determining the weld, TIA, basic or additional material qualities specific to each area but also the delimitation of these areas for the constructions of specimens necessary to attempts is some- times difficult but they are suited to statistic interpretations.

The most dangerous phenomenon owed to techno- logical factors appeared in TIA at welding laminated pieces (weld made transverse on the laminated fiber) with a thickness larger than 25 - 30 mm is the lamellar crack.

This is owed to the tensions appeared in the direction of the piece thickness between layers, because of the local chemical inhomogeneity between BM and AM and also to the uneven tensions that lead to step cracking.

The lamellar cracking (unraveling) is very dangerous for the whole construction because the cracks do not reach the surface, being primers for later fragile breaking. The inclusions from the structure are made from various impurities agglomerations such as silicates, manganese sulfides, oxides that group in ferrite pearlite structure accentuated by lamination.

Calming by deoxidation with silicon and aluminium for obtaining steel OL 52.4k assures the minimum breaking energy that has the value of 27 J at – 30 °C and lowers the tendency of lamellar cracking, being obtained at specimens trials with V notch. However, there are not recommended solutions that request transversally the laminated layers at resistance welding.

In these cases, there is recommended In these cases, there is recommended the constructive reprojection of welding joint, as well as the modification of the joints on the board with the tendency of cracking (Figure 1 a), with big joints having a large penetration (Figure 1 b) and the weld in more passes (Figure 1 c), when the tendency of lamellar cracking is provided.

Changing the way of preparation of joint and its size, starting from the solution from figure 1a leads to changing contraction effects of the additional material as contraction direction. Instead some perpendicular contractions on lamination direction (Figure 1a) contractions parallel to lamination direction appear, (Figure 1c).

The basic material BM_1 must not take efforts on transversal direction where there are perpendicular on lamination direction (Figure 1c).

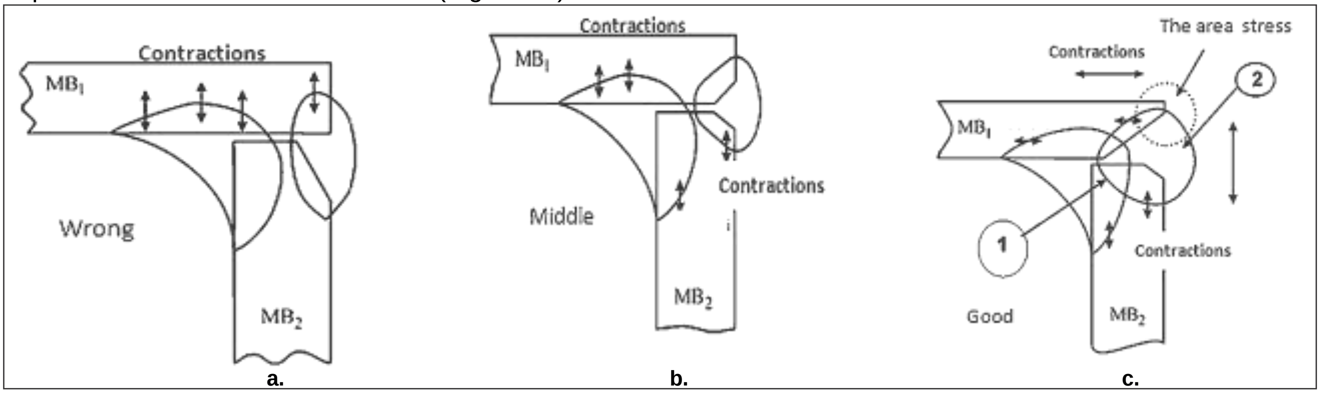

Fig. 1 - Solutions for removing the lamellar unraveling at corner welding

In case of unilateral corner welding with short lengths in pilgrim step made on one side and then on the opposite side as in Figure 2, for one single pass the stub-cracking that can be avoided by preheating the pieces and increasing the number of passes simultaneously with lowering the length between cords compared with the length of the cord ($L_n < L_s$) for L_s <40 mm when the thickness of basic materials is $g_{MB1} \cong g_{MB2} \cong 6$ M.

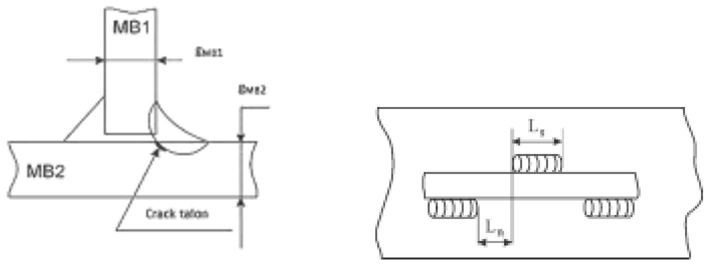

Fig. 2 - The embrittlement and stub-cracking effect

Besides the maximum hardness in the thermal-influenced area, other correlations for a metallurgical behavior at weld have in view the equivalent carbon and the angle obtained at static bending and the values are:

$$C_{max}=0,2\text{-}0,22\ \% \tag{5}$$

$$\propto \geq 20\ °C \tag{6}$$

where $\propto$: - the angle of static bending of the specimens under constant force, until fragile breaking. The bending angle correlated with the maximum hardness in TIA and with carbon content of C $\leq$ 0, 25 % where the content of S and P in the steel is low are the information that warn that there is no danger of fragile cracking.

The size of the grain is also important and it influences positive the flow limit and the beginning of plastic deformation. The steels with a good plasticity sup- port overloads without deterioration which is important for the life span of the welded aggregate, also having a fine structure of grains.

By the successive submission of layers is also made the microstructure regeneration because when melting a layer the one submitted before heats over the transformation point A_{C3}, resulting a mainly perlitical finer eased structure for the steel OL 52.4k after cooling in the air. The only layers that remain unregenerate are those that submit the last. Preparing the joint has in view the equilibration of the contraction tensions and the avoidance of deformation in assembly area.

CONCLUSIONS

- technological and constructive factors influence directly the sub-aggregates characteristics made by welding. The deviations from the quality norms in- crease the negative influence in all the phases of technological process.
- technological and constructive factors have direct influence over sub-aggregations made by welding. The deviations from the quality norms increase the negative influence in all the phases of technological process.
- respecting the technology in all the phases of the process with the effectuations of controls in the imposed stationary points makes better the characteristics of the welded joints.
- the quality deviations and the unevenness in trans- verse sections due to welding process have negative effects over the metallic constructions by appearing degradations in welding area.
- the hardness analysis of melted material and also the study of embrittlement and stub-cracking effect and the analysis of static bending angle under constant load offer very important information over the quality of welded joints and their behavior when exploiting them.

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GPS GUIDED AGRICULTURAL MINIROBOT
/
MINIROBOT AGRICOL GHIDAT PRIN GPS

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Keywords: *Raspberry Pi, agricultural robot, GPS, Unmanned Ground Vehicle*

ABSTRACT

The research is to design an autonomous agricultural robot, specifically an unmanned ground vehicle UGV. The UGV is fitted with a GPS tracking system and programmed to be able to autonomously monitor environmental factor from one location to another using GPS coordinates. With the autonomous system, it is possible to reduce the overall labour costs and thereby improve the socio-economic benefit. The goal of the project is to act as a proof of concept for small scale autonomous UGV delivery like that nearing deployment by agricultural machinery manufacturers. The tests have shown that the measurements made with the selected sensors are consistent and it seems possible to design economic viable robotic systems for agriculture.

REZUMAT

Cercetarea de față prezintă etapele de proiectare a unui robot agricol autonom, în mod specific, un vehicul terestru fără pilot UGV. Vehicolul este echipat cu un sistem de urmărire GPS și programat pentru a putea monitoriza autonom factorii de mediu dintr-o locație în alta folosind coordonatele GPS. Cu ajutorul vehiculelor autonome este posibil să se reducă costurile generale ale forței de muncă în fermele agricole și, prin urmare, să se amelioreze beneficiile socio-economice. Scopul principal al proiectului este de a acționa ca o dovadă de lansare a conceptului de mașină autonomă la scară redusă, în apropierea celor implementate deja de către marii producători de mașini agricole. Testele au arătat că măsurătorile efectuate cu senzorii aleși sunt coerente și că este posibil economic să se proiecteze sisteme robotice viabile pentru agricultură.

INTRODUCTION

Increasing productivity by optimizing plant breeding and harvesting processes is a certainty in developed countries that are already implementing precision farming. With new technologies, state-of-the-art computer systems, and last but not least, robots, humanity prepares for the moment when it has to produce at least a double quantity of food to feed itself. In the field of agriculture, robots perform various repetitive, sometimes boring operations, or require force and skill for workers, such as monitoring development and selective harvesting of crops, irrigation or spreading of nutrients, perform proper pest control, or handling heavy materials (*Blackmore et. al., 2005; Kushwaha et. al., 2016; Gonzales-de-Santos et. al., 2017; Ruiz-Larrea et. al., 2015; Tokekar et. al., 2013*). However, despite the advanced stage of research, rising investment and more recent advances in the field, the current capabilities of robotic platforms in understanding the environmental environment and the assigned tasks are limited (*Gemignania et. al., 2015*).

According to several papers in the literature (*Blackmore et. al., 2005; Pedersen et. al., 2008; Gonzales-de-Santos et. al., 2017; Roldán et. al., 2018; das et. al., 2015*) small vehicles are obviously lighter than large machines, which reduces soil compaction and increases safety in use for operators as well and for crops, also ensuring greater positioning precision during work.

As described by *Yaghoubi et. al. (2013),* there is a significant number of automatic harvesting systems equipped with a camera and GPS navigation system. With the development of new hardware and software technologies, the work that they can perform is also growing. They essentially define agricultural robotics as the logical proliferation of automation technology in bio systems such as agriculture, forestry, greenhouses, horticulture, etc.

De-An et. al. (2011) designed and developed a prototype robot for harvesting apples consisting of a servo system for manipulator and effector control and an image-based viewing system. This platform can integrate approaches such as GPS, route planning and crew piloting as a navigation strategy. They report a successful harvesting rate of apples in the field of 77%, and the average harvest time was 15 s per apple.

This paper's main objective is the design and implementation of agricultural minirobot guided GPS for training in engineering and act as a proof of concept implementation of autonomous small cars in normal agricultural work. On-field testing conducted on our campus has verified the functionality of the proposed robotic system and its practical application in performing its proposed environmental monitoring tasks.

MATERIAL AND METHOD

Global positioning system reference

The GPS operating principle is to use some space satellites as reference points for ground location. Satellite Navigation is a method employing a Global Navigation Satellite System (GNSS) to accurately determine exact position and exact time anywhere on Earth. In this case, speed and direction of travel can be derived from these values and are obtained from satellites orbiting the Earth [13]. Satellite Navigation Systems use satellites as time-signal transmitters and in three-dimensional space we need four time-signal transmitters. The distance D between the GPS receiver and the satellites is made by measuring the time required Δτ for the radio signal to be transmitted from the time of its being issued by the GPS and when it is received by the receiver:

$$D = \Delta\tau \cdot c \tag{1}$$

where, ***c*** is speed of light.

Receiving satellite signals and positioning can be done in absolute mode using a single GPS receiver and the positioning accuracy is about 10 - 15 m, and in differential mode using two receivers, one of which is the station of base, being installed at a fixed point with known coordinates. The combined effect for position and time is called global DOP (Dilution of Precision) and is calculated with the relationship:

$$GDOP = \sqrt{(PDOP)^2 + (TDOP)^2} \tag{2}$$

where, PDOP – refers to precision of three-dimensional positioning; TDOP refers to accuracy of time determination. Different sources can contribute to the total error in GPS measurements. The total error values should be viewed as typical averages and can vary from receiver to receiver.

Algorithm for controlling the agricultural minirobot when follow a specified path at varying speeds, using a Global Positioning System (GPS) and Inertial Measurement Unit (IMU), must satisfy a criterion to move outside the path with a maximum lateral error (*Fischer and Palm, 2017*). The algorithm begins with finding the direction required for the minirobot to move. This can only be done with two sets of reference coordinates, latitude and longitude. If the GPS is placed in the top right corner of the robot platform, for lateral control, the midpoint of the front axle is estimated. The position is estimated considering both the rotation of the robot body and the translation vector. Since the system can introduce perturbations, the GPS position can be corrected according to the equation (*Fischer and Palm, 2017*):

$$GPS_{pos\ cor} = GPS_{pos} + GPS_{noise} \tag{3}$$

where GPS_{pos_cor} is the estimated position of GPS.

By calculating the rotation matrix of the vehicle body, tracking is possible the front axle in the middle of the mobile platform. The rotation matrices are defined as:

$$R_x(\theta) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos(\theta) & -\sin(\theta) \\ 0 & \sin(\theta) & \cos(\theta) \end{bmatrix}; R_y(\beta) = \begin{bmatrix} \cos(\beta) & 0 & \sin(\beta) \\ 0 & 1 & 0 \\ -\sin(\beta) & 0 & \cos(\beta) \end{bmatrix}; R_z(\gamma) = \begin{bmatrix} \cos(\gamma) & -\sin(\gamma) & 0 \\ \sin(\gamma) & \cos(\gamma) & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$R_{xyz}(\theta, \beta, \gamma) = R_x(\theta) * R_y(\beta) * R_z(\gamma) \tag{4}$$

The roll (***θ)***, pitch (***β***), and yaw (***γ***) angles, needed for the rotation matrix calculation, were extracted from the IMU sensor measuring.

Hardware and software

Mechatronic systems are composed of four main groups of elements: sensors, actuators, controllers and mechanical components. The proposed robotic system in our research is presented in Figure 1. The main component of hardware section is the **Raspberry Pi 3 B+**, a single board computer. It contains a microprocessor, memory (1GB LPDDR2 SDRAM), supporting I/O and other circuit components like: Gigabit Ethernet LAN, Wi-fi, Bluetooth Low Energy, HDMI Ports, Camera Serial Interface. It's based on Broadcom BCM2837B0, a system-on-a-chip technology integrating a compatible processor Cortex-A53 (ARMv8) 64-bit SoC @ 1.4GHz, graphics processor, cache memory and core supporting interface circuitry. Raspbian is the "official" operating system of the Raspberry Pi, a version of Linux built specifically for the Raspberry Pi. Software implementation of our minirobot control system uses Python language. The Raspberry Pi has been chosen due to its performance, connectivity and programming. The hardware setup of minirobot for performing navigation consists of a NEO-6m GPS module, which is connected to a Raspberry Pi 3 board via a serial, USB and an MPU 9250 Inertial motion sensor (IMU) connected through i2c interfaces.

Fig. 1 - Agricultural minirobot platform

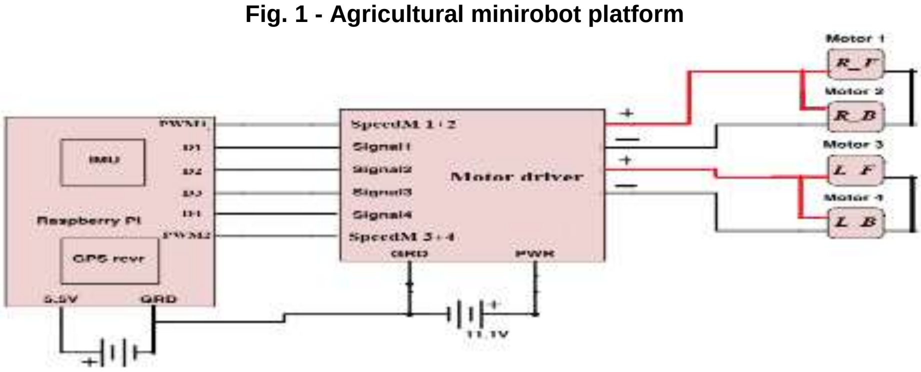

Fig. 2 - Block diagram of UGV electronic speed control

The basic electronic schema for the robot control, driven by four DC motors, is shown in Figure 2. The L298N Motor Driver Module, a high voltage Dual H-Bridge manufactured by ST company, is used to drive the motors. It is designed to accept standard TTL voltage levels. H-bridge drivers are used to drive inductive loads that require forward and reverse function with speed control such as DC Motors

Figure 3 shows an illustration of a typical Neo 6m module produced by U-blox Holding AG Switzerland. It is well-performing complete GPS receiver with a built-in ceramic antenna and a volatile RAM to save configuration parameter data. The device is powered by the USB bus, and therefore no additional power supply is needed. The default maximum current that can be drawn by the receiver is 120 mA in that mode.

Fig. 3 – Module GPS Ublox Neo 6m

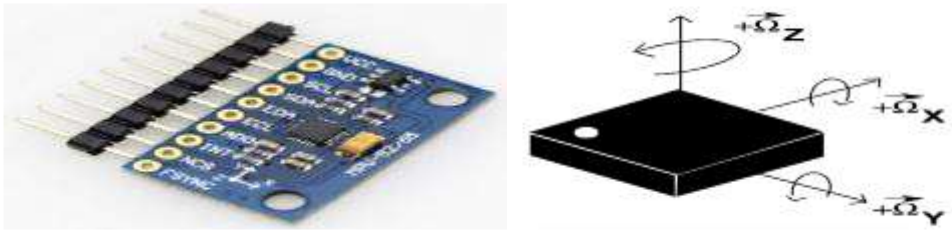

Fig. 4 - Module IMU 9250

Inertial motion sensors (IMU) are a booming industry, mainly because they are autonomous, require a low power supply and are miniaturized. IMU sensors typically contain three orthogonal accelerometers and three orthogonal gyroscopes, and three orthogonal magnetometers, measuring angular velocity, acceleration and magnetic field respectively. MPU 9250 developed by InvenSense Inc., a full 9DoF inertial sensor, is used as the motion sensor in our research. It has accelerometer, gyroscope and compass on all three axes as is shown in Figure 4. As can be seen in the robot's block diagram (Figure 5), the prototype of our agricultural robot is very much a minimalist system with just enough components to demonstrate autonomous behaviour's.

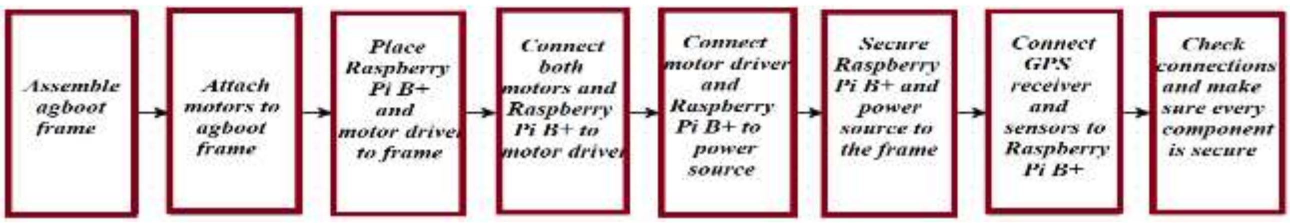

Fig. 5 – Block diagram of agribot hardware assembly

The data set or information from GPS receiver is called NMEA, which stands for National Marine Electronics Association. The NMEA protocol version 2.3 is default configured on U-blox receivers. The GPS data is normally received and transmitted in a standard NMEA-0183 format (*Berman et. al., 2013*). To display the NMEA protocol sentences transmitted by the GPS receiver via the serial port (/dev/ttyAMA0 in the case of the Raspberry Pi board) we can use the following Python script code:

```python
import time
import serial
import string
import pynmea2
import RPi.GPIO as gpio


gpio.setmode(gpio.BCM)


port = "/dev/ttyAMA0" # the serial port to which the pi is connected.

#create a serial object
ser = serial.Serial(port, baudrate = 9600, timeout = 0.5)

while 1:
    try:
        data = ser.readline()
    except:
        print('loading')
        if data[0:6] == '$GPGGA': # the long and lat data are always contained in the GPGGA string of the NMEA data
            msg = pynmea2.parse(data)

#parse the latitude and print
            latval = msg.lat
            concatlat = "lat:" + str(latval)
            print (concatlat)

#parse the longitude and print
            longval = msg.lon
            concatlong = "long:"+ str(longval)
            print (concatlong)


    time.sleep(0.5)#wait a little before picking the next data.

```

RESULTS

A series of experimental tests have deployed in the UPB campus, Depart. of Biotechnical Systems. To evaluate the performance of the GPS receiver antenna as well as the conditions of the satellite observation environment, we use GNSS evaluation software provided by manufacturer. The polar plot graphically displays the averaged relative satellite signal strength (Figure 6), the position of satellites in the sky, identifies satellites by number and indicates which satellites are being used in the receiver's calculation. Red color indicates that satellite signal is not available and not used for navigation solution.

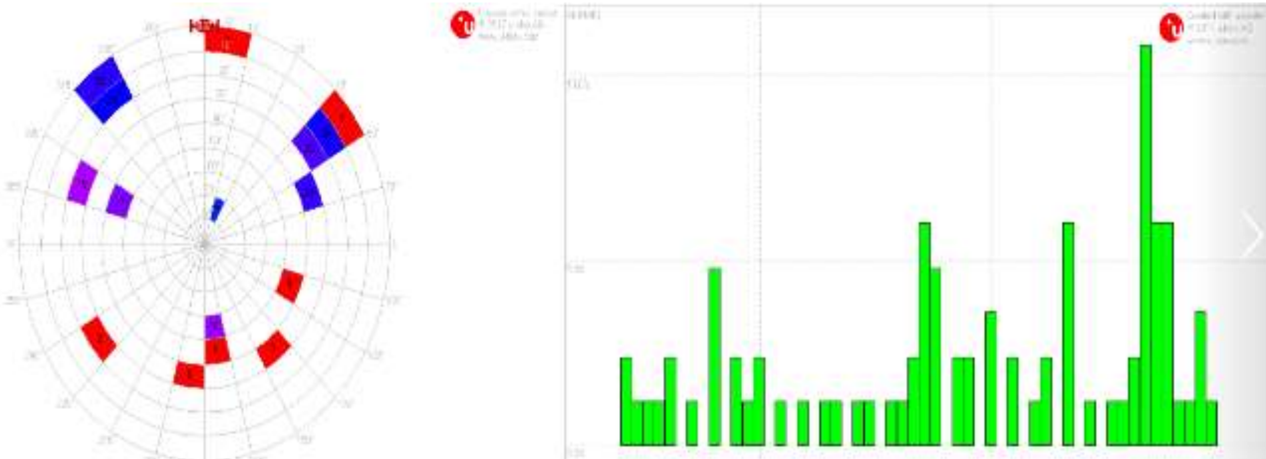

Fig. 6 - Sky view - position of satellites

To test the IMU module, we have conducted several series of measurements to check the system and data accuracy. Accelerometers are extremely sensitive to attitude changing and impact forces while gyroscopes are sensitive to temperature changes and suffer from a slow-changing bias. The gyroscopes measure the angular velocity along the three axes, so it is not directly able to predict roll, pitch or yaw angles (*Tran L., 2017*).

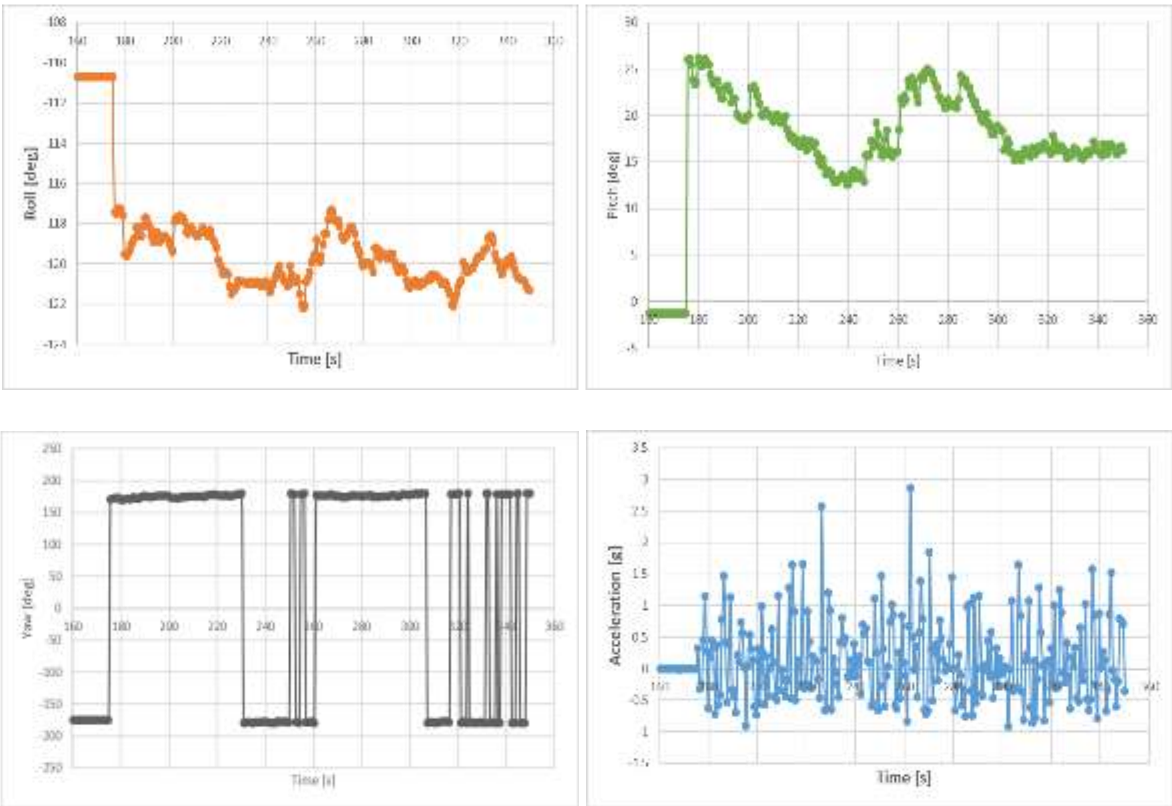

Fig. 7 - The data stream from IMU 9250 device

Figure 7 depicts the total acceleration and angular displacement test measurements with respect to time. Data come in 16 bits with the range of (±4g). When the machine system is stationary as the top of the sensor faces upward, Z axis stays on 1g while X and Y axes give the value of 0g. A translational orientation is given to the system and quantification of fluctuations is observed as a response.

From data, analyzing of roll and pitch angle we conclude that using techniques such as Complimentary and Kalman filter we can obtain good values without making the system too complex. Data acquisition from the third component of our IMU, digital magnetometer, has been done using i2c interface at address 0x1e. Unfortunately, this value, not presented in paper, should be corrected considering the angle on the horizontal plane between magnetic north and true north.

The GPS Ublox Neo6m receivers use a sophisticated signal quality detection scheme, to produce the best possible position output. The NMEA data streams include information on latitude, longitude, time, altitude and other variables [16]. The data is transmitted in sentence codes and is decoded into string format which we then manipulate to find our required information, as can be seen in Figure 8.

This GPS continuously outputs NMEA sentence codes such as GSA (GPS DOP and active satellites) and GLL (Geographic Position – Latitude/Longitude). In this case, the only concerned is the ($GPGGA) sentence, which represents the Global Positioning System Fix Data. These data strings based on ASCII are communicated at a rate of 9600 bits per second which is equivalent to the baud rate of 9600 characters per-second.

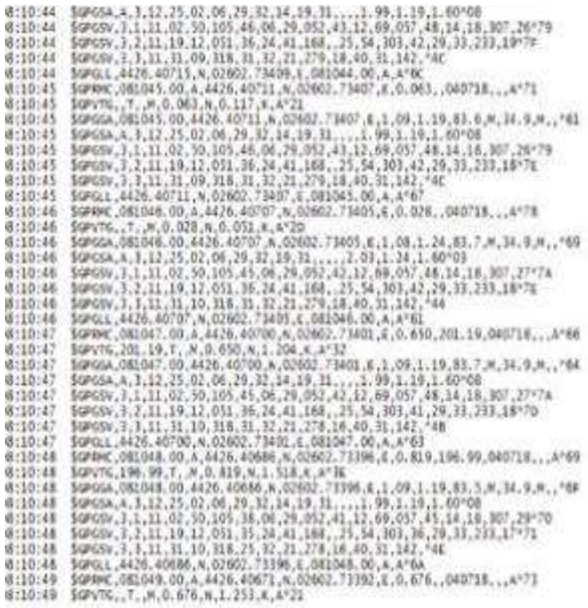

Fig. 8 - Received data from GPS using USB serial interface

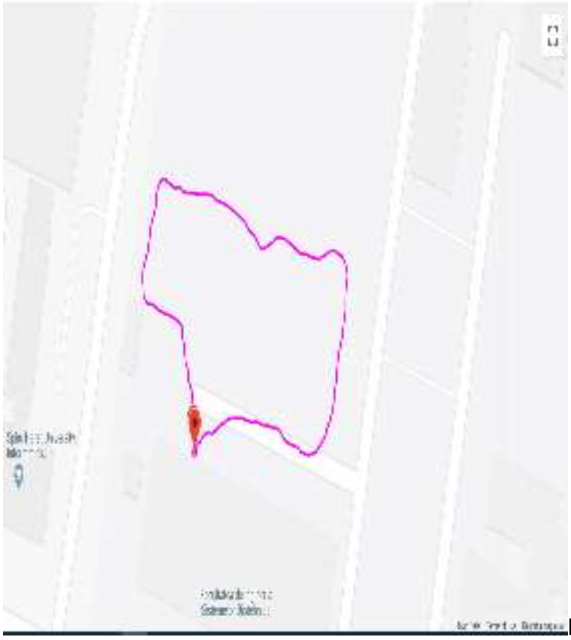

Fig. 9 - Google Map view of the minirobot path

The minirobot followed a free-planned path using a mobile device as remote control and obtained its location using GPS receiver and measurements from its Inertial Measurement Unit (IMU). The position in the geographic coordinates (latitude and longitude) was recorded and is illustrated in Figure 9, a Google Map view of the minirobot route. The data in this figure clearly illustrates that Ublox Neo6m continues to read most of the satellites with strong signal strength and provides a constant position. As we can observe measurements have been taken in good receiving conditions and that have a very pronounced impact on the accuracy of results.

CONCLUSIONS

A GPS guided agricultural minirobot for monitoring environmental factor was designed, constructed and tested. The proposed system can be used as part of a complex modular robotic system for inspection and exploration or can be used independently as a stand-alone mini robot. The engine modules have been designed so that the drive motors can be easily changed and controlled by controlling the voltage applied to them. The vehicle requires a significant amount of energy to perform they tasks. The results of experimental tests have shown that the proposed system, ensure optimal working conditions. The main purpose of using farm robots is to reduce labor cost and to modernize traditional farming using available technology.

By using small agricultural robots, the study of mechatronic systems for future engineers becomes very simple and, most importantly, it is possible to show virtually all dependencies and performance of the system through various experiments, as well as motivating work by stimulating creativity.

ACKNOWLEDGEMENT

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EXPERIMENTAL RESEARCH ON THE KNIFE BLADES USED TO CUTTING AND SHREDDING FIBROUS FUDDER

CERCETĂRI EXPERIMENTALE ASUPRA ORGANELOR DE TĂIERE-MĂRUNŢIRE A FURAJELOR FIBROASE

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Keywords: *cutting shredding organs*

ABSTRACT

In the process of harvesting fibrous fodder an important and negligible requirement is the appropriate shredding of the fiber feed directly or indirectly into the composition of animal feed, whether it be fresh fodder, high moisture or fodder feed or even dried *(Neculăiasa V., Dănilă I. 1995)*. The degree of comminution of feeding stuffs decisively influences the speed of assimilation by animals of the administered feed, implicitly their weight gain, the profitability of the respective cattle farm and not only. In the paper are presented the possibilities of technically obtaining a finest shredding of fibrous fodder, especially by using multirow knives in the feed channel of self-loading hay trailer. However, these technical solutions also have certain disadvantages in the daily operation of such machines.

REZUMAT

În procesul de recoltare a furajelor fibroase o cerinţă importantă şi de loc de neglijat este mărunţirea corespunzătoare a furajelor fibroase care intră direct sau indirect în componenţa hranei animalelor, indiferent dacă este vorba de furaje fibroase proaspete, cu un grad de umiditate ridicat sau despre furaje vestejite sau chiar uscate (Neculăiasa V., Dănilă I. 1995). Gradul de mărunţire a furajelor influenţează în mod hotărâtor viteza de asimilare de către animale a nutreţului administrat, implicit sporul în greutate al acestora, rentabilitatea de funcţionare a fermei respective de bovine şi nu numai. În lucrare se prezintă posibilităţile de a obţine tehnic o mărunţire cât mai bună a furajelor fibroase, cu precădere prin utilizarea a cuţitelor multiple aşezate pe mai multe rânduri în canalul de alimentare ale remorcilor autoîncărcătoare fân. Aceste soluţii tehnice însă prezintă şi anumite dezavantaje în exploatare de zi cu zi ale utilajelor de acest gen.

INTRODUCTION

In order to counteract all these shortcomings presented above, we carried out some theoretical research, resulting in a universal knife profile, which has the advantage of general usability.

Its profile is thus conceived from the design stage to meet the requirements of cutting - shredding of all types of green fodder feed used in animal feed in zootechnics, regardless of their degree of humidity.

In the experimental researches we performed a series of cutting - shredding tests on different types and kinds of fibrous feeds in order to establish the correctness regarding the results of the experimental research and the actual shape of the knife obtained from the researches.

For this purpose, we designed and executed a cutting bench at the laboratory, where we used different forms of knives to determine the specific energy needed to cut different types of fibrous feed (*Caba I. 2001*).

MATERIAL AND METHOD

In order to carry out experimental laboratory tests to ascertain the usefulness and viability of the projected knife profile, it was necessary to design and execute a test stand where successive, repeated cuts with different shapes and sharpening angles could be performed, where the section of the test samples fodder feed remained constant and measurable at all times (*Ciocârdia C. 1999; Dănilă I. 1981; Neculăiasa V., Dănilă I. 1995*). The actual operation scheme is shown in Figure 1.

Another requirement was ease, simplicity and last but not least the safety of clamping of different shapes of their edges. The basic element of the experimental laboratory tests was the Charpy pendulum (*Duttonand Mines, 2002; Truşculescu M., 2016*), for which we designed and built a special support device for easy gripping of the knives and samples. This support allowed the knives to snap and loosen easily and ensured that they were hardened during the laboratory experiment. The clamping-fastening device of the knife is made up of a metal plate identical in shape to the pendulum profile. Stiffening of this plate (the knife holder) to the pendulum profile was accomplished by the application of four fastening heels welded to the surface of the plate. On the surface of the disc, I have reinforced with electric arc welding four clamping clamps, which serve to stiffen the cutting and grinding blade during the measurements, but also allow for a slight change of the clamp.

Balancing the accessories applied to the surface of the pendulum profile was done with great care, while recording these values. The weight of the initial hammer arm of 2074 g was reached after the knife fastening device was mounted at 2530 g, but the balancing was so carefully chosen that it did not significantly change the center of gravity of the knife.

Another urgent necessity has also been to provide a certain distance between the knife and the hammer, failure to meet this requirement, and the removal of the detached part by cutting from the length of the specimen automatically led to the locking of the cutting knife in the feed material used as the test samples. In order to achieve a proper grip of the feed material specimen and to ensure a constant cutting section throughout the measurements, we designed and made a simple clamping vice, with three rigid walls and a fourth movable. Thus, we ensured a cross section of the constant and measurable specimen. The vise movable wall was operated with a press screw, and the vise supply was possible by completely detaching the movable wall and its support bracket into stiffening screws.

The drawings of the Charpy hammer pendulum are shown in Figure 2, which allows us to easily determine the specific energy consumed in the cutting of the fibrous feed specimen and the technical data related to this device used in the experimental determinations made in the laboratory are as follows:

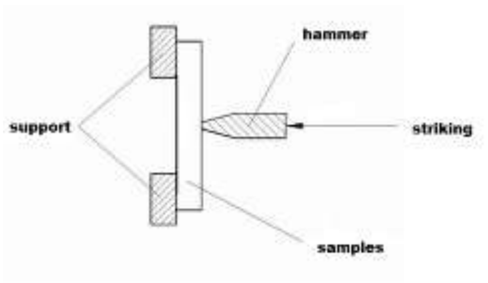


Fig. 1 - The principle of the test

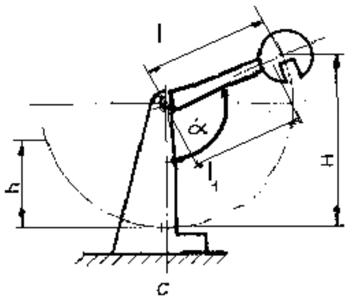


Fig. 2 - Scheme of Charpy hammer operation

where:

l - the distance from the axis of rotation - the suspension at the cutting center of the knife blades, in this case l = 0.380 m;

l_1 - distance from rotation axis - suspension at the center of gravity, having the following value l_1 = 0.335 m;

d - angle of hammer launch, in the present case α = 130^0;

β - the angle of maximum hammer position after cutting of the specimen, read on the graduated screen of the appliance;

H - the hammer launch height;

h - the height at which the hammer is lifted after cutting the specimen

In the case mentioned above for the equilibrium position of the pendulum hammer, the condition is that:

$$G\, l \neq G_1\, 1_1 \quad (1)$$

where: G_1 - the weight of the hammer;

G - the weight of the hammer reduced in the percussion center.

The energy consumed when cutting a fiber feed specimen is determined by calculating the difference between potential potentials of the Charpy pendulum hammer in the initial and final position.

By calculating the heights H and h we obtain:

$$H = l_1 + l_1 \sin(ά - 90^0) = l_1 (1 - \cos ά) \quad (2)$$

$$h = l_1 - l_1 \cos β = l_1 (1 - \cos β) \quad (3)$$

of these two relationships, the value of the energy W consumed at the cutting of the fibrous feed specimen results:

$$W = G_1\, l_1 (\cos β - \cos ά) \quad (4)$$

With this cut-off energy calculated with the above relationship, we can easily determine the value of the specific energy used to cut the surface unit:

$$W_S = W/S_O \quad (5)$$

where: S_O - surface area of the fibrous feed material specimen.

Knowing the angular values, the hammer weight and the length from the axis of rotation to the cutting center (values determined in the laboratory experiments), we can obtain the specific energy and cutting energy values for each cut. These calculated and tilted values can also be graphical.

The working procedure in the Charpy hammer-pendulum experiments and the fibrous feed samples were practically carried out as follows:

1. place the indicator needle at zero on the dial with the hammer left in the static equilibrium position;
2. raise the hammer and fasten it to the heel, place the knife in the holder;
3. place the test samples of the fibrous feed material on the support of the apparatus so that one end of it is locked in the vise and the other end is free, measure the dimensions of the samples by means of a caliper, make adjustments with the central screw if it is applicable;
4. the fall occurs;
5. after cutting the samples, stop the hammer and read the values indicated by the needle from the dial;
6. collect the comminuted feed material by repeated cuts into the capsules to determine the moisture content of the samples used.

These tests have been repeatedly carried out for cutters having the cutting angle between 0^0, 20^0, 25^0 and 30^0 and the cutting edge angle of 20^0. The sliding cutting angle represents the angular cutting tangent and had the values k = 0.57 for $\alpha = 30^0$; k = 0.46 for $\alpha = 25^0$ and k = 0.36 for $\alpha = 20^0$ (*Krasznicsenko A.1965; Letoşnev M. 1969*).

The laboratory experiment was performed on samples of fibrous feed material, which is used mainly in livestock breeding for livestock feed. So we used lucerne, in the two versions available at the moment, corn - stalk, sunflower and freshly harvested lolium pasture grass and we also made some attempts on dried wheat straw. After each cut, we collected the detached material and proceeded to determine the moisture content of the specimen (*Nosov V. 1988; Szendro P. 2000*).

The fibrous feed material, detached by cutting the knife, was placed in crucibles, weighed, dried in the oven, and then weighed again. The data thus obtained were tabulated. Also in these tables are the values indicated by the needle on the graduated dial, whenever cuts are made. Several determinations were made with each knife profile, precisely to ensure accuracy in the processing and interpretation of the results obtained from experimental laboratory tests.

RESULTS

Following experimental laboratory determinations carried out using the Charpy hammer pendulum simulating the actual cutting of the fibrous feeds made by the grinding knives of the furrow-gathering machines during its exploitation, we find that an almost perfect simulation of the phenomena what is happening in reality.

Here, I refer to the grinding process - cutting which is made by knives, existing in a larger or smaller number, inside the feed channel, constructive part of self-loading hay trailers, cutting knives of different types, in function the type of feed, the way of feeding the feed furnace at the moment of penetration into the feed channel, its degree of humidity, the way of laying the knives in the groove, the profile of their cutting line, the angle of sharpening, the material used to make the knife, the frequency sharpening, s.o. Keeping the sharpening angle at 20^0, we try blades with different angles of bend in order to determine the specific energy when cutting (*Csulak and Stoica, 1968; Gainov N.S., 1985*).

These experimental laboratory tests should indicate the ideal profile of a knife that if we have correctly calculated it should be similar to the one we obtained from the calculations.The fodder materials used for the test specimens are as follows: freshly harvested lucerne; semy dry lucerne; lolium; dry wheat straw; corn stalk; sunflower stem.The results obtained are shown in the tables as follows:

Table 1

Cutting the fresh lucerne samples. Cutting angle knife 0^0, sharpening angle 20^0

Nr. crt.	Test-bar size (mm /mm)	Angle indicator(^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
1	27*27	117	1.57	0.58	Tip of the stem with leaves
2	27*27	117	1.57	0.58	
3	27*27	116	1.70	0.63	
4	27*27	114	1.96	0.73	Rods and leaves
5	27*27	112	2.23	0.82	
6	27*27	113	2.09	0.78	
7	27*27	113	2.09	0.78	Rods at the harvesting level
8	27*27	109	2.64	0.98	
9	27*27	109	2.64	0.98	

Table 2

Cutting the fresh lucerne samples. Cutting angle knife 0^0, sharpening angle 25^0

Test-bar size (mm /mm)	Angle indicator(^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
27*27	112	2.23	0.82	Tip of the stem with leaves
27*27	112	2.23	0.82	
27*27	111	2.36	0.87	
27*27	110	2.50	0.93	Rods and leaves
27*27	110	2.50	0.93	
27*27	109	2.64	0.98	
27*27	105	3.19	1.18	Rods at the harvesting level
27*27	103	3.47	1.29	
27*27	101	3.76	1.31	

Table 3

Cutting the fresh lucerne samples. Cutting angle knife 0^0, angle of sharpening 30^0

Nr. crt.	Test-bar size (mm /mm)	Angle indicator(^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
1	27*27	104	3.33	1.23	Tip of the stem with leaves
2	27*27	103	3.47	1.29	
3	27*27	103	3.47	1.29	
4	27*27	99	4.04	1.50	Rods and leaves
5	27*27	97	4.33	1.60	
6	27*27	95	4.62	1.71	
7	27*27	94	4.62	1.76	Rods at the harvesting level
8	27*27	94	4.62	1.76	
9	27*27	92	5.05	1.87	

Table 4

Cutting the lucerne lucerne samples. Cutting angle knife 0^0, sharpening angle 20^0

Test-bar size (mm /mm)	Angle indicator(^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
27*27	105	3.19	1.18	Tip with leaves
27*27	104	3.33	1.23	
27*27	104	3.33	1.23	
27*27	101	3.76	1.39	Rods and leaves
27*27	101	3.76	1.39	
27*27	100	3.90	1.44	
27*27	98	4.19	1.55	Rods at the harvesting level
27*27	98	4.19	1.55	
27*27	96	4.19	1.66	

Table 5

Cutting the semy dry lucerne samples. Cutting angle knife 0^0, sharpening angle 25^0

Nr. crt.	Test-bar size (mm /mm)	Angle indicator(^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
1	27*27	100	3.90	1.44	Tip with leaves
2	27*27	98	4.19	1.55	
3	27*27	99	4.04	1.50	
4	27*27	95	4.62	1.71	Strains with leaves
5	27*27	95	4.62	1.71	
6	27*27	93	4.90	1.82	
7	27*27	92	5.05	1.87	Rods at the harvesting level
8	27*27	90	5.34	1.98	
9	27*27	89	5.49	2.03	

Table 6

Cutting the semy dry lucerne samples. Cutting angle knife 0^0, angle of sharpening 30^0

Test-bar size (mm /mm)	Angle indicator(^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
27*27	94	4.76	1.76	Tip with leaves
27*27	93	4.90	1.82	
27*27	93	4.90	1.82	
27*27	92	5.05	1.87	Strains with leaves
27*27	90	5.34	1.98	
27*27	90	5.34	1.98	
27*27	88	5.63	2.09	Rods at the harvesting level
27*27	88	5.63	2.09	
27*27	88	5.63	2.09	

Table 7

Cutting the wheat straw samples. Cutting angle knife 0^0, sharpening angle 20^0

Nr. crt.	Test-bar size (mm /mm)	Angle indicator(^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
1	27*27	90	5.34	1.98	Rods
2	27*27	89	5.49	2.03	
3	27*27	89	5.49	2.03	
4	27*27	87	5.78	2.14	Rods
5	27*27	85	6.07	2.25	
6	27*27	86	5.92	2.19	
7	27*27	84	6.21	2.30	Rods
8	27*27	84	6.21	2.30	
9	27*27	82	6.50	2.41	

Table 8

Cutting the wheat straw samples. Cutting angle knife 0^0, sharpening angle 25^0

Test-bar size (mm /mm)	Angle indicator(^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
27*27	88	5.63	2.09	Rods
27*27	86	5.92	2.19	
27*27	86	5.92	2.19	
27*27	83	6.36	2.35	Rods
27*27	82	6.50	2.41	
27*27	80	6.79	2.51	
27*27	79	6.93	2.57	Rods
27*27	79	6.93	2.57	
27*27	79	6.93	2.57	

Table 9

Cutting the wheat straw samples. Cutting angle knife 0^0, angle of sharpening 30^0

Nr. crt.	Test-bar size (mm /mm)	Angle indicator(^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
1	27*27	83	6.36	2.35	Rods
2	27*27	82	6.50	2.41	
3	27*27	83	6.36	2.35	
4	27*27	81	6.64	2.46	Rods
5	27*27	80	6.69	2.51	
6	27*27	79	6.93	2.57	
7	27*27	79	6.93	2.57	Rods
8	27*27	75	7.50	2.78	
9	27*27	75	7.50	2.78	

Table 10

Cutting the lolium samples. Cutting angle knife 0^0, sharpening angle 20^0

Test-bar size (mm /mm)	Angle indicator(^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
27*27	98	4.19	1.55	Strains and leaves
27*27	97	4.33	1.60	
27*27	96	4.47	1.66	
27*27	95	4.62	1.71	Strains and leaves
27*27	93	4.90	1.82	
27*27	91	5.20	1.92	
27*27	89	5.49	2.03	Strains and leaves
27*27	89	5.49	2.03	
27*27	88	5.63	2.09	

Table 11

Cutting the lolium samples. Cutting angle knife 0^0, sharpening angle 25^0

Nr. crt.	Test-bar size (mm /mm)	Angle indicator(^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
1	27*27	27*27	5.20	1.92	Strains and leaves
2	27*27	27*27	5.49	2.03	
3	27*27	27*27	5.49	2.03	
4	27*27	27*27	5.78	2.14	Strains and leaves
5	27*27	27*27	5.78	2.14	
6	27*27	27*27	5.78	2.14	
7	27*27	27*27	5.92	2.19	Strains and leaves
8	27*27	27*27	5.92	2.19	
9	27*27	27*27	6.07	2.25	

Table 12

Cutting the lolium samples. Cutting angle knife 0^0, angle of sharpening 30^0

Test-bar size (mm /mm)	Angle indicator(^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
27*27	87	5.78	2.14	Rods and leaves
27*27	85	6.07	2.25	
27*27	86	5.92	2.19	
27*27	84	6.21	2.30	Rods and leaves
27*27	84	6.21	2.30	
27*27	83	6.36	2.35	
27*27	82	6.50	2.41	Rods and leaves
27*27	82	6.50	2.41	
27*27	82	6.50	2.41	

Table 13

Cutting the fresh corn stalk samples. Cutting angle knife 0^0, sharpening angle 20^0

Nr. crt.	Test-bar size (mm /mm)	Angle indicator(^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
1	27*27	109	2.64	0.98	Rods and leaves
2	27*27	108	2.77	1.03	
3	27*27	108	2.77	1.03	
4	27*27	106	3.05	1.13	Rods and leaves
5	27*27	105	3.19	1.18	
6	27*27	105	3.19	1.18	
7	27*27	101	3.76	1.39	Rods and leaves
8	27*27	100	3.90	1.44	
9	27*27	99	4.04	1.50	

Table 14

Cutting the fresh corn stalk samples. Cutting angle knife 0^0, sharpening angle 25^0

Test-bar size (mm /mm)	Angle indicator(^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
27*27	102	3.61	1.34	Rods and leaves
27*27	101	3.77	1.39	
27*27	101	3.77	1.39	
27*27	99	4.04	1.50	Rods and leaves
27*27	98	4.19	1.55	
27*27	99	4.04	1.50	
27*27	98	4.19	1.55	Rods and leaves
27*27	97	4.33	1.60	
27*27	97	4.33	1.60	

Table 15

Cutting the fresh corn stalk samples. Cutting angle knife 0^0, angle of sharpening 30^0

Nr. crt.	Test-bar size (mm /mm)	Angle indicator(^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
1	27*27	101	3.76	1.39	Rods and leaves
2	27*27	99	4.04	1.50	
3	27*27	99	4.04	1.50	
4	27*27	97	4.33	1.60	Rods and leaves
5	27*27	96	4.47	1.66	
6	27*27	96	4.47	1.66	
7	27*27	93	4.90	1.82	Rods and leaves
8	27*27	94	4.76	1.76	
9	27*27	93	4.90	1.82	

Table 16

Cutting the fresh sunflower samples. Cutting angle knife 0^0, sharpening angle 20^0

Test-bar size (mm /mm)	Angle indicator(^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
27*27	105	3.19	1.82	Especially rods and sloppy leaves
27*27	103	3.47	1.29	
27*27	104	3.33	1.23	
27*27	100	3.90	1.44	Especially rods and sloppy leaves
27*27	100	3.90	1.44	
27*27	99	4.04	1.50	
27*27	98	4.19	1.55	Especially rods and sloppy leaves
27*27	98	4.19	1.55	
27*27	95	4.62	1.71	

Table 17

Cutting the fresh sunflower samples. Cutting angle knife 0^0, sharpening angle 25^0

Nr. crt.	Test-bar size (mm /mm)	Angle indicator(^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
1	27*27	97	4.33	1.60	Especially rods and sloppy leaves
2	27*27	95	4.62	1.71	
3	27*27	96	4.47	1.66	
4	27*27	95	4.62	1.71	Especially rods and sloppy leaves
5	27*27	94	4.76	1.76	
6	27*27	93	4.90	1.82	
7	27*27	94	4.76	1.76	Especially rods and sloppy leaves
8	27*27	93	4.90	1.82	
9	27*27	91	5.20	1.92	

Table 18

Cutting the fresh sunflower samples. Cutting angle knife 0^0, angle of sharpening 30^0

Test-bar size (mm /mm)	Angle indicator(^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
27*27	93	4.90	1.82	Especially rods and sloppy leaves
27*27	92	5.05	1.87	
27*27	92	5.05	1.87	
27*27	89	5.49	2.03	Especially rods and sloppy leaves
27*27	88	5.63	2.09	
27*27	86	5.92	2.19	
27*27	87	5.78	2.14	Especially rods and sloppy leaves
27*27	87	5.78	2.14	
27*27	85	6.07	2.25	

From the above, it appears that the best results in terms of energy consumption required for the cutting of the fibrous feed samples were made using the blades with a sharpening angle of 20^0, and in cases where we increased the angle of sharpening at 25^0 and 30^0, respectively, we had business with a significant increase in energy consumption when cutting samples.

Next, we retain the most convenient sharpening value obtained by the laboratory tests, the sharpen angle remains at 20^0, and alter the tilting angle of the knife so as to achieve a truly sliding cutting process. In the same manner as before, we will proceed to the cutting of samples from fibrous feed materials, with the difference that the angle of inclination of the cutting knife changes, taking successive values of 20^0, 25^0 or 30^0. Applying the above, we obtain the following experimental values:

Table 19

Cutting the fresh lucerne samples. Knife with cutting angle 20^0, sharpening angle 20^0

Nr. crt.	Test-bar size (mm /mm)	Angle indicator (^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
1	27*27	116	1.70	0.63	Tip of the stem with leaves
2	27*27	114	1.96	0.73	
3	27*27	114	1.96	0.73	
4	27*27	110	2.50	0.93	Rods and leaves
5	27*27	109	2.64	0.98	
6	27*27	104	3.33	1.23	
7	27*27	102	3.61	1.34	Rods at the harvesting level
8	27*27	98	4.19	1.55	
9	27*27	97	4.33	1.60	

Table 20

Cutting the fresh lucerne samples. Cutting angle knife 25^0, sharpening angle 20^0

Test-bar size (mm /mm)	Angle indicator (^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
27*27	117	1.57	0.58	Tip of the stem with leaves
27*27	116	1.70	0.63	
27*27	116	1.70	0.63	
27*27	111	2.36	0.87	Rods and leaves
27*27	112	2.23	0.82	
27*27	110	2.50	0.93	
27*27	109	2.64	0.98	Rods at the harvesting level
27*27	107	2.91	1.08	
27*27	107	2.91	1.08	

Table 21

Cutting the fresh lucerne samples. Knife with cutting angle 30^0, sharpening angle 20^0

Nr. crt.	Test-bar size (mm /mm)	Angle indicator (^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
1	27*27	119	1.31	0.49	Tip of the stem with leaves
2	27*27	118	1.44	0.53	
3	27*27	116	1.70	0.63	
4	27*27	115	1.83	0.68	Rods and leaves
5	27*27	115	1.83	0.68	
6	27*27	112	2.23	0.82	
7	27*27	111	2.36	0.87	Rods at the harvesting level
8	27*27	109	2.64	0.98	
9	27*27	109	2.64	0.98	

Table 22

Cutting the lucerne lucerne samples. Knife with cutting angle 20^0, sharpening angle 20^0

Test-bar size (mm /mm)	Angle indicator (^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
27*27	106	3.05	1.13	Tip of the stem with leaves
27*27	105	3.19	1.18	
27*27	103	3.47	1.29	
27*27	102	3.61	1.34	Rods and leaves
27*27	102	3.61	1.34	
27*27	99	4.04	1.50	
27*27	98	4.19	1.55	Rods at the harvesting level
27*27	99	4.04	1.50	
27*27	98	4.19	1.55	

Table 23

Cutting the lucerne lucerne samples. Cutting angle knife 25^0, sharpening angle 20^0

Nr. crt.	Test-bar size (mm /mm)	Angle indicator (^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
1	27*27	108	2.77	1.03	Tip of the stem with leaves
2	27*27	107	2.91	1.08	
3	27*27	106	3.05	1.13	
4	27*27	105	3.19	1.18	Rods and leaves
5	27*27	103	3.47	1.29	
6	27*27	102	3.61	1.34	
7	27*27	100	3.90	1.44	Rods at the harvesting level
8	27*27	98	4.19	1.55	
9	27*27	98	4.19	1.55	

Table 24

Cutting the lucerne lucerne samples. Knife with cutting angle 30^0, sharpening angle 20^0

Test-bar size (mm /mm)	Angle indicator (^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
27*27	110	2.50	0.93	Tip of the stem with leaves
27*27	110	2.50	0.93	
27*27	108	2.77	1.03	
27*27	107	2.77	1.08	Rods and leaves
27*27	104	3.33	1.23	
27*27	104	3.33	1.23	
27*27	102	3.61	1.34	Rods at the harvesting level
27*27	99	4.04	1.50	
27*27	99	4.04	1.50	

Table 25

Cutting the wheat straw samples. Knife with cutting angle 20^0, sharpening angle 20^0.

Nr. crt.	Test-bar size (mm /mm)	Angle indicator (^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
1	27*27	95	4.62	1.71	Rods
2	27*27	94	4.76	1.76	
3	27*27	91	5.20	1.92	
4	27*27	92	5.05	1.87	Rods
5	27*27	90	5.34	1.98	
6	27*27	88	5.63	2.09	
7	27*27	87	5.78	2.14	Rods
8	27*27	87	5.78	2.14	
9	27*27	87	5.78	2.14	

Table 26

Cutting the wheat straw samples. Cutting angle knife 25^0, sharpening angle 20^0

Test-bar size (mm /mm)	Angle indicator (^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
27*27	97	4.33	1.60	Rods
27*27	97	4.33	1.60	
27*27	95	4.62	1.71	
27*27	94	4.76	1.76	Rods
27*27	94	4.76	1.76	
27*27	93	4.90	1.82	
27*27	90	5.34	1.98	Rods
27*27	91	5.20	1.92	
27*27	90	5.34	1.98	

Table 27

Cutting the wheat straw samples. Knife with cutting angle 30^0, sharpening angle 20^0

Nr. crt.	Test-bar size (mm /mm)	Angle indicator (^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
1	27*27	99	4.04	1.50	Rods
2	27*27	98	4.19	1.55	
3	27*27	97	4.33	1.60	
4	27*27	97	4.33	1.60	Rods
5	27*27	94	4.76	1.76	
6	27*27	94	4.76	1.76	
7	27*27	93	4.90	1.82	Rods
8	27*27	92	5.05	1.87	
9	27*27	92	5.05	1.87	

Table 28

Cutting the fresh corn stalk samples. Knife with cutting angle 20^0, sharpening angle 20^0

Test-bar size (mm /mm)	Angle indicator (^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
27*27	110	2.50	0.93	Rods and leaves
27*27	109	2.63	0.98	
27*27	108	2.77	1.03	
27*27	108	2.77	1.03	Rods and leaves
27*27	105	3.19	1.18	
27*27	102	3.61	1.34	
27*27	100	3.90	1.44	Rods and leaves
27*27	99	4.04	1.50	
27*27	97	4.33	1.60	

Table 29

Cutting the fresh corn stalk samples. Cutting angle knife 25^0, sharpening angle 20^0

Nr. crt.	Test-bar size (mm /mm)	Angle indicator (^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
1	27*27	111	2.36	0.87	Rods and leaves
2	27*27	110	2.50	0.93	
3	27*27	109	2.63	0.98	
4	27*27	109	2.63	0.98	Rods and

Table 30

Cutting the fresh corn stalk samples. Knife with cutting angle 30^0, sharpening angle 20^0

Test-bar size (mm /mm)	Angle indicator (^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
27*27	116	1.70	0.63	Rods and leaves
27*27	114	1.96	0.73	
27*27	114	1.96	0.73	
27*27	112	2.23	0.82	Rods and

5	27*27	107	2.91	1.08	leaves
6	27*27	106	3.05	1.13	
7	27*27	103	3.47	1.29	Rods and leaves
8	27*27	100	3.90	1.44	
9	27*27	99	4.04	1.50	

Table 31

Cutting the fresh sunflower samples. Knife with cutting angle 20^0, sharpening angle 20^0

Nr. crt.	Test-bar size (mm /mm)	Angle indicator(^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
1	27*27	107	2.91	1.08	Especially rods and sloppy leaves
2	27*27	105	3.19	1.18	
3	27*27	103	3.47	1.29	
4	27*27	101	3.76	1.39	Especially rods and sloppy leaves
5	27*27	100	3.90	1.44	
6	27*27	97	4.33	1.60	
7	27*27	97	4.33	1.60	Especially rods and sloppy leaves
8	27*27	95	4.62	1.71	
9	27*27	94	4.76	1.76	

Table 33

Cutting the fresh sunflower samples. Knife with cutting angle 20^0, sharpening angle 20^0.

Nr. crt.	Test-bar size (mm /mm)	Angle indicator(^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
1	27*27	112	2.23	0.82	Especially rods and sloppy leaves
2	27*27	110	2.50	0.93	
3	27*27	109	2.63	0.98	
4	27*27	109	2.63	0.98	Especially rods and sloppy leaves
5	27*27	106	3.05	1.13	
6	27*27	104	3.33	1.23	
7	27*27	101	3.76	1.39	Especially rods and sloppy leaves
8	27*27	99	4.04	1.50	
9	27*27	99	4.04	1.50	

Table 35

Cutting the lolium samples. Cutting angle knife 25^0, sharpening angle 20^0.

Nr. crt.	Test-bar size (mm /mm)	Angle indicator(^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
1	27*27	107	2.91	1.08	Strains and leaves
2	27*27	105	3.19	1.18	
3	27*27	105	3.19	1.18	
4	27*27	104	3.33	1.23	Strains and leaves
5	27*27	103	3.47	1.29	
6	27*27	100	3.90	1.44	
7	27*27	100	3.90	1.44	Strains and leaves
8	27*27	99	4.04	1.50	
9	27*27	98	4.19	1.55	

27*27	111	2.36	0.87	leaves
27*27	107	2.91	1.08	
27*27	105	3.19	1.18	Rods and leaves
27*27	101	3.76	1.39	
27*27	100	3.90	1.44	

Table 32

Cutting the fresh sunflower samples. Cutting angle knife 25^0, sharpening angle 20^0

Test-bar size (mm /mm)	Angle indicator(^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
27*27	110	2.50	0.93	Especially rods and sloppy leaves
27*27	108	2.77	1.03	
27*27	109	2.63	0.97	
27*27	106	3.05	1.13	Especially rods and sloppy leaves
27*27	105	3.19	1.18	
27*27	103	3.47	1.29	
27*27	102	3.61	1.34	Especially rods and sloppy leaves
27*27	99	4.04	1.50	
27*27	96	4.47	1.66	

Table 34

Cutting the fresh sunflower samples. Cutting angle knife 25^0, sharpening angle 20^0.

Test-bar size (mm /mm)	Angle indicator(^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
27*27	104	3.33	1.23	Strains and leaves
27*27	103	3.47	1.29	
27*27	102	3.61	1.34	
27*27	102	3.61	1.34	Strains and leaves
27*27	99	4.04	1.50	
27*27	99	4.04	1.50	
27*27	98	4.19	1.55	Strains and leaves
27*27	97	4.33	1.60	
27*27	95	4.62	1.71	

Table 36.

Cutting the lolium samples. Knife with cutting angle 30^0, sharpening angle 20^0

Test-bar size (mm /mm)	Angle indicator(^{0})	Energy needed to cut (J)	Specific energy to cut (J/cm^2)	Observation
27*27	109	2.64	0.98	Strains and leaves
27*27	109	2.64	0.98	
27*27	107	2.91	1.08	
27*27	106	3.05	1.13	Strains and leaves
27*27	105	3.19	1.18	
27*27	103	3.47	1.29	
27*27	103	3.47	1.29	Strains and leaves
27*27	101	3.76	1.39	
27*27	100	3.90	1.44	

After a simple analysis, it can be noticed that the specific cutting energy values vary not only depending on the humidity or origin and type of the feed material samples used during the experimental laboratory determinations, but also according to the place where the cutting along the rod the knife sharpening angle, and the degree of inclination of the knife used for cutting, as well as a number of other factors that are not considered in this research phase.

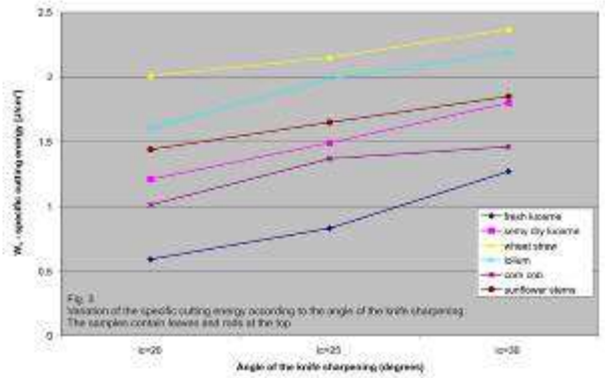
There is a decrease, in some cases even significant, of the value of the specific cutting energy, starting from the base of the stem, to the tip of the stem. This is represented in the graphs below, grouping the values of the specific cutting energy into three value groups, while taking into account the constructive angles of the knife.

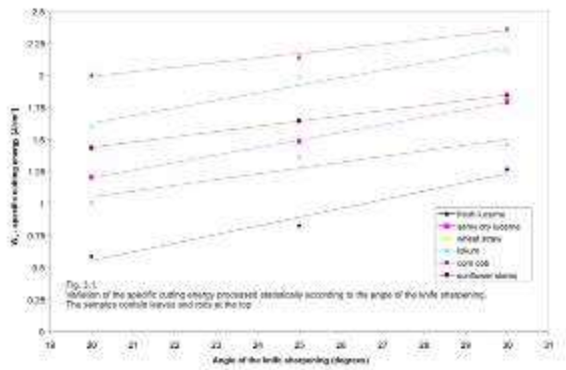
The first group is the specific energy values for cutting in the upper area of the feed material rods used as test samples, where the rods are mostly thin, with many leaves, the relative humidity of this part is higher and, last but not least, the rods contain tissues young, soft. In this first group, we can analyze a constructive variant, which is the straight knife variant, where only the angle of sharpening i_c changes, but the angle of inclination of the alpha knife is equal to zero; $\alpha = 0$. Under these conditions, we obtain according to figure 3. a slow increase in the specific cutting energy values due to the gradual increase in sharpen angle values. In fact, this phenomenon occurs when using uncut knives, blunted due to a high workload. There is also a well-known phenomenon, namely the increase of the specific energy in the cutting of fodder materials with a low humidity, such as the grinding of wheat straw, where the humidity determined during the laboratory experiments did not exceed 6% .

At high relative humidity levels of plants, in the case of semy dry lucerne or corn and sunflower, the cutting-specific energy gets lower values, cuts can be made easier, and hence a number of functional exploitation advantages, lower costs accounted for per kg of harvested forage.

We must also remember that it is very important to choose the material from which the knife is made. Good materials, quality steels are more expensive but resist over time, keep the angle of sharpening longer, their wear is reduced. Poor quality steels cost less, but their use is limited precisely because of repeated regrinding and their premature exit from use (*Caba I. 2001*).

These losses also have to be added to the losses suffered by the company through the non-use, the stagnation of the machinery, mostly due to the increased working capacity with these knives.





Processing the experimental data represented graphically in Figure 3. obtained in laboratory conditions, using the statistics applied in mathematics, we traced the real curves, obtaining some straight lines related to the cuts made on the fodder samples made from different feeds, according to the legend of the figure 3.1, with strictly linear variations, has confirmed the initial assumption, that is, the increase in the sharpness values of the cutting-chopping knife, entails increasing the values of the specific energies at cutting, resulting in extreme cases at forces so large that no cutting actually takes place, breaking the samples material, or even stopping the knife in the material of the test specimen used.

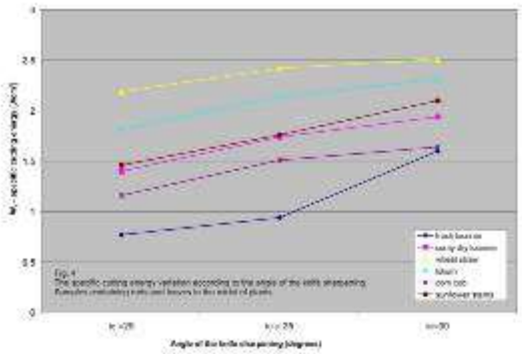
The second group, represented by Figure 4. signifies the specific cutting energy values from the middle of the length of the samples, the area where the fiber feed samples has, besides many rods and leaves, in most cases this ratio is substantially equal.

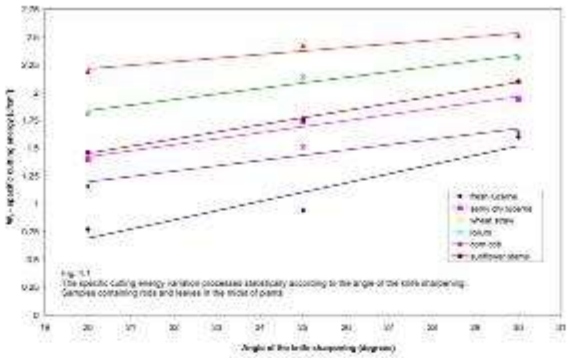
There is a noticeable increase in the specific energy required to cut samples from feed materials to the values recorded at the cutting of samples formed from foliage and stems at the tip of the plants.

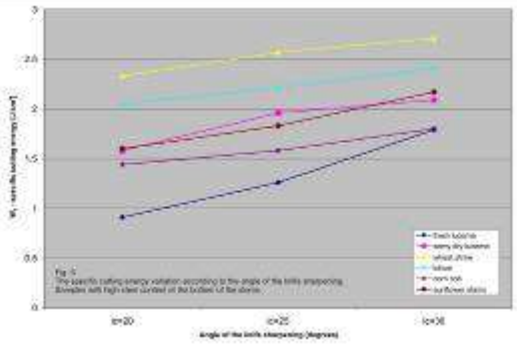
This increase is due to the decrease of the foliage and the increase in the number of rods, which have a more pronounced lignin structure in this area of plants. The increase in specific cutting energy expressed as a percentage represents approximately 10-15%, copying the percentage increase expressed as a sharp increase in the knife sharpening angle.

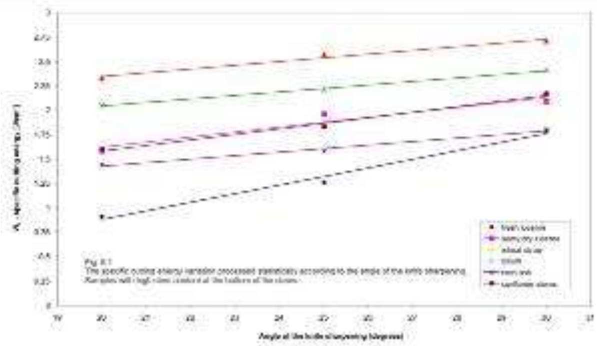
Applying identically, as in the previous case, the statistical processing of the experimental values obtained in the laboratory determinations on fodder samples and graphs, a linear variation, represented in Figure 4.1. was also obtained (*Goleţ I., 1998*). And in the third group, represented by Figure 5. the values of the specific cutting energy in the lower area of the plants near the harvest area, which have been used as cutting material, are found.

This area is rich in lignite, aging, and low-moisture tissue, with a marked lack of leaves. Rods are ubiquitous in this type of samples, the cross section of the stems is much higher compared to the cross section of the stems at the tips, they are characterized by the high resistance to penetration of the knife blade.









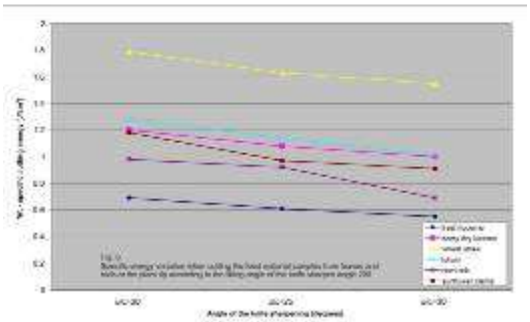
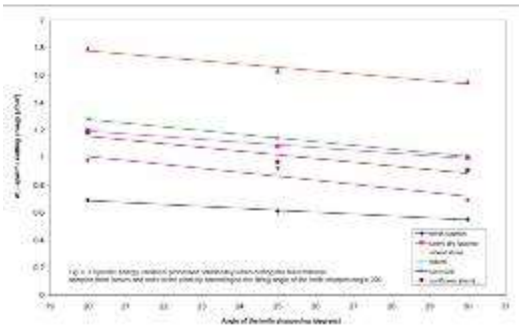
After the statistical processing of the values obtained in the laboratory tests at the cutting of samples from feed materials, we obtain, according to expectations, also a linear variation, but with higher values than in the other two studied cases, phenomenon explained by taking into account the increased resistance of the strains aged, ligninous, with a relatively lower moisture content as compared to the stem tips.

The sharpening and tilting angles of the knife also play an important role in modifying the specific cutting energy values, their correct choice depending on the material of the samples, its moisture content and other factors, may lead to a a significant decrease in the specific energy consumed in the cutting of the feed material used to make the daily feed of livestock from zootechnical farms.

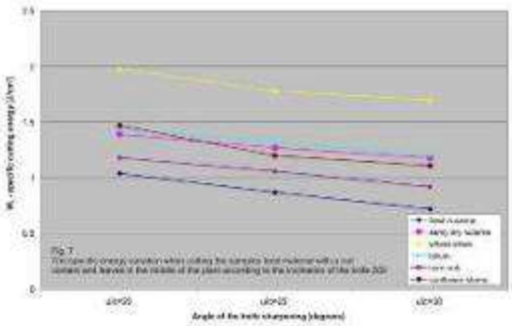
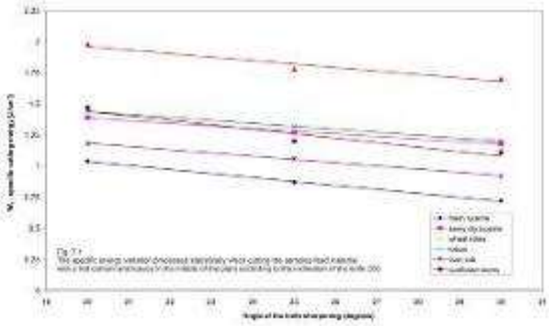
This also results from the laboratory determinations performed on feed specimen specimens, where we modified only the angle of inclination alpha of the knife, while keeping the most convenient angle of sharpening, determined by the experimental tests performed, being $i_c = 20^0$. The specimen in this case, it mostly contains leaves and thin rods from the tip of the forage plant, from which it can be concluded that the cutting is carried out with a lower energy effort, according to Figure 6, we have values that gradually decrease with increasing the angle of inclination of the knife .

This decrease is not very spectacular and cannot be achieved to extreme values because of some conditions of exploitation and design of the shape of the knife and its resistance to daily exploitation. An inclination of more than 30^0 of the cutting-grinding knife in the laboratory experiment has made it technically impossible for the knife to be executed and used with the projector.

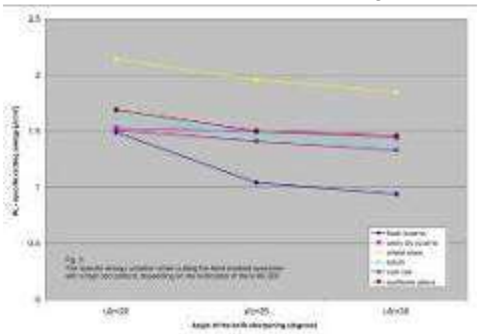
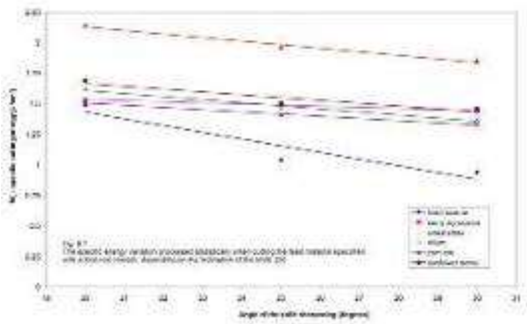
After performing the statistical processing of the obtained experimental data, we can see that this time a linear variation of the specific cutting energies was obtained, according to Figure 6.1.

If the angle of sharpening of the knife $i_c = 20^0$ is maintained, but we vary the angle of inclination, using high-feed feed samples in rods and leaves harvested from the middle of the forage plants where the ratio of rods and leaves is substantially equal, values represented in Figure 7.

As can be seen, a linear decrease in the specific energy required to perform the cutting of the samples was obtained in this case, which is shown in Figure 6.1.

The last evaluation of the specific cutting energy represented by figure 8. which is carried out in the case of cuts made on samples of feed materials mainly made of rods with a high content of hard tissues, and in these determinations the value of the angle of sharpening the knife at $i_c = 20^0$, but altering the tilting of the knife, alpha, in those three previously known steps, previously described.

After the statistical processing of the experimental data obtained from the cutting of samples of feed materials with a high content of rods and this time a linear variation of the values of the specific cutting energies according to Figure 8.1. was obtained. There is a relative increase of these values compared to those obtained in the experiments performed on specimens with high leaf or mixed samples (leaves and rods) but after a realistic analysis it was found that this increase is justified by changing the structure of the stems, which are lighter, less water content, and last but not least we notice the total absence or low presence of leaves.

CONCLUSIONS

Starting from the experimental results obtained from the laboratory research on the fibrous fodder organs, we obtained conclusive results which, after their processing, proved the veracity of the theory presented in the above chapters regarding the design of a cutting knife that is universally usable to the cutting-off of a variety of assortment of fibrous feed, irrespective of the maturity status or the time elapsed since harvesting.

In the first part of the experiments, straight knives were used and we only varied their angles of sharpening, from 20^0 to 25^0 or 30^0, thus obtaining a permanent increase in the specific cutting energy (*Neculăiasa V., Dănilă I. 1995*). In the second part of the experiments carried out in the research laboratory, the angle of the most convenient knife sharpening angle of 20^0 was chosen, at which the specific cutting energy values were the lowest and we varied this time the angle of inclination of the knife 20^0, 25^0 and 30^0 to the corresponding cutting factor k = 0,36; k = 0.46 and k = 0.57.

Conclusions on the results obtained are as follows:

1. plant humidity significantly influences the consumption of the specific energy of cutting fodder plants;
2. specific cutting energy consumption varies according to the place where the cutting is done, higher at the base of the plants and gradually decreases towards the top of the plant;
3. the angle of sharpening of the knives has an important role in establishing the energy balance at the cutting-shredding of the plants, a small angle of sharpening leads to a specific consumption of low cutting energy, and if the angle of rotation increases, we have a significant increase in the specific energy of cutting;
4. sharpen angle of less than 20^0 leads to rapid knife cut, resulting in an increase in cutting-specific energy, knife rewind stops, machine productivity decreases, increases operating cost;
5. a solution to this problem is the use of knives made of special materials which do not require repeated re-drilling, but the cost of the special knives would be too high and their equally fragile, which would lead to their frequent change with repeated stops , the loss of precious harvest time;
6. the sharpening angle of more than 30^0 causes an excessive energy consumption of excessive cutting, especially in the case of drier fodders, because the actual cutting is partially replaced by the breaking of the fibrous feed material, vibrations occur during the cutting and even the clogging of the cutter;
7. a specific energy consumption of balanced cutting and at the same time a minimal wear of the blade cutting edge during the work we obtained at the angle of sharpening of the knife 25^0, even with a material not recommended for making the knife;
8. while keeping the knife sharpening angle at 20^0, where the specific cutting energy values were the smallest, we varied the tilting angle of the knife by which we obtained the sliding cut, the cutter energy values gradually decreasing with the increase of the inclination angle knife;
9. the highest cut-off energy values were recorded for the cutting angle 20^0 and the tilting angle of the knife 20^0 as well, and the lowest specific cutting energy values for the sharpen angle of 20^0 and the angle of inclination of the knife of 30^0;
10. passing over these values causes some knife execution problems, and in extreme cases slipping the material on the cut.

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CONSIDERATIONS REGARDING HEMP HARVESTING
/
CONSIDERAȚII PRIVIND RECOLTATUL CÂNEPEI

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ABSTRACT

Hemp is one of the oldest plants cultivated in Romania (over 2000 years). In the past, there was a tradition in hemp cultivation, and nowadays there are existing European and national programmes that aim at increasing the surfaces cultivated with hemp. The hemp has over 25, 000 utilizations, starting from food, paints and fuel up to clothes and building materials [2]. According to European laws, In Romania might be cultivated only the hemp varieties with a tetrahydrocannabinol content smaller than or equal to 0.2%. The hemp varieties chosen for direct payments are Denise, Diana, Lovrin 110, Silvana and Zenit.[3]. This article tackles several combines and equipment designed to mechanized harvesting of hemp cultivated on larger surfaces due to its food and energy potential.

REZUMAT

Cânepa este una dintre cele mai vechi plante cultivate în ţara noastră (peste 2000 de ani). In trecut a existat o traditie in cultivarea canepei iar in prezent exista programe nationale si europene ce urmaresc creşterea suprafeţelor cultivate cu cânepă. Canepa are peste 25 000 de utilizari, de la alimente, vopsele si combustibili si pana la imbracaminte si materiale de constructii [2]. Potrivit legislaţiei europene, în România puteau fi cultivate doar soiurile de cânepă cu un conţinut de tetrahidrocanabinol mai mic sau egal cu 0,2%. Soiurile de cânepă eligibile pentru plăţile directe sunt Denise, Diana, Lovrin 110, Silvana şi Zenit. [3]. In cadrul articolului sunt abordate cateva combine și echipamente pentru recoltarea mecanizată a cînepei cutivată pe suprafete din ce in ce mai mari datorită potentialului energetic si alimentar.

INTRODUCTION

The hemp has a non-branched stem, long lanceolate leaves with serrated edges and dense semi-compact inflorescences. Plant leaves are hairy, male flowers forming poliniferous panicles, and female leaves are green and the fruit is a greenish-grey achene (*Bruce et all, 2001*).

It is made of three parts, all useful: seeds can be used to prepare different food, oil and medicinal products ; fibres are used in industry (to clothes up to cars) – they form the stem middle layer and are covered by a thin protecting stratum; the wooden core remained after extracting the fibres is the part used (lime included) for buildings (although we found information showing that it is possible to use the whole stalk –meaning that fibres and ligneous core should not separate).

There are several varieties of hemp (*http://agroromania.manager.ro; http://bhudeva.org; http://www.scda.ro*):

✓ Denise – is a mixed monoecious variety, for fibres and seeds, homologated in 1999, obtained by hybridization, cross breeding and repeated selections, aiming to obtain high yield of stems and seeds ; it represents a variety with mixed cultivation features, being more resistant to spring low temperatures, allowing an early sowing. It blossoms by 4-5 days earlier than Secuieni 1, in the first stage the female flowers bloom ; the interval of blossoming lasts 20-25 days. The stem crop has a growing period of 120-130 days and 140-150 days for seeds. The average stem harvest can range between 8.2-10.5 t/ha depending on the agrofond applied and thermal and rainfall regime. The seed harvest reaches 1200 kg/ha, and fibre content is of 29-30%, determining a production of 2900-3200 kg/ha technical fibres.

✓ Zenit- is obtained by hybridization and monoecious selection of Secuieni and a local population De Arieş. It is a monoecious variety with the smallest content of THC for homologation. Plant size is very reduced and the growing period is of 110-120 days.It is a specific variety designed to seed, -1100-1500 kg/ha, but also to fiber production (28% content of technical fibres and a production of 7.8-8.5 t/ha stems), can be obtained.

✓ Diana is a variety obtained by selection and repeated crossbreeding between Hungarian dioecious varieties of high yield of stems and fibres, but tardy and with coarse fibre and monoecious selections from laboratory genetic sources.

✓ Dacia –Secuieni, is a variety of monoecious hemp, homologated in 2011 for stems and fibres. It was achieved by selection of line AR-1 component of Diana variety brought at maximum yield after genetic and biological degradation through uncontrolled multiplication within the process of obtaining seeds and dioecious line K-7.

✓ Secuieni – Jubileu – is a monoecious variety, homologated for production of seeds and oil, 33.8% content, as well as for its quality. It is a very precocious variety, the seed maturation happening in early august, by 15 – 20 days earlier than Zenit variety. Production of stems and fibres is close to Zenit variety, being an ultra precocious derivation of its component families. [5]. Sowing density: at hemp for fibres- 70 kg/ha distance between rows 12.5 cm; at hemp for seeds- 15-25 kg/ha distance between rows 70 cm (http://www.scda.ro).

Hemp seeds contain: 36% oil, 28% proteins, 14-27% non-nitrate elements, 17.8-26.3% cellulose and 2.5-6.8% ashes. Due to this composition, hemp seeds can be used for extracting oil used directly for food and for obtaining margarine. Non-refined oil is designed to obtain varnishes, paints, linoleum, soap and waxed cloths. Seed is widely used directly, as such, or in concentrated fodder, bird food (especially for feeding exotic birds: parrots, canaries, peacocks, etc.).

Fig. 1 - Hemp crop

Fig. 2 - Hemp inflorescence, [12]

The cakes remained after extracting the oil are used as such or in concentrated fodder for feeding birds, calves, horses, fish, etc. – 600 g of cakes equal as nutritive value 1000 g grains of cereals. Cakes should be carefully used for feeding cows with calf, as they provoke abortions. Hemp wood represent about 55% out of stalk weight and contains over 50% cellulose. The flake dust resulted when extracting the fibres or whole plant is used for obtaining: paper, agglomerated plates – phono-insulating panels, for furniture industry, artificial silk, puff for phonic insulation between the building plates. The seed crop chaff is a very valuable fertilizer: 10 t of chaff equal 40 t of litter. Leaves and inflorescences are used in medicine (*Pari et. Al., 2009*).

Hemp harvesting can be performed in two stages both for fibres and seeds. For fibre hemp, the plants should be cut and left in the field, and in second stage after drying, their leaves are shaken and tied as sheafs of 20-25 cm diameter and transported to melting houses. For seed hemp, the plants should be cut and left in the field to dry 7-8 days. Threshing the inflorescences is made by cereal harvesting combine. Seeds threshed are immediately cleaned, conditioned and dried (*https://www.revista-ferma.ro*). In Figure 4 is shown the harvesting combine for seed hemp.

Fig. 3 - Hemp manual harvesting (*http://www.scda.ro*)

MATERIAL AND METHOD

In olden times, hemp harvesting was made manually (Figure 3), but, as surfaces cultivated with hemp increased, the harvesting methods modernized, thus appearing the harvesting machines of hemp both for seeds (Grabowska L.) and stalks. In Figure 4 is presented a hemp field mowing with side rear mower. The hemp is mown and left in furrow for being tied as sheafs. In this case, hemp stem has different utilizations in industry.

Fig 4 - Rear side mower (Grabowska and Baraniecki, 2013)

Mechanized harvesting can be performed with Multi Combine HC 3400 (Figure 5), which is a self-propelled combine designed to hemp harvesting, launched in 2015, in Slovenia, at World Congress of Hemp. MultiCombine HC 3400 is endowed with a header similar to that of cereal harvesting combine. This header comprises: cutting apparatus with knife blades, rasp bar, header, conveying belt of material cut towards the right end of header, where it discharges the material to another elevator that takes over the material and transports it to the combine body. The Multi Combine HC3400 body is tipping for enabling the harvested material discharge, respectively the hemp extremities where seeds are located (*Kaniewski R., 1997*). During the field movement, the combine tows the header on the transporting cart and folds the conveying belt of right part, belt that takes over the header material for easily displacing and surpassing the clearance issues.

Fig. 5 - Multi Combine HC3400 for hemp harvesting (*https://www.revista-ferma.ro*)

In Figure 6a, we have: Tractor CLAAS XERION 4000, working in field, for harvesting the hemp crop. This tractor is endowed with a cabin that can rotate front-rear and with an equipment made of two harvesting headers. In front, there is one Jaguar type header for cutting the stems of hemp and in upper part, there is a rotor type equipment, that cuts the hemp top (where seeds are placed). On right side, the tractor has a conveyor that takes over the material harvested by header rotor type, that harvests only the hemp extremities and transport them to trailer (*Pari L., 2009*). In Figure 6b, tractor Claas Xerion 4000 discharges the harvested material into the red trailer, towed by John Deer tractor, that transports the material. Body of tractor Xerion 4000 equipped for hemp harvesting, is tipping and is endowed with two hydraulic lifting cylinders, inclination of body under an angle of 30 degrees, conveyor chains on the body bottom, that are driven when the material is unloaded to the other trailer that ensures the transport to the farm.

a **b**

Fig. 6 - Claas Xerion 4000 (*https://www.revista-ferma.ro*)

RESULTS

In Figure 7a is presented the equipment for hemp harvesting that is endowed with a wide belt on longitudinal bars of rasp bar, where elastic teeth are placed, (popularly called hedgehogs). This belt is mounted for protecting the plant to be piqued by elastic fingers or to clogg. The belt may be made of wood, plastic, textolite, light sheet iron, rubber, and helps to introduce the plant into the cutting apparatus in right position. After cutting the material, it is transported to the header right end, where it is taken over by the conveyor mounted at the header end and is discharged on the conveying belt of elevator mounted on the truck that goes in parallel with tractor that harvests the hemp. In Figure 7b is presented the frontal image of both tractor and truck going in parallel during the harvesting. The truck is endowed with an elevator of conveying belt type, that takes over the material harvested from the header. This conveying belt is mounted on left side of truck, situated between tractor and truck in the picture shown. At the end of the conveying belt, there is one person that controls the discharge of material into raphia square bags of 900x900x900 mm size.

a b

Fig. 7 - Hemp harvesting equipment (*Pari L., 2009*)

Hemp seeds harvesting withJohn Deer 660i caterpillar combine is shown in Figure 8 a, b, that is endowed with two headers extension and chopper of CSU type, mounted in rear left side. Harvesting is performed by upper header, namely the cereal header with rasp bar and cutting apparatus with blades that cut the hemp extremities (where seeds are) and then the threshing flow is performed, obtaining the seeds in combine tank. The lower header is of Jagur type and chops the ligneous fibre, transforming it in chaff and incorporating it into soil when ploughning.

a b

Fig. 8 - Caterpillar combine John Deer 660i during hemp harvesting (*Pari L., 2009***)**

In Figure 9 is presented the combine Claas Jaguar 650 type, endowed with 2 extended equipment, one original, the lower equipment that chops the ligneous fibre, leaving in furrow the fibre separated from hemp, and the second upper one of header type that cuts the extremities and remove them into furrow through the right part of upper header, leaving in another furrow the extremities with seeds harvested, (*Kobayashi Y., 2003*). The harvested material, namely the seed extremities are left in furrow for several days for drying, approximately 7-8 days, after which they are threshed by the combine.

Fig. 9 - Combine Claas of Jaguar type (*Kobayashi et. al., 2003*)

Shortening the hemp with windrower Figure 10, is performed in order to obtain short size harvest and enable the harvesting with combine with straw header. By this method, a short height hemp is obtained and harvesting is facilitated, beacuse there is no need of two harvesting equipment (one that cuts the plant extremities and other that cuts the ligneous fibre) as in case of high hemp of about 2 meters height.

Fig. 10 - Shortening the hemp with windrower (*http://bhudeva.org*)

CONCLUSIONS

Hemp is a plant that can be successfully cultivated in our country because of its good adaptation features. The crop has a wide range of utilizations in industry of construction, textile, cars, pharmaceutics and it has found that it also has a high energetic and food potential. Recently, the surfaces cultivated with hemp have increased, as well as the varieties number that give a better yield and are more resistant to draught, illness and pests.

Hemp harvesting both for fibres and seeds has modernized very much, the agricultural machinery manufacturers being permanently concerned of creating high-performance harvesting machines. While certain manufacturers adapted the hemp harvesting equipment to tractors, others built self-propelled combines for hemp harvesting. Optimization of technology of cultivation of energy and food potential plants is an ongoing development activity, the hemp crop bringing by efficient capitalization, great profits to farmers.

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BUILDING UP OWN MARKETS FOR ORGANIC BEE PRODUCTS
/
ИЗГРАЖДАНЕ НА СОБСТВЕНИ ПАЗАРИ ЗА БИОЛОГИЧНИ ПЧЕЛНИ ПРОДУКТИ

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***Key words**: organizational, consumer, markets, organic bee products.*

ABSTRACT

The present paper's aim is to study the possibilities of forming their own organic beekeeping markets to overcome the difficulties in their realization. The construction of own organizational markets, such as auctions, producer markets, contracts for the realization of bee products and online markets, given their investments and turnover, only makes sense in bringing together organic beekeeping farms. Direct realization, stalling and bargaining can be quickly implemented by organic beekeeping farms, because they involve least comparative investment compared to other consumer markets. Certified organic bee products are very suitable for online marketing because certification ensures quality and builds trust in customers, making it a promise to build an online store. Producers of organic bee products in comparison with other retailers have lower competitiveness in consumer markets, which requires them to build or participate in strategic alliances.

РЕЗЮМЕ

Целта е изследване на възможностите за формиране на собствени пазари на биологични пчелни продукти, за преодоляване на трудностите при реализацията им. Изграждането на собствени организационни пазари, като аукциони, пазари на производителите, договори за реализация на пчелни продукти и онлайн пазари, предвид техните инвестиции и обороти има смисъл единствено при обединяване на биологичните пчеларски стопанства. Директната реализация, разкриването на щанд и апаратната търговия могат да се внедрят най-бързо от биологичните пчеларски стопанства, защото предполагат най-малко инвестиции в сравнителен план спрямо останалите потребителски пазари. Сертифицираните биологични пчелни продукти са много подходящи за реализация на онлайн пазари, защото сертифицирането гарантира качество и изгражда доверие в клиентите, което прави перспективно изграждането на онлайн магазин. Производителите на биологични пчелни продукти в сравнителен план спрямо останалите търговци на дребно, имат по-ниска конкурентоспособност на потребителските пазари, което налага да изграждат или участват в стратегически алианси.

INTRODUCTION

Organic beekeeping can't be developed progressively and sustainably in the absence or shortage of markets for unimpeded and profitable realization of the produced organic bee production. Markets for organic bee products are one of the main drivers for the sector's development and a foundation for achieving the liquidity and profitability of beekeeping farms. Therefore, exploring the issue of the markets for the production of organic bee products is vital to all organic beekeepers. This problem also has very serious international and national importance for agro-environment, given the role of bees in polluting and achieving sustainable agricultural production, ensuring organic clean and functional bee products, food, employment and export earnings.

Specialized literature, research and practice in a number of countries, including EU countries, on organic beekeeping give some precedence to production and subsidization, with considerably lesser treatment of problems with the markets for organic bee products. Bulgarian beekeepers are indignant and protest against low prices of organic honey and other organic bee products, and that is why they are mainly criticized by the state, but the reasons for this are a consequence of the organic markets themselves. In the context of severely exacerbating competition on international and national markets for organic bee products (*Любенов Л., 2016*), there is some underestimation of market access issues.

There is a significant lag in the Bulgarian organic bee products market compared to the trends and developments of the world. There is a strong inconsistency with regard to the development of organic beekeeping in Bulgaria in the recent decades and the significantly weaker development of national organic markets, infrastructure and market relations. Bulgarian beekeepers face many difficulties in the marketing of the produced organic production. Their liquidity and profitability are strongly influenced by the opportunities for access to markets, for quick and profitable realization. There are significant difficulties in the implementation of organic bee products produced in Bulgaria. Therefore, the aim is to explore the possibilities of forming their own organic beekeeping markets in order to overcome the difficulties in their realization.

MATERIAL AND METHOD

- **Organizing markets for organic bee products**

Producers of organic bee products can build their own wholesale markets to sell to various organizations (processors, wholesalers and retailers) by creating auctions, manufacturers' markets, and online markets. Contracts for the realization of organic bee products, such as a non-capital form, where a producer (*Любенов Л., 2016*), (*Любенов Л., И. Христаков. 2014*) is also a member party, can also be treated as their own markets.

Auctions for bee products allow rapid and effective implementation of large quantities because they operate on the basis of strictly defined and typical rules. They are an extremely good, specialized and purposeful source of information useful for the production and market orientation of organic beekeeping producers. The auction creates favorable conditions for establishing lasting and effective contacts with reliable partners because a large number of buyers ensure their production periodically and systematically from a particular auction. For example, the Union of Beekeeping Organizations in Serbia annually organizes an auction for buyers companies, which they bid for a price to buy bee products. Only those who offer the highest prices are entitled to buy bee honey from Serbian beekeepers.

The auction also hides a number of risks for organic beekeeping producers, such as sales inefficiencies in certain competitive situations, and significant costs for organizing and conducting auctions, and the risk of cartels to buyers to put pressure on price bidding. Electronic (online) auctions can compensate to some extent some of the auctions of live auctions (offline). They increase the efficiency of the marketing of organic bee products, because they reduce the cost of preparation, risk of damage, etc. Also advantageous is the ability of beekeeping farms to quickly obtain feedback on consumer preferences and their attitude to the quality characteristics of organic bee products. Publication of auction prices is a source of important market information.

Producer markets allow large quantities of organic bee products to be sold directly by their producers. They can be built mainly from beekeeping farms and their organizations, in large production areas. Producer markets operate on the basis of a specific legislative basis, which allows for cases where the beekeeping producer is not registered under the Commerce Act, the Cooperatives Act or the Farmers Support Act, that the transactions on these markets are carried out by the entities which are registered under the said laws or by the producer of the producer at a price determined by the manufacturer (Закон за стоковите борси и тържищата, чл. 55, ал. 3, 2018). This is an exception for the benefit of producers - including organic producers, which allows the use of this market even when they do not have registration under the aforementioned laws.

International and regional manufacturers' markets are emerging as modern and well-equipped markets that rent retail space, provide sorting, packaging, container servicing and provide refrigeration areas with adjustable gas environment for long-term storage of various beehives, products. They trade a great deal of trade in different agricultural products, and they are increasingly taking the place of an important link between bee producers and wholesale markets. Some of them are equipped with auction rooms and even work through the auctions bidding system. Despite the built infrastructure and the existence of clear rules, this market requires a physical presence of organic bee products, according to the current legal base, which increases the costs of transport, storage and safe-keeping and others.

Contracts for the realization of organic bee products allow organic beekeeping farms to form a closer relationship with consumers than at auctions or producers' markets because each party to the contract has clear and binding commitments in terms of quantity, quality, timing, prices and etc. Contracts enable organic beekeeping producers to reduce part of their transaction costs by contacting a small but sustainable number of buyers. The main advantages of the contracts are that the beekeeping holdings receive financial assistance and consultancy services in a secured market and with certain preconditions. The main shortcomings are related to limiting the organic producers to take advantage of better opportunities and prices for realization in other markets, and their implementation often costs, which are not always compensated by the contract price and the insured market.

Online wholesale markets for organic beehives and others products have arisen as a result of the rapid development of modern information systems and technologies. They have a number of advantages over traditional markets, the most important of which are: the possibility of global sales in the absence of spatial barriers and diminishing the need for physical presence; reduction of staff costs, storage, etc.; continuity of business processes from production to consumption; personalization and individualization by building a client database; faster delivery and self-service of customers; faster market research and faster implementation; possibility to reduce the price; providing more choice and etc.

The main issues that accompany the online wholesale markets of organic bee products are: security of transactions; Insufficient reliability of the Internet connection supply difficulties for bee products requiring a refrigeration chain; lack of visibility and contact with organic bee products, their producers and sellers; misuse of user information; delayed delivery deadline of some organic bee products, etc. The outlined advantages and disadvantages of online markets argue that the combination of traditional-offline and online markets is an optimal option for organic bee producers, because much of the so- observers on the Internet, who mostly study what is being offered.

Own markets allow to overcome the objectively arising contradictions between organic beekeeping farms and consumers through the accumulation, distribution, sorting and assortment of organic bee products. Planning, organization, implementation and control are carried out with specific quantitative, qualitative and price characteristics. Own markets provide market information and marketing knowledge, market access and better control options. However, they require significant investment of funds, time and competence to form and maintain commodity stocks as well as to undertake additional activities and risk in a non-production sphere. The formation of these markets requires the reunification of smaller organic beekeeping farms.

- **Consumer markets for organic bee products**

Producers of organic bee products can build their own consumer markets on or off the farm by entering traditional bee trade, products or in the field of catering and tourism, through some of the following options or in combination between them:

- ***Direct realization***

Customers can visit an apiary on the spot and buy organic bee products. It is also possible to deliver pre-ordered biological bee products at hosted address - honey, pollen, jelly, etc. Rural and various types of tourism as well as the Internet provide opportunities for consumption of organic bee products directly from beekeeping farms. This market requires the maintenance of communications, transport, good beekeeping and staff, as well as additional investments. It has an important regional importance for the development of organic beekeeping. The direct realization has a dominant role with a relative share of about 25% of the honey market in Bulgaria and an annual turnover of over 14 million BGN leva. World trends show that this type of local markets will continue to grow steadily.

- ***Revealing a stand***

It can take place in different types of consumer markets as well as in retail outlets. There are also mobile stands such as minibuses that supply bee and others products on specific consumer markets and specific recipient addresses. In the most elementary form the booth may be on the road, most often in close proximity to apiary. Hiring a booth at retail outlets gives access to more customers, improves the image, and requires less investment than building a shop. That is why this form is being applied more and more actively by Bulgarian farmers, including organic beekeepers, by renting a non-storey area in malls, during the inactive winter season.

- ***Apparatus for bee products***

Bee-keeping farms that produce organic bee products, such as honey, propolis, pollen, jelly, etc., can offer them with appropriate packaging and refrigerated circuitry through apparatuses. With their help there are being satisfied quality standards and the provision of healthy organic bee products is provided in places with high concentration of potential consumers. They are very suitable for schools, hospitals, stations and more places with a high concentration of customers leading a dynamic lifestyle and oriented towards the consumption of healthy organic bee products. The tendency to reduce the consumption of refined sugar additionally promotes the supply of organic bee products in combination with other products through means of apparatuses.

- ***Farm Market***

The formation of a farm market allows the supply of local and authentic organic bee products directly from the producers. The construction of such markets from organic beekeeping farms contributes to the preservation of culinary traditions and authentic food and beverages. Through them, local communities have the opportunity to support regional producers of bee products. These markets allow for a lasting relationship between organic growers and consumers of bee products, food and beverages based on them because they have been established for millennia as local markets for the direct realization of products produced by apiculture farms. This market allows access to local organic bee products, which are better absorbed by people living in the area where they are produced.

Farmers' markets raise the income of organic beekeeping farms and stimulate the development of the local economy. They create opportunities for exchange of experience, use of joint transport, general plans for production and realization of the produced bee products, as a result of which they form prerequisites for co-operation of beekeeping farms. They raise awareness among producers and consumers, as well as opportunities for the development of crafts, tourism, etc., thus creating events, culture and traditions at the local level. There is a farm market in Rousse, but it is still lacking only for bee products due to a lack of demand and consumer culture, although beekeeping in the area has a production potential for it.

The EU's Common Agricultural Policy for the period 2014-2020 finances the construction of farm markets depending on the number of farmers participating in the association as well as on the region where the market will be organized. Projects submitted for mountain and other areas with natural constraints will have an additional supplement. Thus, when creating a larger cooperative of farms and building a market in a mountain region, a grant of about 80% of the project cost could be obtained, and in other cases it would be respectively 50-60%. Financing of the projects for the agricultural markets will provide the necessary facilities.

Candidates will be able to make different types of investments, including the purchase of refrigerator showcases, cameras, or offer tables exhibiting the production. It will also finance the development of the necessary accompanying infrastructure, including shelters, landing sites, etc. The projects also provide for the market management association to allocate a budget for advertising to the local population. Only producers registered under the Ordinance on Direct Sales will be able to trade on these markets. Meat, milk, eggs, fish, game, honey, etc. will be offered as well as bee products. The construction of these markets requires additional competencies and investment in packaging and high-value added bee products.

- ***Building a store***

It can be implemented in two variants or a combination of them - offline and online. With the establishment of its own store, organic beekeeping farms become competitors of every retailer and receive fast and relatively easy access to potential consumers in the country and abroad. Online stores are different from physically existing ones, ie. offline, but the full functionality of both types has many things in common. The producer of organic bee products must provide logistics, communications - telephone lines, specialized software, fast internet connection, etc. Online store costs are not small, but may be lower than for an offline store. Entry into retail requires additional investments and competencies by beekeepers.

- ***Discovery of a public catering establishment***

Requires permanent provision not only of own organic bee products but also of additional purchased products. The production of organic bee products, the availability of pre-packing and packing, as well as branded bee products are a significant plus allowing diversification of the assortment offered. This option involves large investments and new competencies in the field of public catering.

Requirements for public catering establishments concern buildings, equipment, supply, storage, product processing and food preparation, site and staff hygiene maintenance, traceability of food and documenting food safety measures. Registration, categorization and introduction of a HACCP (NASSP) system are required.

- ***Apitourism***

Beekeeping offers very good opportunities for rural development, wellness and more types of tourism related to its activity and products, ie. Apitourism (Любенов Л. 2018). In addition to traditional bee products such as honey, wax, propolis, royal jelly and poison, which are widely used by balneology, spa and wellness services, apitourism offers opportunities for diversification of beekeeping by offering additional complex products such as inhalation of air from bee hives and bottled water staying in them, tourist routes with visits to apiaries, museums with educational programs, participations in beekeeping activities and practices, tasting of bee products, food, beverages, etc. Apitourism offers opportunities for direct realization of organic bee products, accompanied by additional beekeeping services, thus resulting in an increase in the complexity and added value of its products.

The interest in prospectus in the future will grow more and more due to the modern society's desire to live in a nature-friendly way, to eat ecologically clean and organic, authentic and fresh local bees and other products combined with the opportunity to enjoy entertainment and protect publicly important causes of bee conservation. Apitourism has the potential to significantly increase the consumption of regional organic bees and other products in the local economy. It allows organic beekeeping farms to directly realize and combine produced bee products with services, which form more complex products with higher added value and, respectively, higher profits for beekeeping farms. Apitourism is a source of additional income and a means of diversifying bee farms. It has the ability to integrate the different markets for realization of organic bee products into one.

RESULTS

The considered forms of own consumer markets allow organic beekeeping farms to make direct contact with end users, but are associated with taking on a number of functions such as: offering and providing organic bee products; informing about the quality of the products offered; advising consumers on the right choice of their bee and others products; providing information to other market units; concluding specific sales transactions; introducing of new organic bee products; consumer behavior survey, and so on.

The direct realization, the opening of a booth and the apparatus trade can be the most quickly implemented by organic beekeeping farms, because they imply the least comparative investments in a comparison plan. They also offer some benefits to both consumers and organic beekeepers: an opportunity for individual service, self-service and tasting before purchase; saving time and effort to visit a grocery store or restaurant; attracting more consumers, especially older, busier and health-oriented beekeeping products through home delivery.

Organic producers offer bee products in the absence of direct competition, avoiding intermediaries and large investments in exacerbated retail business trade.

Producers of organic bee products most often operate on their own, and as smaller farms they usually develop only one of the above-mentioned own markets, which also determine their main characteristics in the retail trade: a relatively limited product assortment; regionally, i.e. local for a given area (a town, a village) meaning; offering a limited range of products and services to end-customers; relatively limited scale of activity and low level of qualification in the sales process.

This shows in a comparative perspective that they will have less competitiveness in the retail sector, which requires them to build or participate in whatever strategic alliances. The penetration of organic beekeeping farms into the retail sector is important because it provides market access, an opportunity to build lasting customer relationships and market information.

CONCLUSION

The existence of significant difficulties in the realization of organic bee products adversely affects the liquidity and profitability of beekeeping farms, which necessitates the formation of their own organizational and consumer markets.

Building their own organizational markets, such as auctions, manufacturers' markets, contracts for the realization of bee products and online markets, given their investments and turnover, only make sense in bringing together organic beekeeping farms.

Direct realization, stalling and bargaining such as apparatus trade can be more quickly implemented by organic beekeeping farms, because they involve least comparative investments compared to the rest consumer markets.

Certified organic bee products are highly suitable for online marketing because certification ensures quality and sets up customer confidence, making it a promise to build an online store. Producers of organic bee products in comparison with other retailers have lower competitiveness in the consumer markets, which requires them to build upon themselves or participate in strategic alliances.

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IMPORTANCE OF PROTECTED AREAS IN GIURGIU REGION FOR SUSTAINABLE DEVELOPMENT
/
IMPORTANȚA ARIILOR PROTEJATE IN JUDE ȚUL GIURGIU PENTRU DEZVOLTARE DURABILĂ

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ABSTRACT

A protected natural area is a model for national use of marginal land, anthropogenic surfaces which have a continous supervision and serve both for research and public education, in the spirit of nature care, sustainable development along with a public recreation and tourism.

By the end of 2016 on the territory of Giurgiu region, there are eleven designated Nature 2000 sites, five of which are Sites of Community Importance (SCI) and six Special Protection Areas (SPA). Bird protection Area ROSPA01018Vedea Danube is an integral part of the European ecological network Nature 2000. The two Directives, the Birds Directive and Habitats Directive are the main legislative instruments to ensure conservation and sustainable use of nature in the European Union.

REZUMAT

O arie naturală este un model de utilizare a terenurilor marginale, suprafețele antropice care au o supraveghere continuă și servesc atît pentru cercetare, cît și pentru educația publică, în spiritul îngrijirii naturii, a dezvoltării durabile alături de recreere și turism.

De la sfârșitul anului 2016, pe teritoriul regiunii Giurgiu, există unsprezece situri Natura 2000 desemnate, dintre care cinci sunt situri de importanță comunitară (SCI) și șase zone de protecție specială (SPA). Zona de protecție a păsărilor ROSPA01018Vedea Dunăre face parte integrantă din rețeaua ecologică europeană Natura 2000. Cele două directive, Directiva privind păsările și Directiva privind habitatele, reprezintă principalele instrumente legislative care asigură conservarea și utilizarea durabilă a naturii în Uniunea Europeană.

INTRODUCTION

Expanding the space of human socio-economic systems, increasing connections between subsystems components and their complexity have result in loss, degradation and fragmentation of natural and semi-ecological systems. Biodiversity loss can have a catastrophic effect on our economic prosperity, on agriculture and on other aspects of our lives that perhaps we have not considered before.

A protected natural area is a model for national use of marginal land, anthropogenic surfaces have continuous oversight and serve both for research and for public education in the spirit of caring for nature, along with a public recreation and tourism.

This protected natural area by the reduced value of natural and human intervention on its territory is the best example and model for some ecosystems and it conserves natural area., Human intervention is almost nonexistent for a large territory or human intervention is reduced.

Ecological network of protected areas Natura 2000 is a true source of food, resting and breeding grounds for migratory birds. These huge mileages and need such protected areas.

The legislation on protected natural areas, conservation of natural habitats, wild flora and fauna covers some problems as: ensuring biological diversity through the conservation of natural habitats, wild flora and fauna in Romania, maintaining or restoring a favorable conservation status of natural habitats and of wild flora and fauna, identification of natural goods that require special protection for their conservation and sustainable use, categories of protected areas, natural habitat types, species of flora and fauna and other natural heritage assets that are subject to special protection, conservation and sustainable use, measures for the protection and conservation of wild animals and plants are endangered, vulnerable, endemic and / or rare, and the protection formations and geomorphological landscape of ecological, scientific, aesthetic, cultural-historical and otherwise, of natural goods interest spelunking, paleontological, geological, anthropological and other natural patrimonial goods naturally existing perimeters of protected natural areas and / or outside.

By the end of 2016 on the territory of Giurgiu region, there are eleven designated Natura 2000 sites, five of which are Sites of Community Importance (SCI) and six Special Protection Areas (SPA).

Natura 2000 sites were designated strictly on scientific criteria, only where special species are present and their surfaces are representative for bio geographical region.

Sites of Community Importance (SCI) shall be declared for the preservation and maintenance of species and habitats of community interest to accept them as Special Areas of Conservation by the European Union.

Protected Areas (SPA) are delimited in order to preserve and maintain the favorable conservation status bird species or to restore the favorable conservation status where necessary.

Compared percentage of 14.22% of the existing protected areas Giurgiu region, accounting for Natura 2000 sites designated in 2007 at the end of 2011 after declaring new county area sites included in Natura 2000 rose to 16.35%.

Bird protection Area ROSPA01018Vedea Danube is an integral part of the European ecological network Natura 2000. The two Directives, the Birds Directive and Habitats Directive are the main legislative instruments to ensure conservation and sustainable use of nature in the European Union. Through the European ecological network Natura 2000 is intended halting biodiversity loss and the degradation of ecosystem services and restoring them where possible.

In the Cama Dinu islets, part of protection area ROSPA01018, were created habitats for new birds communities and pioneering plants. Monitoring of birds is focused on nest birds from the river, information about their migration. Aim of the monitoring activity is detection of long-term changes occurring in birds communities and estimating population size, making of distribution maps.

MATERIAL AND METHOD

Description of bird protection area

Areas of Avifaunistic Protection (SPA) are delimitated to preserve and maintain favorable conservation status of bird species or to restore favorable conservation status where appropriate Avifaunistic Protection Area - ROSPA01018 Seeing the Danube is located in the Lower Danube Meadow. On its territory there are meadow deposits, mostly made up of clay-sandy banks, sands, clays and less frequent small gravel.

ROSPA01018 Seeing the Danube was declared as a protected area of community interest by H.G. No. 1284/2007 regarding the declaration of special aifaunistic protection areas as an integral part of the European ecological network Natura 2000 in Romania.

On the territory of ROSPA01018 Vedea Danube is the area of “Ostroavelor Cama Dinu“, for which protection regime was established by declaring them a natural reserve in 2007. It encounters a typical landscape of alluvial area subject to the regular rhythm of large waters and small waters. Dynamics of Danube waters is responsible for sediment, erosion and shoreline. This creates habitats for creatures and opportunities for setting up new communities and pioneering plants.

The most typical and most extensive formations are the willows of willow, black poplar, white poplar, elm, oak and some ash. It is a rich area in the bird world. The blue gull seeks high shores, as well as shoreline shores, which are very common in the area. This deserves special attention for the mixed colony of nightmares, nightmares, egrets and cormorants, unique in this segment of the Danube. It is a good place to nest, and annual floods discourage permanent stabbing. In the area of the islands there is the largest colony of crayfish and cormorants in the region.

The populations of nesting stallions represent at least 3.2% of the total existing in Romania. The species is threatened with extinction at European level. The yellow stalk, in turn, accounts for 2% of the population nesting in Romania, the species being vulnerable at European level.

Besides these are evidenced the colonies of gray stork, small egret, big egret, nightmare and cormorants. The site is also important for nesting populations of the following species: Ciconia Nigra, Ciconia iconia, Aythya Nyroca, Circus Aeruginosus, Botaurus Stellaris, Platalea Leucorodia, Plegadis Falcinellus. The site is important during the migration period for species of hawks, pelicans, geese, ducks and swans. It is also important for wintering in the case of the following species of worms, geese, ducks and swans.

During the migration period, the site hosts more than 20,000 birds of fowl. In some segments, human intervention is felt by transforming natural forests into hybrid poplar plantations or farmland, but the rhythm and life cycle of floodplains is preserved in this area. Excessive poaching and logging could affect these habitats, which are a vital area for many bird species.

Considering the value of the Nature 2000 site ROSPA0108 as an area of avifauna importance, bird monitoring is an activity that requires particular attention. Birds can be used to examine the long-term effects of fragmentation of their habitats, the effect of introducing new species on the ecosystem, monitoring water quality, obtaining information on fish population health, identifying pollutants such as organ chlorine, pesticides, heavy or radioactive substances.

Bird monitoring focuses on species of major concern:

• nesting birds of shores / shores and water;
• Species of day and night raptors;
• Species characteristic of agricultural areas;
• Species of knives;
• Singing Species;
• Spring and autumn migration of aquatic and planted flying species
•Winter resting birds

Monitoring of nesting species

The purpose of field assessments according to the methodology described below is to obtain data on nesting species on rivers and to detect long-term changes. These data allow the numerical trends of these populations to be computed and the distribution maps produced.

Species targeted:

1. Small Egrete (Egretta garzetta);
2. Coot (Fulica atra);
3. Small Duck(Anas crecca);
4. Red Hawc(Ardea purpurea)
5.Winter Swan (Cygnus cygnus) and summer Swan (Cygnus olor)
6. Small Cormoran(Phalacrocorax pygmeus)
7.Secondary species: other species related to aquatic habitats (e.g. hares, ducks, etc.).

For collecting the necessary data, there were used trails on the river, primarily by boat, but where possible and on shore also.

The water bird counts made annually in January provide a snapshot of number of birds at the selected location. These data collected in successive years under different climatic conditions in January allow understanding of the dynamics of bird populations and a picture of their trends. During this monitoring, it is the hibernate period and the species that use the specific habitats for wintering or passage are dependent on aquatic habitats with fresh water (rivers, lakes, marshes) or marine.

For the monitoring of the above-mentioned species, it was necessary to select trails of rivers that have characteristics corresponding to the ecological requirements of the studied species. Considering that the area chosen for monitoring is a standing water, the fixed-point method was chosen. Because the aquatic surface is larger and cannot be covered from a single point, a four-point number has been set to cover the entire surface so that species identification using binoculars is easy.

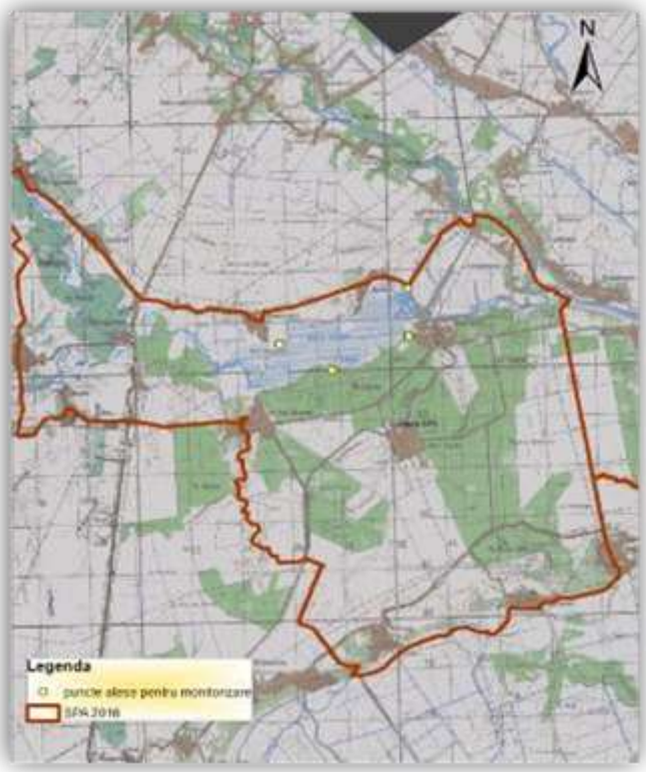

Fig.1 - Location points chosen for monitoring

From the content of the Standard Species of the RIFPA0022 Comana Avifauna Special Protection Area, monitoring was realized for those bird species that are wintering in the chosen area or those that migrate over short distances and which, due to favorable climatic conditions (mild winters), can also be found in winter.

Table1

Number of selected birds in monitoring period

No.	Scientific name of the species	Popular name of the species	Season	Period	Year				
					2014	2015	2016	2017	2018
1.	Egretta garzetta	Small Egrete			27	35	33	24	28
2.	Anas crecca	Small Duck			42	36	44	57	63
3.	Anas platyrhynchos	Big Duck			102	138	173	188	218
4.	Ardea purpurea	Red Hawc			7	11	17	17	15
5.	Cygnus cygnus	winter swan			92	102	131	119	130
6.	Cygnus olor	summer swan	winter	January 10-20	27	29	27	33	36
7.	Larus ridibundus	Sea-gull			127	152	159	147	163
8.	Circus aeruginosus	Reed Kite			11	19	27	29	31
9.	Phalacrocorax pygmeus	Small Cormoran			78	96	85	92	97
10.	Fulica atra	Coot			179	210	256	329	376

The selection of the points was made in such a way that the entire surface on which the birds are distributed can be observed. In this case, counting was done carefully to avoid double counting of the same individuals from two adjacent points.

In addition to the river trails, it is also recommended to observe the shores, especially for the registration of shore colonies, which cannot be seen from the river. These places are selected using orthophotographic maps and Google Earth on a one-kilometer strip in both directions of the river course.Bird's location was marked with GPS. Also noted are all identified holes of the blue codfish marked with the GPS, photographed holes and estimated bank sizes (height x length).

On the ground, some aspects of the blue-hake habitat will be noted: the number of shores suitable for nesting (at least 1 m high and 0.5 m wide), their size (height x length) and their orientation. Other aspects of the habitat (covering the river bank with vegetation and shrubs, the distance of localities, the type of neighboring habitats, etc.) were measured from photomaps.

Every bird species observed during the monitoring (details of the observation or hearing of passing or nesting birds) was recorded daily.

Tracks were recorded while on the river. It will also mark the starting and stopping place during each day. All functional ballasts in or near the river shall be marked in the areas traveled.

In parallel with the boat, a team will travel on the shore by car and on foot (using aerial photographs printed for that purpose), especially to look for shore nesting colonies that may not be present in the immediate vicinity of the river, But at longer distances (eg in gravel pits or in non-functional sand) and not visible from the river. The same data will be noted as in the case of river monitoring. The shore team will also check the ponds near the rivers and will record all species of birds observed on each pond.

All species in Appendix 1 of the Birds Directive, such as the hake colonies, the white stork nests, the species of raptors found in trees or in the river forests were marked with the GPS.

Information to be collected:

• Completed / scanned landforms;
• Photos;
• GPS track / points.

Equipment:

• Binoculars;
• GPS;
• Land form;
• Kayak / boat;
• Camera;
• Machine.

Observers' level of preparedness

At least one of the observers conducting boat and car assessments will need to have advanced knowledge of field determination of all breeding bird species in the country.

CONCLUSIONS

Natural protected areas, due to their natural value and the low degree of human intervention on their territory, are the best examples and models for systems, in case of natural and semi-natural ecology.

In Giurgiu County has been designated since 2000, the following natural areas protected by national interest:

• By Law no. 5/2000 on the national territory, Section III, the following natural reserve: Oloaga Forest Gardens, Padina Tătarului Forest, Manafu Forest and Teşila Reserve;

• Through GD no. 2151/2004 on the establishment of the protected natural habitat regime: Comana Natural Park;

• Through GD no. 1143/2007 on the establishment of new protected natural areas Natural Reservation Cama - Dinu -Bird.

By H.G. No. 971/2011 for the amendment and completion H.G. No. 1284/2007 on the declaration of protection areas, special avifauna as an integral part of the network

European Natura 2000 in Romania was designated a new area of special avifaunistic protection (SPA), their number for Giurgiu County is reaching five.

Birds monitoring was realized in Natural Reservation Cama - Dinu. The data collected in successive years 2014- 2018, under variable climatic conditions in January, allow understanding of the dynamics of bird populations resting on the place and a picture of their trends.

The purchased data will be used to obtain information on the population trend of the target species. Density calculations and estimation of population size will be made. The collected data is the basis for the distribution maps. The species of birds monitored in this paper can be used, especially for water quality monitoring, as we have seen, their ecology and etiology are strictly related to the aquatic environment. They are consuming aquatic species such as: phytoplankton, fish, amphibians and other small aquatic animals. In this way, we can focus on their body, because of the consumed food, various pollutants that can lead to their illness or even their death. Another aspect that could indicate pollution is related to changes in reproductive behavior. These changes result in a decrease in the population of the species concerned.

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AGRICULTURAL CREDITS - IMPORTANT FACTOR IN RURAL DEVELOPMENT OF OLT COUNTY / *CREDITELE AGRICOLE - FACTOR IMPORTANT ÎN DEZVOLTAREA RURALĂ A JUDEȚULUI OLT*

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Keywords: *evolution, milk production, NW Region, Romania, trends*

ABSTRACT

Investments in agriculture are key parts for the development of agricultural domain in Olt county. The investments permit farmers to extend their activity and, indirectly, to participate to the general development of the economy. Thus, their importance is huge within the agricultural processes. Investments are usually made when the farmer has funds at hand. In Romania, there are two major sources to fund an agricultural activity: European funds and bank loans (agricultural credits). In this paper we will focus on the dynamics of the levels of the agricultural credits in Olt County, the region itself being an agricultural area, based on some indices, such as production levels in crops and livestock or population engaged in agricultural activities.

REZUMAT

Investițiile în agricultură sunt părți esențiale pentru dezvoltarea domeniului agricol în județul Olt. Investițiile permit agricultorilor să își extindă activitatea și, indirect, să participe la dezvoltarea generală a economiei. Astfel, importanța lor este imensă în cadrul proceselor agricole. Investițiile sunt de obicei făcute atunci când agricultorul are fonduri la îndemână. În România există două surse majore de finanțare a unei activități agricole: fonduri europene și credite bancare (credite agricole). În această lucrare se va pune accentul pe dinamica nivelurilor creditelor agricole din județul Olt, regiunea însăși fiind o zonă agricolă, pe baza unor indici, cum ar fi nivelele de producție în culturi și animale sau populația angajată în activități agricole.

INTRODUCTION

Funding in agriculture, as in other domains of activity, is a key phase within all processes. Either for raw material or for consumables, the necessary for materials and services is not to be minimized. Olt county is traditionally an agricultural area within the Romanian territory.

In the case of agricultural holdings, the information needed to maintain the competitiveness of its own affairs and its products must be obtained from both internal sources, as well as from external sources (*Sărăcin and Pandia, 2007*).

Agriculture, the third branch of the national economy in terms of gross added value share in GDP by services and industry, are experiencing reduced access to loans from commercial banks, as they perceive agriculture as one risky high compared to other areas to which the bank oriented financial resources.

It, we should base on agricultural cooperatives to include the entire county and on a central cooperative connecting all national and international tasks such as the legislative, financial and organizational framework (*Stanzeleit D., 2013; Georgescu I.L., 2014*).

The position of farmers in the food chain must be strengthened for a proper operation of markets and the fight against disloyal commercial practices, this objective may be reached by encouraging the farmers to organize themselves into cooperatives, which would allow them to obtain better income on the market and a larger percent of the added value of their products (*Peas C., 2014*).

Agricultural activity must be conducted on principles which should govern the farms producing agricultural goods and services in agriculture, resources used costs and revenues, including educational management necessary for both those who produce, but also for those who sell and consumer goods and services in question (*Oancea M., 2003; Zahiu et al., 2010*).

MATERIAL AND METHOD

In order to show the evolution of the agricultural credit in the area of Olt County, we will proceed by presenting the actual economic and social context of the situation in this space. Thus, we will present the dynamics of indicators such as the number of employees in the agriculture, the cultivated surfaces, the prices of some important agricultural products, the active enterprises in agriculture or the investments made in this domain.

After the presentation of these indicators that also show the extent of rural development, we will present the dynamics of the agricultural credit and the main causes of the development of agricultural domain within the development of the county economics. Also, we will show the cause-effect relationship between the indicators that show this economic development. In order to show these relationships, we will use statistical methods and economical interpretations. As methods, we will use correlations and trend lines.

RESULTS

In order to show the role of the economic indicators as a context for the agricultural development, we will present their evolution and some correlations between some main indicators of economic growth in Olt County. Figure 1 presents the evolution of the number of agricultural enterprises in Olt County.

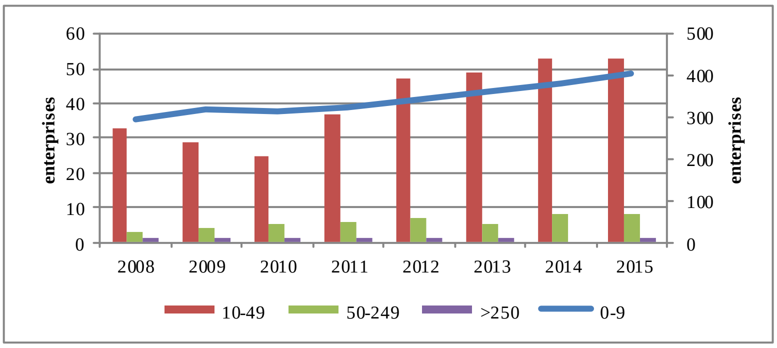

Fig. 1 - Evolution of enterprises in Olt County

As we can observe in Figure 1, the overall trend for the all categories of enterprises depending on the number of employees is one of growth, in the worst case of stagnation (as in the case of enterprises with more than 250 employees). One of the most oscillator categories is the one with enterprises with 10-49 employees, with the highest fall, but also with the most notorious increase. Figure 2 presents the evolution of the arable land cultivated in Olt County in parallel with the land that was left uncultivated.

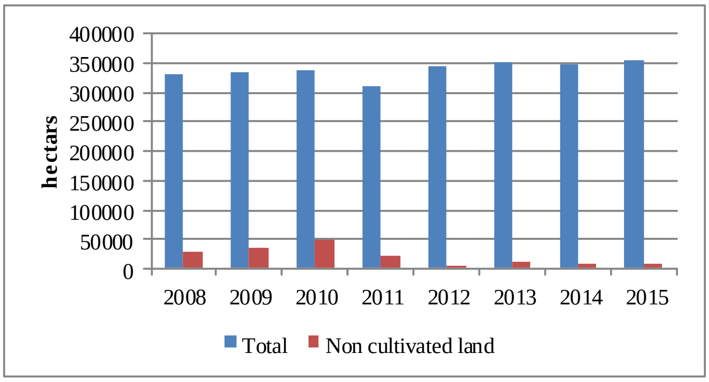

Fig. 2 - Evolution of arable land in Olt County

As we can observe, the dynamic of the cultivation of the land in Olt county was a relatively stable one, given the fact that the not cultivated land had a severe decrease followed by a stagnation in the latter years. Next, (figure 3) present the dynamic of the livestock, the other branch of the agricultural domain besides crops.

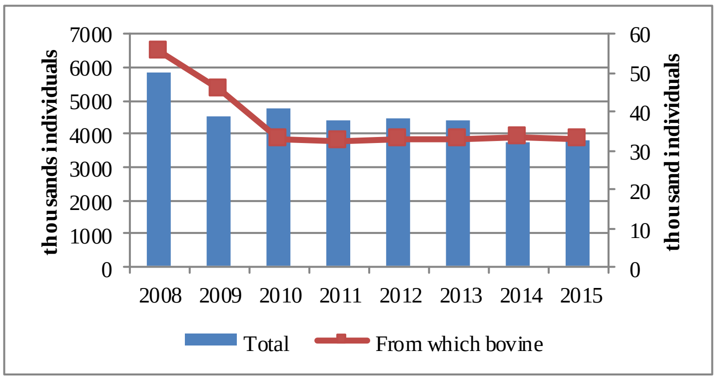

Fig. 3 - Evolution of livestock in Olt County

While the cultivation of plants had a constant trend, the livestock had a constant decrease during the latter years of the period 2008-2015. The causes of this decreasing trend may be found in the instable period after the economic contraction and in the reluctance of the people to engage in such an action due to the nature of breeding animals.

Figure 4 presents the dynamic of the workforce volume in agriculture in Olt County, correlated with the dynamic of the other indicators.

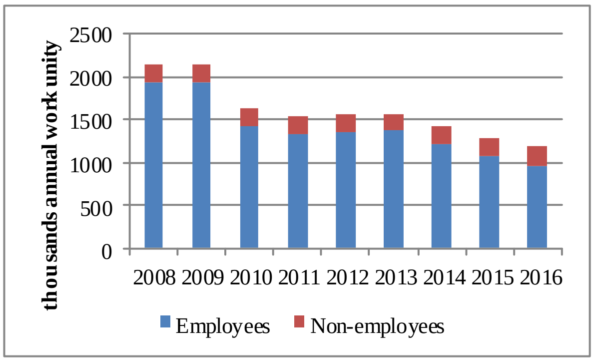

Fig. 4 - Evolution of workforce volume in agriculture in Olt County

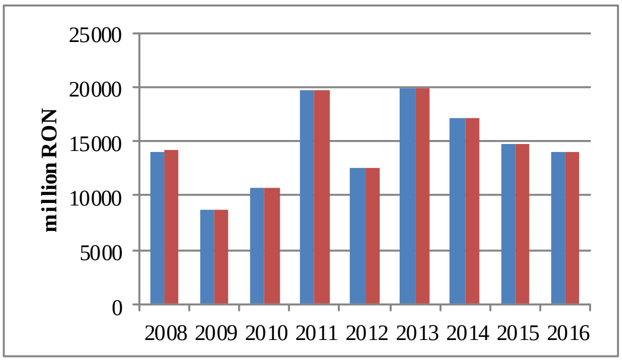

Fig. 5 - Producer product value (blue) and the impact of subsidies (red) (cereals

The workforce volume in agriculture had a decreasing trend up to 2016 in the area. However, this trend may not be entirely negative, because it not reflects the number of employees or the activity intensity, but it may show the degree of intrusion of new technologies within the agricultural process. Figure 5 presents the prices of cereals (representative for Olt County) at the producer level within the agrifood chain and the impact of subsidies for this producer price.

As we can see, the subsidies representation in the base price for cereals is closing to none in the period 2008-2016. The base price had an oscillator evolution, between 8660 million lei (2009) and 19889 million lei (2013), with a decreasing trend at the end of the period starting from 2013.

Investments are starting to be more and more made by farmers and agricultural enterprises administrators. Thus, while the investment help had an increasing trend, added value decreased with small fluctuations.

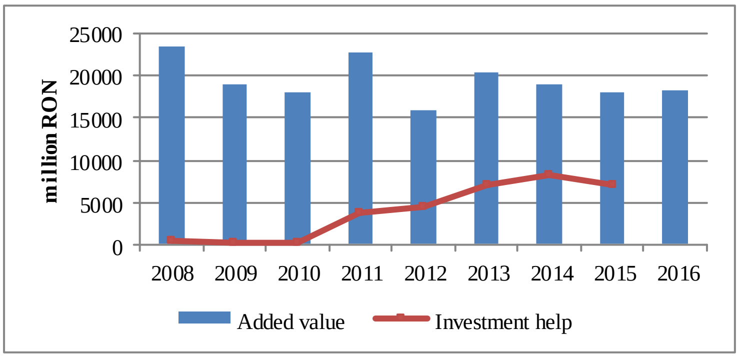

Fig. 6 - Added value at the base price and the investment help

Total production values (at least for cereals) were not convincingly increasing in the period 2008-2015, which means that the sector in Olt County is still fully developed to its potential (Figure 7).

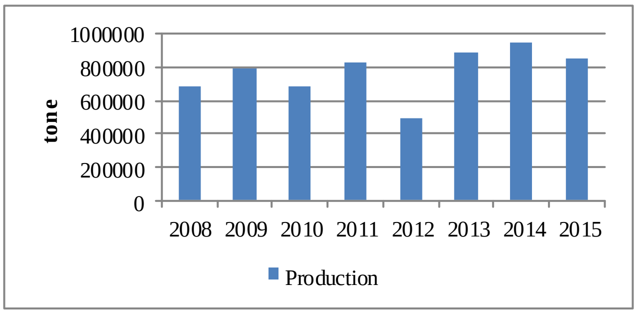

Fig. 7 - Production values for cereals in Olt County

We have presented until now the main indicators that describe the economic and social context in Olt County regarding agriculture (Figure 8).

In the period 2004-2009, the volume of agricultural loan was increasing constantly, having a steep growth, from 267 thousand RON to 7623 thousand RON.

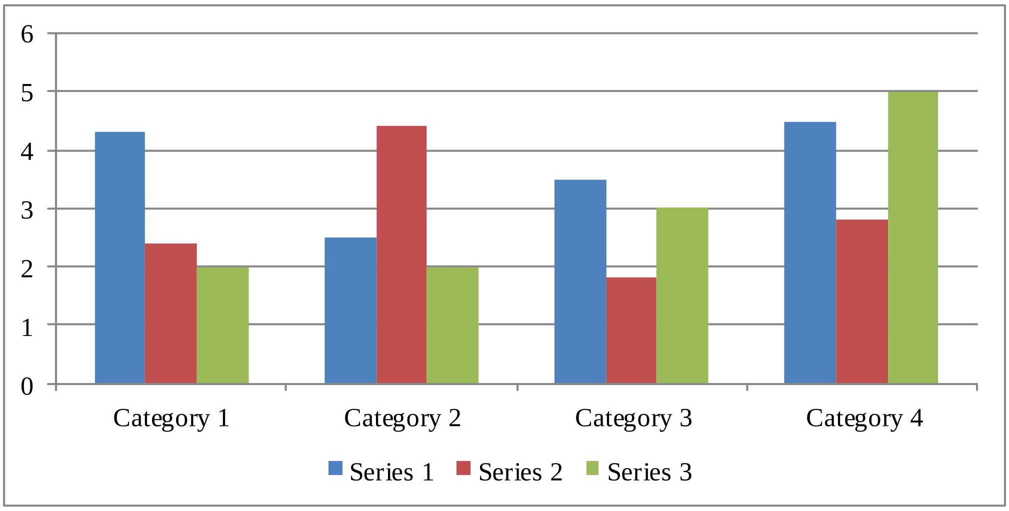

Fig. 8 - Agricultural loans in Olt County

CONCLUSIONS

While the number of enterprises of any kind had increased in the period 2008-2015, the other parameters of the economic environment in Olt county had fluctuant values.

Some of them, as the workforce volume, had even decreased during this period, due to a start in investing in various steps within the agricultural process.

However, values of production (at least for cereals) and added value still remain at a fuzzy level, fluctuating outside a visible pattern.

In this moment, the agricultural loans have a great importance in the context of growth in investments and the possibility of using European funds in order to finance the needs in the agricultural process.

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THE IRIGATED AND NON-IRREGATED SYSTEM IMPROVES QUANTITY THE PRODUCTION OF EXISTING AMINOACES IN POPCORN BOATS TOM THUMB
/
SISTEMUL IRIGAT ȘI NEIRIGAT INFLUENȚEAZĂ CANTITATIV PRODUCȚIA DE AMINOACIZI EXISTENTĂ ÎN BOABELE DE POPCORN TOM THUMB

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Keywords: *tryptophan, corn grain, amino acids, hybrid, methionine*

ABSTRACT

In order to determine and establish the quantity and quality of proteins used by the body, many researchers, scientists, geneticists, physiologists, ameliorators have made numerous studies on completing the necessary of amino acids taken from vegetable products in order to maintain the balance of amino acids, vital for the harmonious and healthy development of the body.

The importance of capitalization of corn grains pop corn Tom Thumb and their commercialization, led to detailed research of the content of amino acids at corn hybrid Tom Thumb. Taking into account the genetic dowry of that hybrid, in the two systems irrigated and not irrigated the quantity and quality of amino acids and essential amino acids and their connection in the two systems. As in proteins can be found 23 different amino acids which plays important role in obtaining qualitative production at corn grains, it will be imposed getting more significant results, to improve their quality: protein substances.

REZUMAT

Pentru a determina și a stabili cantitatea și calitatea proteinelor utilizate de organism, mulți cercetători, oameni de știință, geneticieni, fiziologi, amelioratori au făcut numeroase studii privind completarea necesarului de aminoacizi luați din produse vegetale pentru a menține echilibrul aminoacizi, vitale pentru dezvoltarea armonioasă și sănătoasă a corpului.

Importanța valorificării boabelor de porumb pop corn Tom Thumb și comercializarea acestora au dus la o cercetare detaliată a conținutului de aminoacizi la hibridul de porumb Tom Thumb. Având în vedere zestrea genetică a acestui hibrid, în cele două sisteme irigate și neirigate cantitatea, calitatea aminoacizilor, a aminoacizilor esențiali și legătura lor în cele două sisteme. Ca și în proteine se pot găsi 23 de aminoacizi diferiți, care joacă un rol important în obținerea producției calitative la boabele de porumb, va fi impusă obținerea unor rezultate mai semnificative, pentru a îmbunătăți calitatea lor: substanțe proteice.

INTRODUCTION

Protean substances from corn grain belong to globulins, prolamin and glutein. Methionine was also observed, an essential amino acid together with lysine and tryptophan increase the alimentary quality of this one, expecting from corn, the increase of the protein content at 12-15%.

Within Oltenia region, corn occupies the first place among the field crops (*Bonea and Urechean, 2011*). The combined influence of cultivar and crop technology (application of irrigation and administration of appropriate fertilizer doses) leads to changes in the main physiological processes that can lead to optimization of technologies in order to obtain maximum yields at doses of rationally applied fertilizers (*Pandia O. 2009; Saracin I.. 2010*).

Because most essential amino acids are in different quantities in the food composition of a group where some nutrient factors are in large quantities, while others are in small quantity or missing, therefore in order to have a balanced diet it is necessary to eat food from different groups (*Saracin and Pandia, 2013*). Thus, in this paper, we study some basic essential amino acids taken from corn grains, besides other existing therein and required for the daily ratio supplement of amino acids useful to humans, such as tryptophan and methionine (*Pandia and Saracin, 2011).* Due to its high contents in fiber, corn regulates bowel movement, prevents constipation, leading to occurrence of colorectal cancer. Rich in polyunsaturated fatty acids, corn oil stops the growth of blood cholesterol, being a good diuretic and permanent consumption can prevent water retention in the body.

The percentage of protein in corn grain can range from 10.8% to 20% and fat percentage from 4.7% to 15%, this is an important factor for studying all amino acids present in the grain, but mainly corn caryopses are followed containing more lysine and tryptophan by diversifying more hybrids.

With this paper, the author attempts to emphasis the economic importance of corn for pop corn but also the nutrient value for human, for zoo technical sector, in the industry of bio fuels.

MATERIAL AND METHOD

Tom Thumb hybrid was studied, which due to the high value of protein existing in corn grains, led to determining the existing essential and nonessential amino acids particularly in studying tryptophan and methionine as essential amino acid required for supplementing the protein deficiency in the human body. Hybrids were planted in Oltenia area, Pleșoi village in two years of study: 2016-2017, at a density of 50.000 plants / ha, after the wheat crop in two systems: irrigated and non-irrigated in order to observe the amount of existing amino acids existing in grains especially tryptophan and methionine.

Soil analyzes were performed year 2016 can be characterized in terms of climate as a year of two distinct parts: the first half, from January to June (with inadequate water supply), followed by the second half with excess rainfall. This led to obtaining satisfactory yields. In 2017, the water demand is not satisfied, having a lower deficit, being a poor year in terms of water.

For the soil chemical, physical and hydrophysical analyzes (*ICPA 1987; ICPA 1980*), were performed by methods known as:

The pH of the soil was measured by the potentiometric method, which is based on the determination of hydrogen ions according to the potential difference between the two electrodes introduced into the soil suspension and the results are read on the scale of the measuring apparatus that is graduated in pH units.

The Ah was determined by treating the soil with the solution of an alkaline hydrolysis salt with 0.1 N sodium hydroxide in the presence of phenolphthalein.

Sb. the method of determination is to treat the soil with an excess of 0,05 HCl 0,005 n and the sum of the bases being equivalent to the amount of HCl consumed in the reaction is determined by titration with NaOH in the presence of the methyl red used as an indicator.

Phosphorus was determined by the Engner-Riehm-Domingo method and was carried out by removing the mobile phosphorus with a solution of ammonium lactate acetate. The concentration in the phosphorus thus obtained is determined by colorimetry.

Potassium was determined by the same method as phosphorus, and its dosing was carried out on a flame photometer.

For the determination of Humus, the Walkle and Black method was used and was made by oxidizing the organic substance in the soil with potassium dichromate in the presence of sulfuric acid and titrating excess potassium dichromate with a Mohr's salt solution.

Nt was obtained by applying the Kjeldahl method, which was done by soil mineralization with concentrated sulfuric acid, and by measuring excess sulfuric acid with 0.1N NaOH, the nitrogen content of the sample to be analyzed can be calculated.

The chemical analyses of corn grains emphasized differential quantities of amino acids on corn grains that were cultivated in the two systems: irrigated and not irrigated.

Analysis of expansion within the laboratory

At hybrid Tom Thumb, depending on the production of grains was calculated the content in amino acids in kg/ ha. The determination of analyses was realized through the method of spectrophotometry and chromatography, after preliminary the tests that were analyzed have been dried in the kiln. The acids: monoaminomonocarboxylic - were studied: alanine, valine, leucine, isoleucine and oxydrilats and sulfurhydrate of acids from the group of monoaminomonocarboxylic have been studied: serine, treonine, cysteine, methionine.

From monoaminomonodicarboxylic acids have been studied: aspartic, glutamine. From diaminomonocarboxylic acids: arginine and lysine. An important aromatic amino acid that was studied was thyeozin and from heterocyclic amino acids has been studied: tryptophan, proline and histidine.

RESULTS

The characteristic soil of this area is luvic reddish brown which has a lower natural potential by applying the two irrigated and non-irrigated systems, it has been demonstrated to obtain the amount of amino acids.

Table 1

Chemical properties of the soil harvested from the studied area - Pleșoi in october 2016

Ground test	Depth	pH	Humus	N total	NO_3	P_2O_5 total	P mobile	K mobile	Ah	S.B.	S.H	T	V
	[cm]	[H_2O]	[%]	[%]	[mg/100 g sol]	[%]	[ppm]	[ppm]	[me/100 g sol]				[%]
P1	0-25	5.4	2.22	0.108	5.73	0.111	13.53	107	3.07	21.7	7.8	20.73	66.46
P2	0-25	5.4	2.22	0.108	5.73	0.111	13.53	107	3.07	21.7	7.8	20.73	66.46
P3	0-25	5.2	2.24	0.108	4.14	0.086	13.19	108	2.96	21.4	7.6	21.85	67.21
P4	0-25	5.2	2.26	0.109	3.14	0.087	13.07	109	2.95	20.9	7.5	22.89	69.48
P5	0-25	5.4	2.22	0.108	5.73	0.111	13.53	107	3.07	21.7	7.8	20.73	66.46
P6	0-25	5.3	2.26	0.109	3.14	0.087	13.07	109	2.93	20.9	7.5	22.88	69.48
P7	0-25	5.5	2.29	0.111	2.19	0.088	12.12	112	2.69	20.9	7.4	24.78	71.51
P8	0-25	5.4	2.22	0.108	5.73	0.111	13.53	107	3.07	21.7	7.8	20.73	66.46
P9	0-25	5.3	2.29	0.111	2.19	0.088	12.12	112	2.67	20.9	7.4	24.78	71.51
P10	0-25	5.3	2.29	0.111	2.19	0.088	12.12	112	2.69	20.9	7.4	24.78	71.51
P11	0-25	5.4	2.22	0.108	5.73	0.111	13.53	108	3.07	21.7	7.8	20.73	66.46
P12	0-25	5.4	2.22	0.108	5.73	0.111	13.53	107	3.07	21.7	7.8	20.73	66.46

So, in the not irrigated system of culture can be observed significant values of the aspartic acid, proline, alanine, leucine, thyrozin, phenilanin and arginine (g/100 g S.U. In the irrigated system of production, the content at 100 g s.u., presents significant values at the same amino acids, existing a significant difference at the amount of amino acids, as well as essential amino acids of almost 300g, and at hectare the difference is of about 7.8 kg/ ha at essential amino acids.

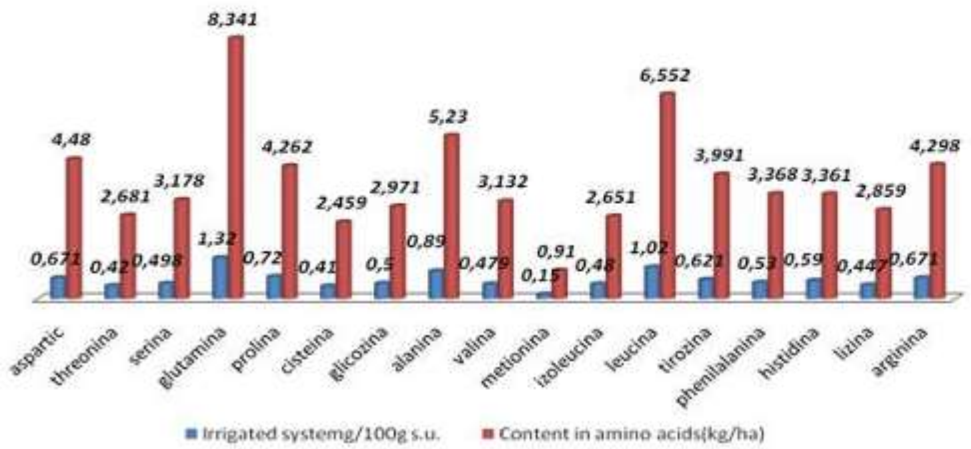

Fig. 1- The contents in amino acids expressed as kg/ha
(a function of the crop grains production) and Tom Thumb hybrid irrigated system

For the quantitative determination of amino acids have been used the chromatographic method. Essential amino acids are those amino acids which can be synthesized only in the vegetable kingdom. They are of a special importance because in their absence specific proteins that are necessary to the organism cannot be synthesized.

From the class of essential amino acids is a part: valine, leucine, isoleucine, phenilalanin, treonin, methionine, lysine, tryptophan, histidine.

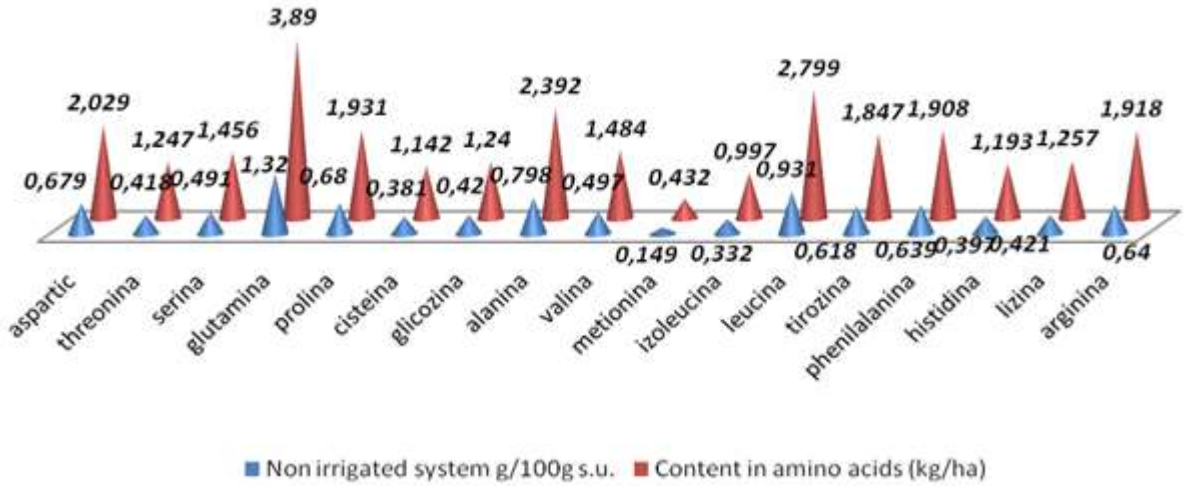

Fig.1- The contents in amino acids expressed as kg/ha (a function of the crop grains production) and Tom Thumb hybrid non irrigated system

It was observed the dose of tryptophan which was read at photocolormeter with red filter and will be compared with the standard curve made with casein.

Dosing the lysine was determined and read at spectrophotometer, and aromatic amino acids have been identified through xanto protein reaction.

CONCLUSIONS

The content in amino acids presents values that are superior depending on the culture system in favor of the irrigated one, being observed low levels of the amino acids in the hybrid Tom Thumb.

We recommend for production the hybrid Tom Thumb, in irrigation conditions

The main protein of the corn grain will be characterized by an increased content of glutaic acid obtained in both systems, on second place being leucine.

It is also recommended the cultivation of this hybrid with a shorter period of vegetation because are richer in protein substances than late hybrids.

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METHODOLOGICAL INSTRUMENT FOR FORMING THE MARKETING STRATEGY OF AGRICULTURAL PRODUCTION ECOLOGYZATION
/
МЕТОДОЛОГІЧНИЙ ІНСТРУМЕНТ ФОРМУВАННЯ МАРКЕТИНГОВОЇ СТРАТЕГІЇ ЕКОЛОГІЗАЦІЇ СІЛЬСЬКОГОСПОДАРСЬКОГО ВИРОБНИЦТВА

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***Keywords**: marketing strategy, ecologization, agrarian production, strategic analysis*

ABSTRACTS

It is determined that marketing strategy of ecologization of agrarian production is a strategy of innovative development that can solve problems of economic growth, increase of competitiveness of agrarian industry, provide high quality of life, national security, environmental protection and high technical level of agricultural production in Ukraine.

According to the results of the research, the methodological approaches and the main stages, tools, mechanisms of formation and implementation of the marketing strategy of ecologization of agrarian production were determined.

ТЕЗИ

Визначено, що маркетингова стратегія екологізації аграрного виробництва є стратегією інноваційного розвитку, здатної вирішувати завдання економічного зростання, підвищення конкурентоспроможності аграрної галузі, забезпечення високої якості життя, національної безпеки, охорони навколишнього середовища і високого технічного рівня сільськогосподарського виробництва в Україні.

За результатами дослідження визначено методологічні підходи та основні етапи, інструменти, механізми формування і реалізації маркетингової стратегії екологізації аграрного виробництва.

INTRODUCTION

The problem of the marketing strategy formation for the environmentalization of agrarian production is still not sufficiently investigated in the theoretical as well as practical aspects. There is a need to deepen theoretical research and methodological developments associated with the formation of a marketing strategy for environmentalization as a component of the ecological and economic mechanism for managing agrarian production. Agriculture ecologization is based on the development of environmentally friendly management to provide an extended reproduction of natural and human resources through the formation of sustainable ecological and economic systems aimed at increasing the volume of production of competitive products (*Tkachuk, 2014*). The basis of the formation of a marketing strategy for the ecologization of agrarian production is the systematic approach, which is based on the existence of implementation mechanisms that ensure system consistency, its purposefulness; interdependence; interdependence and complexity of its elements determines the integrity of the system; All tasks that execute individual elements of the system are interconnected; System elements and their associated actions have a certain subordination that builds hierarchy; The system changes under the influence of specific factors, which determines its dynamism; The ability of the system to adapt to the variability of the external environment, while not losing its own individuality (*Zaliznyuk, 2015*). According to the system approach, the elements that make up the content of the marketing strategy of the enterprise, not only functionally derived from each other, but all without exception, are interconnected. Changing one of them inevitably leads to changes in others, and ultimately - in the entire marketing strategy. This requires a comprehensive solution to any of its problems: large and small, simple and complex, tactical and strategic (*Larina, 2008*). The basis of the formation of a marketing strategy for environmentalization of agricultural production are the main strategic categories that are considered the basis of strategic marketing. The initial stage in developing the marketing strategy of environmentalization is the definition of the mission, which is what is the main philosophy, the main purpose of the existence of this strategy (*Kudenko, 2012*).

The purpose of the article is to substantiate the methodological approaches and to study the main stages, tools, mechanisms of formation and implementation of the marketing strategy of ecologization of agrarian production.

MATERAIL AND METHOD

The main task of the marketing strategy of ecologization of agrarian production at the state and regional levels is to create economic conditions for economic entities, in which they will be interested in preservation and restoration of natural resources potential when introducing innovative approaches in their activities. In addition, it is important to ensure the ecological and economic security of the agro-food market and the agrarian sector of the economy as a whole. It can be done by developing environmental policy measures in the agrarian sector, which will allow changing the format of relations between production and the environment towards rational use and reproduction of agro-systems. At the level of business entities, the main objective of the marketing strategy of ecologization of agrarian production is the development of economic organizational and economic mechanism of management of an agrarian enterprise with the application of its main components: planning, stimulation (motivation), organization of management, control, etc. At the same time it is necessary to orient production to meet the ecological needs of consumers. An important task of the marketing strategy of ecologization of agrarian production for agricultural producers is to promote the reduction of the load on the natural environment in the planning, coordination and control of all management activities (*Khromushina, 2008*). The marketing strategy for environmentalizing agrarian production consists of next steps:

- the formation of environmental needs of the market;
- creation of conditions for the environment protection;
- adaptation of production to the market conditions;
- production of competitive environmental products;
- intensification of sales of ecological products;
- profit from the environmentalization of agricultural production.

These goals and tasks fulfillment is possible only due to the formation of ecological consciousness in society, the development of environmental needs and the awareness of the need for the use of environmental goods. It is necessary to organize marketing researches in order to solve the following issues when forming a marketing strategy for environmentalizing agrarian production to decide next problems:

1. Research of the main environmental problems of the agrarian sector and assessment of the ecological situation in different regions of Ukraine. It is the concern of consumers that environmental problems form their potential demand for environmental goods.

2. Provision of ecological characteristics of products of agrarian production. Given the emphasis on the environmental safety of the agrarian sector, organic production, Ukraine must become a competitive producer in the global food market and be able to meet not only its own needs, but also satisfy part of the ever - growing world food needs. The basis of the environmental policy of the development of domestic agriculture should be its environmental safety based on ecologization, through the development of organic production.

3. Research needs in new products. At the same time, the following methods are used: forecasting of future needs and demands of consumers, changes in the motivation of their behavior (in line with the market transformation of the economy); Situational and simulation modeling of consumer behavior.

4. Determination of trends in the development and change of environmental, technological, economic, legal, political, social and cultural components of the environment.

5. Analysis of market attractiveness factors of environmental goods, market size, growth of demand, intensity of competition, inflation, technological requirements, power consumption, performance of social and political factors.

6. Diagnosis of ecological consciousness of consumers and needs in environmental goods. It is knowledge and assessment of the factors of development of environmental needs that will enable enterprises to feel more confident in a market where there are constant changes.

7. Development of environmental innovations, the specifics of which is that their development is associated with the creation of goods, analogues which did not exist before, and it is due to the following reasons:

a) the needs and demands of consumers, for the satisfaction of which new products are intended, were previously satisfied with a completely different way (the first kind of fundamentally new innovations);

b) needs for the satisfaction of which the appointment of new products, previously just did not arise (the second kind of fundamentally new innovations) (*Illyashenko, 2003*).

The receipt of information on these issues will determine the main directions of development of this strategy. An important stage in the formation of a marketing strategy for ecologization is a strategic analysis of the macro- and micro-environment. This process involves an analytical evaluation of the parameters of the external and internal environment with the help of general scientific and applied methods of strategic analysis. The external environment in which there are domestic farms, is qualitatively different, escalating competition in the market, increasing its degree of uncertainty, there are unforeseen risk factors. That is why the work on the strategy begins with a comprehensive study of the market situation in the industry (*Danylyshyn and Lyubchenko, 2008*). At the stage of strategic industry analysis, special attention should be paid to assessment of environmental and economic potential because of resource development concepts of marketing strategy changes the vector of reactive (reacting on changes in the environment) to proactive (prevention events) (*Andreeva and Martynyuk, 2009*). Therefore, an essential step in the formation of a marketing strategy greening of agriculture, we believe is the providing strategic relevance, providing coordination of resources and production capacity with market conditions. The marketing strategy of environmentalizing agrarian production should be oriented towards the formation of sustainable competitive advantages. Therefore, the results of the assessment of environmental factors are a prerequisite for the formation of a complex information and analytical support of marketing management, which is an essential condition for the development of this strategy.

RESULTS

In the process of forming an agrarian production ecological marketing strategy, system and situational approaches, methods of strategic analysis, most often using matrix models, are used. However, it is not enough to involve only these models, all statistical-economic, economic-mathematical methods of analysis should be used for comprehensive vision of the situation, all available possibilities and alternatives.

Marketing strategy for ecologizing agrarian production includes instruments of ecological and economic management (Figure 1).

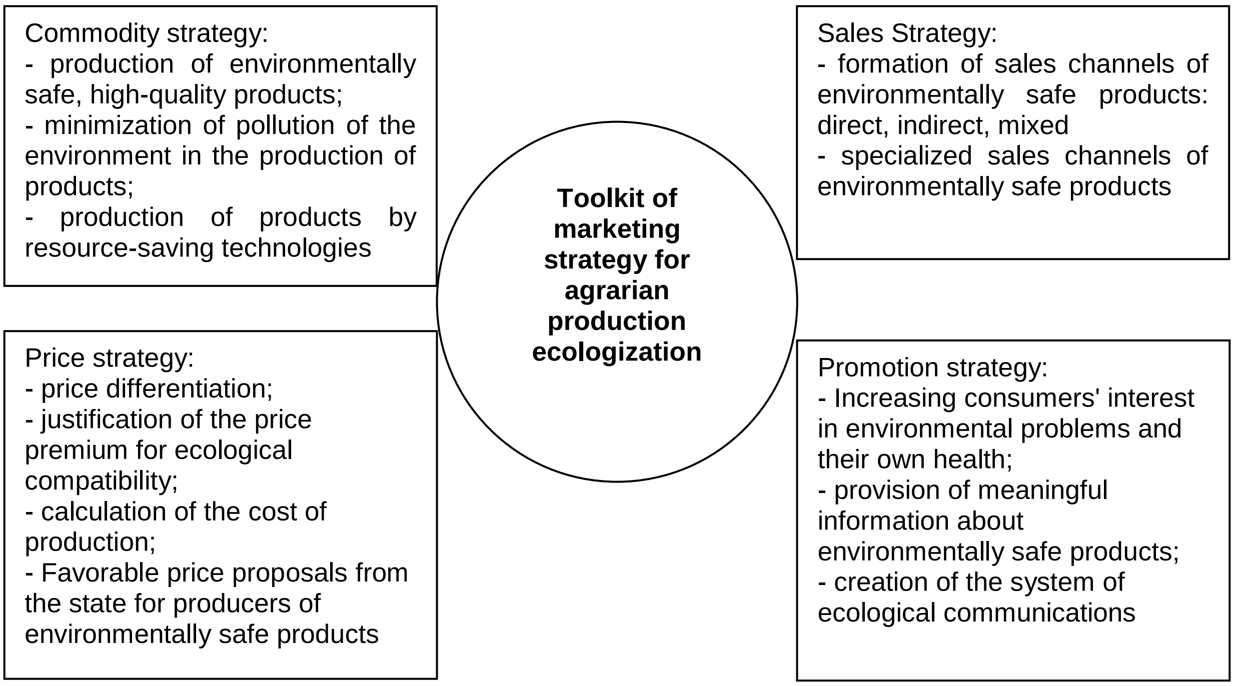

Fig. 1 - The main components of the marketing strategy of ecologization of agrarian production

Traditional system of tools includes product, price, promotion and distribution from the consumer's point of view - needs, costs, communication and convenience. In contrast to the traditional system of tools of the marketing complex, the environmental strategy takes into account the environmental aspects of the marketing strategy (*Kuchmiev, 2014*). The ecological component is present in each of the four elements of the marketing complex. The main requirements for the formation of a marketing strategy for the environmentalization of agrarian production are the following:

a) the reality, which involves its compliance with the situation, objectives, market, production and resource factors, experience and skills of the management system in the industry;

b) logical, internal integrity and consistency of individual elements;

c) compatibility with the external environment, providing an opportunity to interact with it;

d) risk is justified;

e) focus on the formation of sustainable competitive advantages.

The implementation of the marketing strategy greening of agricultural production by using environmental-economic management mechanism, based on up measures to allow, in our opinion, to change the format of relations between production and the environment towards sustainable use, reproduce agricultural systems.

CONCLUSIONS

It is established that marketing strategy of ecologization of agrarian production is a strategy of innovative development that can solve problems of economic growth, increase of competitiveness of agrarian industry, provide high quality of life, national security, environmental protection and high technical level of agricultural production in Ukraine. The main strategic categories of the marketing strategy for environmentalizing agrarian production use are following: definition of mission, goals and objectives; strategic analysis of factors of macro- and micro-environment; the choice of priority strategic directions, the formation of tools for implementing this strategy; evaluation and control over its implementation. A combination of ecological and economic instruments at the state regulation of ecological and economic components is important for implementing the marketing strategy of agrarian production ecologization.

It's necessary to understand that this strategy forming is not just about the one-time use of innovations to achieve instant advantages. This policy includes detailed planned strategic innovation development that forms new methods and controls, transforming the intensive introduction of innovation processes into the factor of economic growth in the industry of Ukraine.

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IMPROVEMENT OF TECHNOLOGY AND MECHANIZATION FOR WEED CONTROL / *ÎMBUNĂTĂȚIREA TEHNOLOGIILOR ȘI MECANIZĂRII PENTRU CONTROLUL BURUIENILOR*

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Keywords: *Precision agriculture, Intra-row weed control, Machine vision, autonomous platform*

ABSTRACT

Automated, non-chemical, intra-row weed control techniques for commercial crop production systems are an important and challenging task in industrialized countries. Non-chemical weed control methods are increasingly in demand for conventional field vegetables, mainly accentuated by regulatory restrictions on the use of herbicides. Intelligent camera-based systems capable of guiding mechanical weeding devices so as to avoid injuring crop plants are now available for practise. The aim of the present study was to present the weeding performance of some mechanical weeding machines.

REZUMAT

Tehnicile automate, nechimice, de control al buruienilor în rândul sistemelor de producție a culturilor comerciale reprezintă o sarcină importantă și provocatoare în țările industrializate. Metodele de combatere nechimică a buruienilor sunt din ce în ce mai solicitate pentru legumele de câmp convențional, accentuate în principal de restricțiile de reglementare privind utilizarea erbicidelor. Sistemele inteligente bazate pe camere, capabile să ghideze dispozitive mecanice de distrugere a buruienilor pentru a evita rănirea plantelor de cultură, sunt acum disponibile pentru practică. Scopul studiului a fost de a compara performanțele de distrugere a unor mașini de plivit mecanic.

INTRODUCTION

Machine vision systems applied to agricultural tasks have great potential, as explained in (*Brosnan and Sun, 2002; Davies, 2009*). The use of technology, including machine vision systems, in agricultural applications can reduce manual tasks and the cost of crop production (*Barreda et. al., 2009*), and can contribute to the productivity and competitiveness of farmers to ensure agricultural supplies. Moreover, the use of traditional farming methods sometimes may lead to indiscriminate use of chemicals (herbicides, fertilizers), increasing production costs, soil depletion and environmental pollution (*Astrand and Baerveldt, 2005; Kataoka et. al., 2003*). In organic crop management the use of conventional pesticides is prohibited, placing a major challenge and priority on most organic farms for mechanical weed control (*Walz, 2004*). While economic non-complex equipment is available to control the inter-row weeds, intra-row weed control still requires costly hand weeding (*Silvesind et. al., 2009*). In many crops (e.g., onions) this added labor force cost can be significant (*Mojzis, 2002*). Process automation is gaining an important relevance today. In this regard, crop/weed discrimination based on images has currently received special dedication in precision agriculture. Indeed, plants located inside the inter-row spaces can be considered with very high probability to be weeds, requiring site-specific treatments (*Gonzalez-de-Soto et. al., 2014; RHEA, 2014*). The intra-row weed identification is important too. However, this task is complex because crops and weeds located in the intra-crop row space are intermixed and overlapped, with a high degree of similarity in their spectral signatures.

Direct non-chemical weed control methods used in practice are: cultivation with mechanical tools, flaming and steaming. The mechanical tools used for weed control needs to be adapted to the plant species. Considering weeding strategies in the row planted crops, inter-row and intra-row weed control can and should to be combined, affecting as well the close to crop area. Conventional tools for inter-row weed control with exact row following can handle with approximately 80% of the field area. However, the weeds emerging in the remaining area between (intra-row) and around the plants (close to crop) have significant impact on the yield and development of the plants (*Heisel et al., 2002*) and could be the major problem in organic production in row crops, such as vegetable and maize (*Van der Weide et al., 2008*).

MATERIAL AND METHOD

A review of the typical mechanical weeding tools and implements resulted with the hypothesis that the new system should provide adequate adjustment possibilities considering the position and shape of the motion trajectories, according to the size and shape of the plants. Furthermore, discussions with farmers and stakeholders lead to the hypothesis that the mechanics need to be optimized toward universal intra-row weeding tool, which can be used in different plant spacing systems, different plant in row distances and growth stages. The complex tasks such as accurate row following and retaining of the exact cultivation depth was recognized as additional requirements which needs to be considered if development of a highly reliable and effective mechanical intra-row weeding system is targeted. A new concept was built up based on the idea that the design of the intra-row weeding system should allow emulation of the motion of the hoes blade under the soil surface during the hand hoeing.

The first paper analyses an automatic intra-row weeding machine was designed using a pair of intra-row mechanical weed knives similar in concept to the thinning knife used in the commercial vegetable crop thinner developed by Eversman (*Kepner et al., 1978*) but modified for precision intra-row weed control and RTK-GPS actuation, Figure 1.

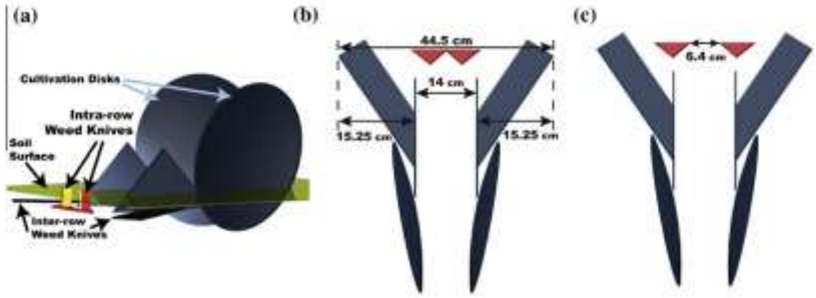

Fig. 1 - Weed knife system for row crops

(a) Side perspective view showing the inter-row cultivation disks (grey) and sweep knives (grey), the soil surface (yellow), and the intra-row knives (red) in the closed position about 2.5 cm below the soil surface. (b) Top view showing the intra-row knives (red triangles) in the closed position, killing any weeds in the central 14 cm seed line region (called zone B in Fig. 1). (c) Top view showing the intra-row knives (red triangles) in the open position, creating a 6.4 cm uncultivated gap to allow crop plants to pass unharmed.

The intra-row weed knives had two operating positions. The position shown in Figure 2b, where the inside tips of the red triangular blades touched each other, was defined to be the ‘‘closed’’ position. With the intra-row knives in the closed position, all plant material in the central 44.5 cm area of regions A and B of the crop row was killed, either by the inter-row cultivation implement (killing plants in region A) or by the intra-row weed knives (killing plants in region B). Additional intra-row mechanical weeding tools (not shown) used in standard inter-row cultivation killed all weeds in the furrows and along the edges of the planting beds. The second operating position was defined to be the ‘‘open’’ position, shown in Figure 2c. By actuating the pneumatic valve, each linkage arm and the associated intra-row knife blade was positioned away from the seed line and toward the two sweep knives, creating a knife-free uncultivated central region 6.4 cm wide centered about the seed line. With the intra-row knives in the open position, any plants growing within the central 6.4 cm wide region were not killed, while all plants growing outside the central 6.4 cm region would be killed.

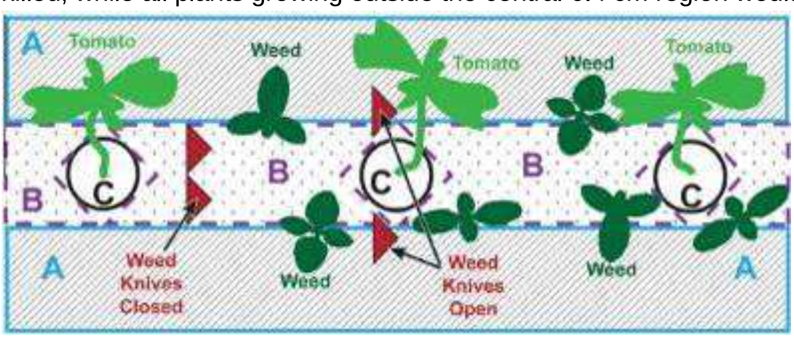

Fig. 2 - Illustration showing the three weeding zones:

A = inter-row (blue border with grey diagonal hatching), B = intra-row (purple dashes with + symbols), and C = close-to crop (black circles) and the ideal path of the intra-row weed knives (red triangles)

In second paper the newly designed weeding tool consists of an arm holder and three or more integrated arms rotating around the horizontal axis placed directly above the crop row. A concept of integration of the weeding tool onto an autonomous platform, in form of a digital prototype is presented in Figure 3, where several design alternatives of the hoeing tool are shown.

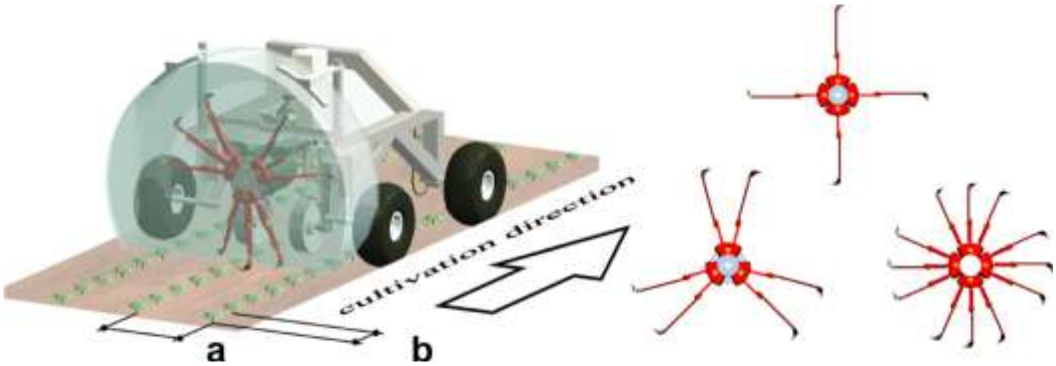

Fig. 3 - Concept of weeding system and design variants of the hoeing tool assembly
(a – distance between rows and b – distance between adjacent plants).

The guiding principle followed during the development of this hoeing system concept was that the rotational speed of the hoeing tool needs to be accurately tuned in real-time, according to the forward speed of the carrier, estimated in-row distance between adjacent plants and the observed angular position of the arms. It was identified that according to required dynamics and accuracy an electrical drive could be a most suitable solution. An additional characteristic of the weeding tool is the possibility of manual adjustment of the arm length ($R_{LA} + R_{UA} \cos \theta$) and their angular position (h) in relation to the plane, perpendicular to the rotation axis, in which the arm holder is placed, by means of the pin-in-slot joint between the forearm (R_{LA}) and upper arm (R_{UA}). The consequence and main advantage of these adjustment possibilities are variable trajectories of the end effectors. As end effectors, tools such as small duck foot blades, rigid thinness, torsion weeders are applicable and can be easily implemented.

The optimal trajectories of the end effectors with cultivation depth (d) need to be chosen depending on the required size of the non-cultivated (protected) area around the crop plant and chosen end effector. The modular design of the hoeing tool allows optimal selection of the number of hoeing passages between two adjacent plants, depending on the in-row distance between the plants and their stage of the development. Knowing the main weeding parameters such as cultivation width of the chosen end effector, sowing distance and typical (approximate) growth stage and size of the plants immediately before carrying out the weeding, the most suitable design variant (Figure 3) and angular position (θ) need to be defined and the system configured before the application. In case of adequately selected angular position (θ) and constant weeding parameters, the angular position stays constant during one passage. A schematic diagram of a weeding tool consisting of three sections with two weeding arms in each section, containing geometry and characteristic design parameters is shown in Figure 4.

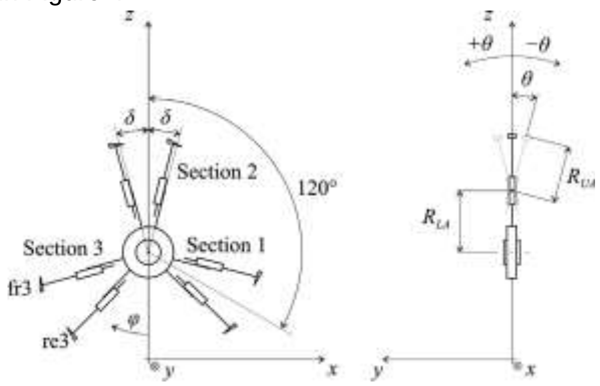

Fig. 4 - Design parameters of a weeding tool with 6 arms *(y travelling direction, fr3– position of the front-end effector of section 3, re3 – position of the rear end effector of section 3).*

In another paper Intra-row weeding with intelligence was performed with the Robovator intra-row weeder produced by Frank Poulsen Engineering in Denmark. Treatments were conducted on 21 May and 18 June in 2010 and on 24 May in 2011 only. The weeds had predominantly developed 2-4 true leaves at the time of intelligent weeding. Treatment timing was slightly delayed compared to the simpler implements because this is regarded more optimal for Robovator where the guidance system allows the use of a more aggressive weeding device. The weeding effectiveness of the device is claimed to be equally effective against weeds in the range of 0-4 true leaves. Moreover, a delay would cause more weeds to germinate prior to control than with an earlier treatment; as a consequence, overall weed control of one pass will increase.

The Robovator weeding device consists of a pair of tines where each tine is equipped with a flat knife-like blade assumed mainly to cut the weeds at 1-2 cm soil depth horizontal to the soil surface (Fig. 5). The hoe blades treat either side of the crop row. The blades stay in the crop rows and cultivate the intra-row area until they approach a crop plant, at which point the computer settings determine exactly when to move the blades apart to avoid injuring the crop plant. When the crop plant has been passed, the blades close again to continue cultivating the intra-row area.

The movement in and out of the crop row is performed by an hydraulic actuator connected to a camera mounted in front of it. There is a camera for each crop row that detects every single transplant based on the size differential between the crop and weed plants. The images are processed by a computer that calculates the points at which the actuator needs to be activated according to the driving speed and proximity to the crop plants that the hoe blades are programmed to cultivate (Figure 5).

The proximity is defined by a buffer zone that is always respected by the system. In cases when the crop leaves go beyond the buffer zone, a border zone is defined that can be adjusted either to move the hoe blades apart before the edge of the crop leaves or to allow them to cultivate under the leaves either until they reach the buffer zone or some distance before the buffer zone (Figure 5). For example, a border zone of 0 mm means that the hoe blades are moved apart just before the edge of the crop leaves, while a border zone of -70 mm means that they are allowed to cultivate 70 mm under the crop leaves before being moved apart.

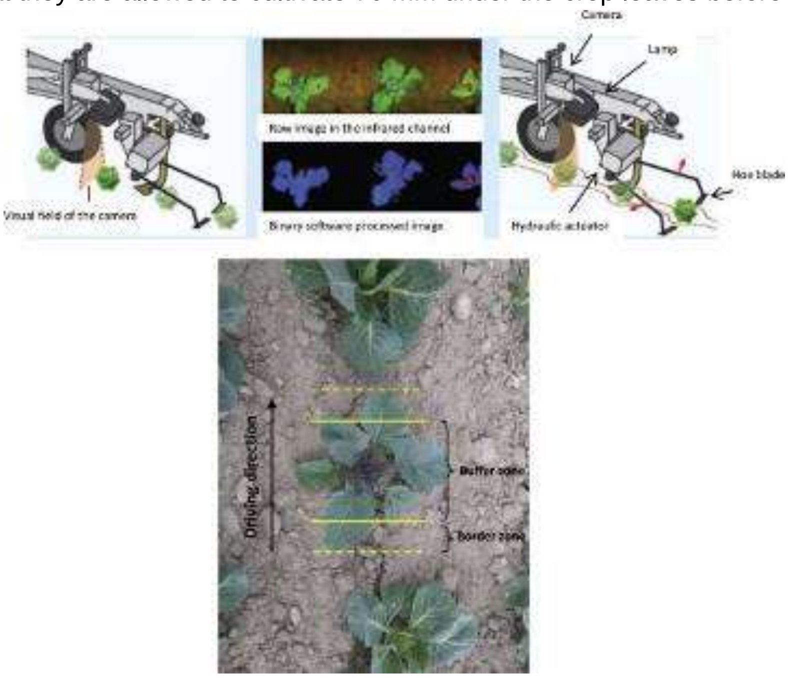

Fig. 5 - The working principles of the Robovator, intelligent mechanical intra-row weeder

RESULTS

The results of first paper, where the automatic intra-row system was operated in four crop rows under two different nominal forward travel speeds, are shown in Table 1. Within this study, the real-time intra-row weed knife path to circumvent a total of 682 tomato plants were used to assess the performance of the knife control system: 396 for the test conducted at a forward travel speed of 1.6 km/h and 286 at the 0.8 km/h travel speed. The average size of the close-to-crop zone C achieved by the knife was 15.70 cm at the travel speed of 1.6 km/h and 7.15 cm at the travel speed of 0.8 km/h on average for the four rows, which are close to the operator selected target sizes 15.24 cm, and 7.62 cm, respectively for the two travel speeds. Ideally this would represent the diameter of the circles labelled C in Figure 1.

However, with the on/off style solenoid valve used in this design, the knives follow an approximate straight-line path (assuming constant knife opening and tractor velocities) represented by the purple dashed lines in Figure 1.

Table 1

Accuracy and precision of intra-row weed knife position control

Row	Plants	Speed	Opening distance* error (cm)		Close-to-crop* error (cm)	
			Mean	Std	Mean	Std
1	110	1.6	1.3	3.68	0.6	1.38
2	78	1.6	1.1	3.45	0.8	1.50
		0.8	0.6	1.85	-0.4	0.95
3	110	1.6	0.3	2.94	0.5	1.28
		0.8	0.5	1.83	-0.6	0.9
4	98	1.6	1.0	3.03	0.0	1.22
		0.8	0.8	1.57	-0.4	0.89
All	396	1.6	0.9a	3.28b	0.5d	1.39f
	286	0.8	0.6a	1.75c	-0.5e	0.94g

* Differences in values between the 1.6 km/h and 0.8 km/h travel speeds with the same letter for a specific table column are not significantly different (p-value < 0.0001) by ANOVA, or Levene's homogeneity of variance test for the mean and standard deviation values, respectively.

In second paper the results of the set of simulations for the cultivated row (CR), row left from the cultivated row (LR) and row right from the cultivated row (RR) are summarised in Table 2. The results emphasise that the relation between the arm length and the distance between the rows, which under field condition should be constant and depends on the accuracy of the used GPS system or skilfulness of the tractor driver, affects the size of the unaffected space. For the equal size of the arm length and distance between the neighbouring rows, the unaffected space is smaller at the height higher than 200 mm in the rows left and right from the cultivated row in relation to the cultivated row. Thus, by applying of the weeding tool in field with plants higher than 200 mm the length of the arms needs to be adequately chosen. Up to 100 mm height, the weeding tool with arm length equal to the distance between the rows has no significant influence on the size of the unaffected space around the plants in the rows left and right from the cultivated row. By direct comparison of the strategy II and strategy III, it is obvious that the optimisation of arm angular position provides bigger unaffected space around the plant up to 200 mm height, for the almost equal cultivation strip width. This confirms the hypothesis of the positive effect of the angular adjustment of the arms by the cultivation of plants with broad foliage system. Similar results can be achieved by cultivation strategies with three consecutive trajectories between two adjacent crop plants.

Table 2

Estimated size of the unaffected space around the crop plant in the cultivated row, the row left and the row right from the cultivated row.

	Position of the row - height, (mm)	Unaffected space around the crop plant (mm)								
		Strategy I			Strategy II			Strategy III		
		CR	LR	RR	CR	LR	RR	CR	LR	RR
Measuring position	ØA (-20)	125	n.i.	n.i.	78	n.i.	n.i.	79	n.i.	n.i.
	ØB (0)	158	n.i.	n.i.	115	n.i.	n.i.	116	n.i.	n.i.
	ØC (50)	156	n.i.	n.i.	109	n.i.	n.i.	135	n.i.	n.i.
	ØD (100)	148	281	287	107	291	286	157	289	284
	ØE (150)	147	187	196	104	191	190	135	189	192
	ØF (200)	145	123	126	101	123	129	109	122	127
	ØG (250)	137	82	84	94	75	77	67	73	75
	ØH (300)	120	68	79	75	41	37	75	39	41

n.i. – No impact.

In the last paper the author anticipated that intelligent weeding would result in lower intra-row weed control than the non-intelligent tools, given that Robovator does not control weeds in the proximity of the transplants. However, there were no indications of that apart from with the torsion weeding in experiment 1. In fact, the intelligent weeder tended to control more weeds in cabbage in experiment 3 than the non-intelligent solutions despite weeds of a larger size at the time of intelligent weeding. The weeding mechanism of Robovator, although not tested, appears to be more about cutting (and partly uprooting) the weeds than covering them with soil typical of the tine-based weed harrow and the tine-like finger-weeder.

CONCLUSIONS

In-field trials demonstrated that the knife blade design in first papwe was effective in killing three weed species: red-root pigweed (A. retroflexus), purselane (P. oleracea) and black nightshade (S. nigrum). Video analysis showed that soil friction and shear forces did not visibly impair knife blade actuation between the intra-row and inter-row path states. The system successfully circumvented all 682 tomato plants in the study with no crop fatalities in trials conducted at continuous forward travel speeds of 0.8 km/h and 1.6 km/h. Knife path control was good, with a mean error of 0.8 cm in centring the actual uncultivated close-to-crop zone about the tomato main stem. The knife blade path errors at the intra-row to close-to-crop zone boundary appeared to be normally distributed with standard deviations of 1.75 cm and 3.28 cm when travelling at speeds of 0.8 km/h and 1.6 km/h, respectively. Maintenance of the size of the operator's selected close-to-crop zone size was within ±0.5 cm of the target size on average with a standard deviation of 0.94 cm at 0.8 km/h and 1.39 cm at 1.6 km/h.

Tests in second paper proved that angular adjustment of the arms (carriers of end effectors) cause change in the size of the cultivated area between the plants and change in the size of the unaffected space around the plants. With the optimal adjustment of the angular position h, equal size of the cultivated area between two adjacent plants and bigger unaffected space around the crop plant can be left in comparison to the weeding tool without angular adjustment. The P-controller used within the simulation showed satisfactory results concerning the position of the cultivated area between adjacent plants even when irregular in-row distances appeared. The system adaptability allows low level of plant damaging when appropriate detection of the plant centre position is applied. The concept of the intra-row weeding system has sufficient degrees of freedom and thus allows full adaptation to different plant intra-row distances and plant growth stages. Intelligent mechanical weed control capable of operating very close to each individual transplant would suffice in transplant cabbages and other crops which produce quickly expanding leaves that reach canopy closure relatively early.

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THE INFLUENCE OF NITROGEN AND PHOSPHORUS ON CERTAIN PHYSIOLOGICAL PROCESSES TOM THUMB
/
INFLUENȚA AZOTULUI ȘI FOSFORULUI ASUPRA UNOR PROCESE FIZIOLOGICE LA PORUMBUL TOM THUMB

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Keywords: *maize hybrid, irrigation system, azotes and phosphorus, photosynthesis process*

ABSTRACT

Through this paper, the authors enumerates several physiological processes that take place at the Tom Thumb a corn hybrid and the interaction between the hybrid in the irrigated and un-irrigated culture, as well as the appliance of NP fertilizers. To obtain performances at this type of corn culture, soil analyses were made before the establishment of experimental parcels and it was aimed the moment when the corn plants had already formed eight leaves to emphasize the results better. The determinations and the laboratory analyses emphasizes the most important physiological processes from plant life, where the water and fertilizer dosages had a crucial role in obtain of positive results.

REZUMAT

Prin prezenta lucrare, autorii enumeră unele procese fiziologice care au loc la hibridul de porumb Tom Thumb, și interacțiunea dintre hibrid în cultură irigată și neirigată, precum și aplicarea de îngrășăminte de NP. Pentru obținerea de performanță la această cultură de porumb, înainte de înființarea loturilor experimentale, au fost efectuate analize de sol și s-a urmărit pentru evidențierea rezultatelor cât mai bine în momentul în care plantele de porumb aveau deja formate opt frunze. Determinările și analizele de laborator au evidențiat procesele fiziologice cele mai importante din viața plantei și dozele de îngrășăminte aplicate care au rol hotărâtor în obținerea de rezultate pozitive.

INTRODUCTION

The maize is a very important cereal grain of phytotechnical particularities: good resistance to drought and heat, adaptability to different climatic conditions, relatively small number of diseases and pests, is a good precursory for many plants, a good capitalization of organic and mineral fertilizers (*Pandia and Saracin, 2013*).

Within Oltenia region, corn occupies the first place among the field crops the use of heterosis has determined a true revolution in corn cropping technology, countries which are great corn providers, among them, Romania, use only hybrids *(Bonea and Urechean, 2015).* Continuing underestimation of the soil, as it does not bring an immediate profit and the effects of its degradation are felt slower than the degradation of water and air, is a serious concern not only for Romania, but also for the whole contemporary society (*Munteanu I., 2006*).

Since the 1962's, the effect of different types of nitrogen fertilizers, complex fertilizers, organo-mineral fertilizers and slow release of nitrogen has been studied on the production of wheat, maize, sunflower and sugar beet, the results demonstrating that no differences in production between assortments, to the equivalent of the active substance (*Coculescu et al., 1968; Hera et al., 1978*). Culture plants react differently to fertilizer application. Thus, wheat has harvested nitrogen and phosphorus fertilizers better than corn in both the first and subsequent years of application (*Saracin et al., 2013*).

Corn, sugar beet, potato and sunflower are highly potassium-consuming, and react better to the application of potassium fertilizers, to nitrogen and phosphorus agglomerates.

In addition to the direct effect of increasing the production of maize produced by the separate application of fertilizers with a certain element, an important role has the interaction between them when applied together (*Pandia Olimpia, Saracin Ion, 2015*). The combined influence of cultivar and crop technology (application of irrigation and administration of appropriate fertilizer doses) leads to changes in the main physiological processes that can lead to optimization of technologies in order to obtain maximum yields at doses of rationally applied fertilizers (*Pandia O., 2006; Saracin I., 2010*).

Generally speaking, it is necessary to know the specific problems that may arise in different geographical areas due to the soil and climate conditions, the biological particularities of the cultivated plants, as well as the cultivation technologies used (*Saracin et al., 2010).*

MATERIAL AND METHOD

The study was performed using a Tom Thumb a maize hybrid, when the 8 full-grown leaves became visible and this hybrid was cultivated in the north-western part of Olt District, at Plesoi, on chernozem, and both irrigated and non-irrigated systems were a used, after a precursory wheat culture in 2017, and physiological analysis were performed in order to point out the changes of the chemical composition of plants when applying different dosage of NP. Analysis were performed by using variants disposed in four repetitions having as an example one row graduated multi-staged plots of land method. The sowed area of the variant is of 22.4 m² and its density is of 50,000 plants/hectare. Analyses of soil were effectuated at 0-25 cm and 23-34 cm. depth.

The experiment has in view two important factors:

Factor **A**: irrigating system

B1 – irrigated

B2 – non-irrigated

Factor **B**: applying the dosage of fertilizer

RESULTS

Establishing an optimum fertilization system which positive influences the quantity and the quality of the culture and which implies an improving of the soil fertility potential represents an important way of increasing the economic efficiency. The influence of chemical fertilizers upon the maize culture is related to physiological processes which take place at a plant level in certain moments of its growth.

Table 1

Chemical properties of the argic chernosiomus from the Plesoi-Olt

Genetic level	Depth [cm]	pH value [H_2O]	S.B. [m.e/100g]	S.H. [m.e]	Humus [%]	N total [%]	P [p.p.m]	K [p.p.m]
Ap I	0-25	7.02	24.37	3.43	2.78	0.141	22.7	166.8
Ap1	0-25	7.03	24.39	3.47	2.77	0.143	22.9	166.5
Ap2	0-25	7.01	24.36	3.45	2.77	0.142	22.7	166.7
Ap3	0-25	7.02	24.38	3.43	2.76	0.141	22.8	166.5
Ap II	25-34	7.19	26.85	2.32	29.18	0.133	28.2	172.9
Ap1	25-34	7.16	26.84	2.34	29.19	0.135	28.2	172.7
Ap2	25-34	7.18	26.85	2.31	29.18	0.133	28.4	172.8
Ap3	25-34	7.19	26.86	2.33	29.17	0.134	28.3	172.8

Within the experimental filed an important moment was followed, respective the 8 full- grown leaves phase, and lab tests were kept in order to perform physiological determinations.

Table 2

Influence of the nitrogen and phosphorous on some physiological processes of the crop hybrid Tom Thumb - 20 June non irrigated system 2017

Variant	Photosynthesis [$mgCO_2$/ cm^2]	Respiration [$mgCO_2$/ 100g. m.v.]	Absorption capacity [g /apă]	Suction force [atm]	Chlorophyll pigments			
					Chlorophyll A [mg/dm^2]	Chlorophyll B [mg/dm^2]	Carotene [mg/dm^2]	Total [mg/dm^2]
N_0P_0	228.6	183.6	5.89	4.1	0.363	0.168	0.199	0.728
$N_{60}P_{40}$	253.5	189.8	5.94	4.2	0.369	0.173	0.21	0.75
$N_{80}P_{60}$	256.6	201.4	5.87	4.13	0.368	0.175	0.205	0.746
$N_{100}P_{80}$	260.9	210.5	6.03	4.13	0.372	0174	0.202	0.746
$N_{120}P_{100}$	253.5	206.6	5.95	417	0.377	0.172	0.207	0.753

Table 3

Influence of the nitrogen and phosphorous on some physiological processes of the crop hybrid Tom Thumb - 20 June irrigated system 2017

Variant	Photosynthesis [$mgCO_2/cm^2$]	Respiration [$mgCO_2$/ 100g. m.v.]	Absorption capacity [g /apă]	Suction force [atm]	Chlorophyll pigments			
					Chlorophyll A [mg/dm^2]	Chlorophyll B [mg/dm^2]	Carotene [mg/dm^2]	Total [mg/dm^2]
N_0P_0	239.8	186.6	6.03	4.1	0.376	0.177	0.212	0.763
$N_{60}P_{40}$	262.5	192.4	6.11	4.19	0.39	0.179	0.219	0.777
$N_{80}P_{60}$	268.4	205.5	6.22	4.3	0.387	0.182	0.23	0.788
$N_{100}P_{80}$	270.6	215.8	6.16	4.3	0.389	0.188	0.228	0.803
$N_{120}P_{100}$	276.9	220.5	6.24	4.27	0.378	0.186	0.225	0.789

After lab determinations of physiological processes which took place in the case of this hybrid in two different systems and after applying different doses of fertilizers, the results were also graphically represented. The chlorophyll pigments represented by ‘a’ and ‘b’ chlorophyll and carotene are very influenced by irrigated variants compared to non-irrigated ones.

An increase of the content of chlorophyll ‘a’ in the case of the irrigated system is noticeable, no matter what dose of fertilizer was applied, significant values are observed when applying $N_{100}P_{80}$ and $N_{120}P_{100}$.

Chlorophyll ‘b’ has values that have a weak fluctuation no matter what dose of fertilizers was applied, an import factor in this case is the irrigating the area which led to a significant increase of this assimilative pigment.

The content of carotene has significant values towards the control, compared to variants where fertilizers were applied. Irrigating, when applying $N_{100}P_{80}$ and $N_{120}P_{100}$, led to an important increase of this pigment. Combined irrigation and applying moderate dose of fertilizers ($N_{100}P_{80}$) led to a maximum carotene quantity.

The evolution of photosynthesis expressed by mg. CO/dm^2 that was determined in the first moment, that is the 8 full-grown leaves, has an important increase when comparing the non-irrigated and the irrigated variants, and also within the same variant.

Thus, a 20% increase of the photosynthesis intensity towards the control in the case of irrigated variant towards the non-irrigated control is noticeable.

The optimum dose, as it is noticed, was recorded in the case of the irrigated variant, when using $N_{120}P_{100}$, compared to the non-irrigated variant where better results were obtained when applying a dose of $N_{100}P_{80}$.

Regarding the respiration process, expressed as mg CO_2/100 g.m.v., significant values on June, 20 are ascertain within the irrigated system as well as the non-irrigated system as well, the quantity of eliminated CO_2 being significant in the case of the studied variant.

The capacity of absorption, g/H_2O, has minimum values in the case of non-irrigated variants, excepting the $N_{100}P_{80}$ variant which has the highest value, that is 6.03 g/H_2O.

Within the irrigated variants, the difference is important and it is static assured once the content of fertilizer in the case of $N_{120}P_{100}$ variant increases.

The suction force, expressed as atmospheres, has a tendency of slow increase in the case of the first non-irrigated variants, after which it starts to increase and it reaches from 4,1 to 4.17 atmospheres. In the case of variants where irrigation was applied, the most evident suction force was registered when applying a $N_{120}P_{100}$ dose.

CONCLUSIONS

The combined influence between hybrid and culture technology (irrigation and applying the right dose of fertilizers) determines modifications of the main physiological processes which lead to obtaining maximum production when rationally applying dose of fertilizers.

The studied hybrid acted differently from the culture technology point of view, the registered values from the physiological point of view were different, each of them using the right quantity of fertilizer.

The effects of simultaneously applying variable doses of fertilizers and irrigation were studied and its effect upon the main physiological processes which depend on them.

All analyzed physiological processes lead us to the conclusion that the Tom Thumb hybrid has a high physiologic and biochemical potential, and the acquired information situates it among the most productive hybrids that have been studied.

The combined influence of culture system (irrigated non-irrigated) as well as the applied doses of fertilizers determined, from the quantitative point of view, remarkable differences in the case of all qualitative features of the Tom Thumb hybrid.

We highly recommend the Tom Thumb hybrid for production, when using an irrigated system and applying a maximum dose of $N_{120}P_{100}$ and $N_{100}P_{80}$ for an economic efficiency.

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PHARMACEUTICAL PRODUCTS REMOVAL FROM WASTEWATER
/
ELIMINAREA PRODUSELOR FARMACEUTICE DIN APA UZATĂ

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Keywords: *pharmaceuticals, pollution, wastewater, nanoadsorbents*

ABSTRACT

The chemical pollution of water resources with pharmaceuticals is a major challenge facing the humanity in this century. The purpose of this paper was to reviewed methods for removing pharmaceutical products pollutants from wastewater. To assess the efficiency of pharmaceuticals removal from wastewater were presented several methods for removing these residues of drugs. These methods were adsorption on different adsorbent materials, photodegradation and removal during sludge treatment. Among other methods, the adsorption method in the presence of nanoadsorbants is supposed to be one of the best because of its important characteristics. This is due to the remarkable capacity of nanoadsorbants to adsorb a variety of pollutants. Researchers have a special interest in depollution wastewater from the pharmaceutical industry due of their impact on the environment. Water pollution due to drug and pharmaceutical residues is an alarming issue. It is due to the fact that these residues affect human beings and as a result of the degeneration of their biological activities can lead to enzymatic, hormonal and genetic disorders. Pharmaceutical products are widely used in human and veterinary medicine and are present in various samples of water, they can be removed or discharged directly into the domestic wastewater. Moreover, wastewater treatment plants due to insufficient technology to remove these pollutants do not eliminate most pharmaceuticals. Non-eliminated pharmaceutical products get into the groundwater and could be harmful to aquatic organisms even when are present at low concentrations (ng·L-1). Nanomaterials are widely explored as highly efficient adsorbents, photocatalyst and disinfectants for wastewater treatment. Generally, they exhibited various advantages, such as high adsorption capacity, fast kinetics, specific affinity towards targeted pollutants, enhanced photocatalytic response for a broad light spectrum, and strong anti-bacterial activity. The conventional treatment techniques inefficiency for removal pharmaceuticals from wastewater suggests that more attention should be given to for the finding the new treatment processes in order to avoid environmental pollution.

REZUMAT

Poluarea chimică a resurselor de apă cu produse farmaceutice este o provocare majoră cu care se confruntă omenirea în acest secol. Scopul acestei lucrări este de a prezenta cateva metode pentru îndepartarea poluanţilor din apele uzate provenite din industria farmaceutică. Pentru evaluarea randamentului de eliminare a produselor farmaceutice din apa uzată au fost prezentate mai multe metode de îndepartare a acestor reziduri de medicamente. Aceste metode au fost adsorbţia pe diferite materiale adsorbante, fotodegradarea şi îndepartarea în timpul tratării namolului. Datorită caracteristicilor sale importante, metoda de adsorbţie în prezenţa nanoadsorbanţilor se presupune a fi una din cele mai bune metode. Acest lucru se datorează capacității remarcabile de adsorbţie a diverşilor poluanţi de către nanoadsorbanţi. Cercetătorii acordă un interes deosebit depoluării apelor uzate provenite din industria farmaceutică datorită impactului acestora asupra mediului înconjurător. Poluarea apei cu reziduuri provenite din industria farmaceutică este un subiect important. Aceste reziduuri afectează organismele umane și ca urmare a degenerarii activităților lor biologice pot conduce la boli enzimatice, hormonale şi tulburari genetice. Produsele farmaceutice sunt utilizate pe scară largă în medicina umană și veterinară și sunt prezente în diferite probe de apă, ele putand fi eliminate sau deversate direct în apele uzate menajere. Mai mult, cele mai multe produse farmaceutice nu sunt eliminate de staţiile de epurare a apelor uzate oraşeneşti datorită tehnologiei insuficiente de a elimina aceşti poluanţi. Produsele farmaceutice neeliminate ajung în apele subterane și ar putea fi dăunătoare pentru organismele acvatice chiar și atunci când sunt prezente în concentrații scăzute de ordinul nanogramelor (ng.L-1). Nanomaterialele sunt cercetate pe scară largă ca adsorbanți de mare eficiență, fotocatalizatori și agenti de dezinfectantare pentru epurarea apelor reziduale. În general au diferite avantaje,

cum ar fi capacitatea ridicată de adsorbţie, cinetica de reacţie rapidă, afinitate specifică faţă de anumiţi poluanţi, activitatea anti-bacteriană puternică şi raspunsul fotocatalitic intensificat pentru un spectru larg de lumină. Tehnicile de epurare conventionale ineficiente pentru eliminarea produselor farmaceutice din apa uzată sugerează că ar trebui acordată mai multă atenție gasirii unor noi proceduri de tratament, pentru a evita poluarea mediului înconjurător cu acesti poluanţi.

INTRODUCTION

Currently literature shows that pharmaceuticals are releasing continuously into the environment in extremely large amounts from various sources such as pharmaceutical industry (waste and wastewater from hospitals), consumption by humans (95% of the dose can be excreted or discharged directly into domestic wastewater), the use of veterinary medicines (*Farre et. al. 2007, Hong et al. 2007, Imran et al, 2016, Renou et al, 2008*).

Due to the fact that the pharmaceutical products are easily dissolved in aqueous media and do not usually evaporate at normal temperatures or pressures, they can accumulate in the soil and aquatic environments through sewage, treated sludge and irrigation with wastewater not properly treated. Current research findings clearly demonstrate that current wastewater treatment technologies do not sufficiently remove pharmaceuticals and/or their metabolites and by-products of degradation from wastewater and therefore allow them to enter into surface water, underground water and soil (*Kulikowska D. 2008*).

Although some pharmaceuticals degrade after consumption or release into the environment, most of them remain unchanged and eventually become persistent in the environment. It is known that most of these chemicals remain bioactive even at extremely low concentrations after excretion from the body or after getting into the landfills and water, have unpredictable biochemical interactions when mixed and may tend to accumulate in the food chain with a negative impact on aquatic organisms and on consumers. As a result, pharmaceuticals, metabolites and their degradation products are of concern for their potential environmental effects (*Cilek et al 2016*).

Recent literature indicates that the flow of pharmaceuticals from municipal wastewater treatment plants is an important source of chemical pollution in surface water and seawater (*Debska et. al. 2004*).

Although the reported concentrations of individually reported pharmaceuticals worldwide are low and is not sure that can cause any danger to human health, exposure to a mixture of such compounds can disrupt the human body's balance, increase antibiotic resistance and pose a threat to the health of living organisms.

Some of the potential effects reported on living organisms were: delayed development of fish and frogs, delayed frog metamorphosis, increased feminization of fish populations and a variety of reactions, including modified behavior and reproduction (*Shraim et. al. 2017, Escher et. al. 2011*).

MATERIAL AND METHOD

Photodegradation

Photocatalysts, particularly those with high stability and activity have been regarded as suitable materials for applications in energy and the treatment of pollutants (*Zhang et. al 2018*). Numerous photocatalysts, such as Bi-based photocatalysts, doped TiO_2, Bi_2O_3, Bi_2WO_6, $BiVO_4$ and BiOX have been employed for the photocatalytic degradation of organics in wastewater or the ambient atmosphere (*Zhang et. al 2018*).

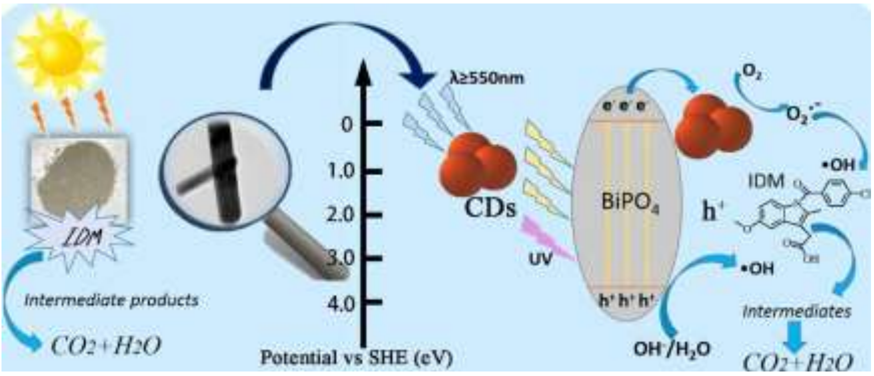

Fig. 1 - Proposed photocatalytic degradation pathways of indomethacin (IDM) under simulated sunlight irradiation with 3.0 wt% CDBP (novel carbon dots/$BiPO_4$) composites (*Zhang Q. et. al, 2018*).

Recently, pharmaceutical and personal care products have emerged as pollutants in ambient aquatic environments, which have attracted increasing concern, due to their potentially hazardous effects on ecosystems and humans (*Escher B.I., 2011*). Because of their stable chemical structures, and thus, they have detected in urban wastewater cycles, and even in drinking water. Some pharmaceuticals have been suspected of directly imparting toxicity to certain aquatic organisms (*Rosal et. al. 2010*)

Several pharmaceutical compounds have been shown to degrade due to the action of sunlight. The most extensively studied of these compounds is the analgesic/anti-inflammatory drug diclofenac, which has been shown to degrade in the aquatic environment due to ultraviolet (UV) light. Other compounds such as the topical antimycotic drugs naftifine, sulbentine, cloxiquin, tolnaftate, and chlorphenesin have also been shown to be light sensitive and an overall elimination rate of 0.03 day−1 due to photochemical degradation was observed for triclosan in the epilimnion of Lake Greifensee by *Jones et. al. (2005)*.

Jones et. al. assessed the biodegradability of the clinically important antibiotics cefotiam, ciprofloxacin, meropenem, penicillin G, and sulfamethoxazole using the closed bottle test (CBT). None of the test compounds met the criteria for ready biodegradability. Of all the compounds studied, only penicillin G was found to be biodegradable to some degree, with approximately 27% being removed after 28 days. Even when the test was prolonged to 40 days, the removal rate was only increased to 35% indicating the compound was relatively stable (*Jones et. al. 2005*).

RESULTS

Adsorption

In the field of wastewater treatment, nanotechnology exhibited great potential in improving the performance and efficiency of water depollution as well as providing a sustainable approach to secure water supply.

Until now, numerous studies have shown that nanomaterials have vast capability and potential in water, in particular, in the areas of adsorption membrane process 2011), catalytic oxidation (disinfection and sensing (*Zhang et. al. 2016*).

Adsorbents or membrane based separation process are two most widely used technology for treatment of water and wastewater. Conventional adsorbents often face challenges such as low capacity and selectivity as well as the short adsorption-regeneration cycle, which significantly reduced the cost effectiveness of the adsorbants. Nanomaterial based adsorbants, i.e., nanosized metal or metal oxides, carbon nanotubes (CNTs), graphene and nanocomposites, often feature large specific area, high reactivity, fast kinetics and specific affinity to various pollutants. Their adsorptive performance towards certain pollutants is sometimes several magnitude higher than conventional adsorbents. Besides adsorption, membrane separation is also a key module in the treatment stage, enabling water reclamation from unconventional water sources such as municipal wastewater (*Zhang et. al. 2016*). Nanocatalysts of high surface-to-volume ratio showed significantly enhanced catalysis performance over their bulk counterparts.

Additionally, the band gap and crystalline structure of the nanosized semiconductors exhibited size-dependent behavior. Their electron hole redox potential and photo-generated charge distribution varied with varying sizes (*Zhang et. al. 2016*).

Separating and recovering nanomaterials from water after reaction has long been a technical bottleneck to overcome. Magnetic nanosized iron oxide adsorbants offered a viable and convenient solution by utilizing an external magnetic field (*Hua et al., 2012*). Another important magnetic adsorbent is nanosized magnetite considering its low cost, simple manipulation and environment-friendly properties.

Nanosized manganese oxides (NMnOs) exhibited superior adsorptive performance towards certain pollutants than other metal oxides because of its polymorphic structures and higher specific area (*Tesh et al., 2014*).

Removal during sludge treatment

Many pharmaceuticals are not thermally stable and so might be expected to break down during processes such as composting due to heat (as well as chemical and biodegradation). Guerin investigated soil composting as an alternative to incineration for the treatment of a silty clay soil that had become polluted with residues of Probenecid (an antigout drug) and Methaqualone (a barbiturate substitute no longer available due to harmful side effects). In pilot scale trials, Probenecid was reduced from 5100 mg kg^{-1} to <10 mg kg^{-1} within 20 weeks during mesophilic treatments. The study also confirmed that thermophilic composting was effective under field conditions (*Guerin T.F, 2001*).

CONCLUSIONS

The results sustain further research on this subject of interest by investigating different types of pharmaceutical products with some removal techniques. Pharmaceuticals are used in large amounts in human medicine and reach the aquatic environment mainly through sewage treatment systems, where their concentrations can reach micrograms per liter levels. There is little experimental evidence showing levels of pharmaceutical compounds in sewage effluent or sludge and even less showing they should be of concern. However, their biological activity alone may support ecotoxicity assessments of chemicals with high production volumes, especially in view of the increasing importance of freshwater resources and use of drug compounds.

Nanomaterials are widely explored as highly efficient adsorbents, photocatalyst and disinfectants for water treatment. Generally, they exhibited various merits, such as high capacity, fast kinetics, specific affinity towards targeted pollutants, enhanced photocatalytic response for a broad light spectrum, and strong anti-bacterial activity. They are arguably the most promising candidate for the development of next generation wastewater treatment technology. In this paper we presented three removal techniques for pharmaceutical products from wastewater. The most promising technique is the adsorption of pharmaceutical products onto nano adsorbants. Despite the increasing research activities in this field, there is still a considerable need for future work and further investigation in order to assess the significance of pharmaceutical products in terms of their persistence and potential.

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WATER DEPOLLUTION USING *TYPHA ANGUSTIFOLIA* / *EPURAREA APEI CU TYPHA ANGUSTIFOLIA*

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Keywords: phytoremediation, copper, nickel, typha angustifolia

ABSTRACT

Nowadays, heavy metals are a real problem for the environment and the human health. It's important to find different ways to deal with this problem. Phytoremediation is one of the possible methods. The aim of this research was to reviewed methods for removing copper and nickel pollutants from wastewater. To assess the efficiency of removal of copper and nickel were presented several methods for removing these pollutants through rush plant. Typha angustifolia is an aquatic macrophyte presented in this study for determination of its capacity to remove copper (Cu^{+2}) and nickel (Ni^{2+}) from wastewater. From literature it has been noted that 95% of copper, 80% of nickel was remove with Typha angustifolia in the wastewater having concentration of 0.01 mole/ L. It is noted that 92% of the pollutants have been removed from wastewater, in the experiment with the two combined heavy metals in a concentration of 0.002 M.

REZUMAT

In prezent metale grele sunt o reală problemă pentru mediu și sănătatea umană. Este important să se găsească diferite metode de a rezolva aceasta problemă. Fitoremedierea este una dintre posibilele metode. Scopul acestei lucrari a fost de a prezenta cateva materiale adsorbante pentru îndepartarea poluanţilor nichel şi cupru din apele uzate.

Pentru a evalua eficiența de îndepartare a cuprului și nichelului cu ajutorul papurei au fost prezentate mai multe metode. Typha angustifolia este un macrofit acvatic prezentat în acest studiu pentru determinarea capacității sale de a elimina cuprul (Cu^{+2}) și nichelul (Ni^{+2}) din apele uzate. In literatura de specialitate se mentioneaza că 95% din cupru si 80% nichel din apele uzate cu concentrație de 0,01 mol / L, au fost indepartate cu Typha angustifolia. Se mentioneaza ca 92% din acesti poluanţi au fost eliminaţi din apele uzate, pentru o concentraţie a ambelor metale de 0,002 M.

INTRODUCTION

Nowadays, wastewater contains many pollutants because of the industries production. There are different kinds of pollutants like pesticide (*Tripathy et. al. 2014)*, insecticide (*Romeh,* 2014) or heavy metal. In this study, we focused on heavy metals which are among the most toxic pollutants, more particularly on the copper and nickel. Even though copper is a crucial component for the growth of plants and also a benefic metal for human in small concentration, high concentrations of it have bad effects on human health and on plants growth. Enzymatic activities, photosynthesis or respiratory processes can be deteriorated *(Monferrán et al. 2011*).

Phytoremediation techniques

Different methods to remove these pollutants from wastewater exist. The problem with these methods is the cost to realize them. Moreover, these techniques have some disadvantages like high-energy requirements, incomplete removal or production of toxic sludge *(Priyanka et. al. 2016*). Then comes the phytoremediation technique which is eco-friendly and cheaper. Phytoremediation consist in using plants to remove pollutants and treatment of wastewater or soil. There are several kinds of phytoremediation techniques like phytoextraction, phytodegradation, phytovolatization, rhizofiltration and phytostabilization (*Priyanka et. al. 2017*).

Phytoextraction is a subprocess of phytoremediation in which plants remove dangerous elements or compounds from soil or water, most usually heavy metals, metals that have a high density and may be toxic to organisms even at relatively low concentrations (*Priyanka et. al. 2017*).

Phytodegradation which is also known as phyto-transformation is the breakdown of contaminants taken up by plants through metabolic processes within the plant, or the breakdown of contaminants surrounding the plant through the effect of enzymes produced by the plants.

Phytovolatilization is a process, in which plants take up pollutants from soil and release them as volatile form into the atmosphere through transpiration. The process occurs as growing plants absorb water and organic contaminants (*Priyanka et. al. 2017*).

Rhizofiltration is a type of phytoremediation, which refers to the approach of using hydroponically cultivated plant roots to remediate contaminated water through absorption, concentration, and precipitation of pollutants (*Priyanka et. al. 2017, Galal M et. al. 2018)*.

Phytostabilization involves the reduction of the mobility of heavy metals in soil. Immobilization of metals can be accomplished by decreasing wind-blown dust, minimizing soil erosion, and reducing contaminant solubility or bioavailability to the food chain.

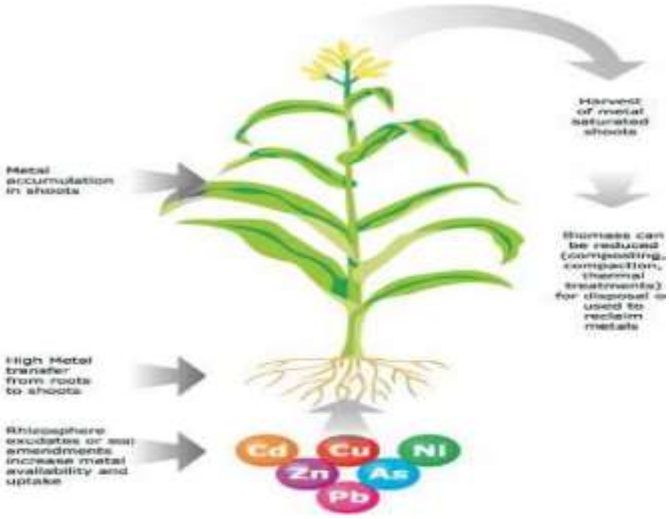

Fig. 1 - Schematic representation of the processes involved in the phytoextraction of metals from soils

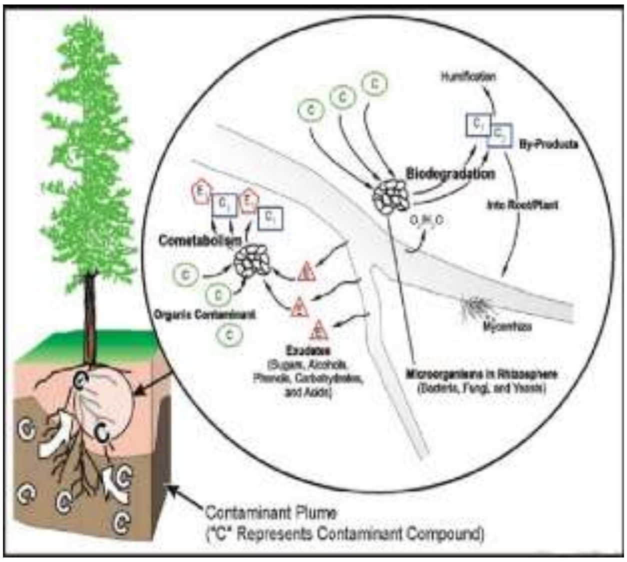

Fig. 2 - Schematic representation of the processes involved in the phytodegradation of metals from soils

Many kinds of plant can be used to make phytoremediation like *Eichhornia crassipes* (Priyanka et. al. 2017), *Azolla Filiculoides* (*Galal T.M, et al. 2018*), P*otamogeton Pusillus* (Priy*anka, et. al 2016*), *Pistia stratiotes* (*Ugya et. al. 2015*), *Spirodela polyrhiza* (*Gini et al. 2017*) or *Salvinia molesta* (*Yin et al. 2016*). In this study, we presented *Typha angustifolia* a plant of the Typha genus integrating the Typhaceae family. This family is characterize by these leaves which are long, strap-like, spongy. Plants fruit look like a cylindrical, brown spike. Typhaceae family grow in wetlands and need sunlight and fluctuating temperature to grow up (*Abubakar M. M., et al 2014*). *Typha angustifolia* plant is a perennial plant can reach 1-2 meters high with a sturdy stem. Its leaves are 4 to 8 mm wide and have a spur separated by a 1-4 cm long space. This plant grows particulary in ponds and rivers and flowered on June and July.

Fig. 3 - Typha angustifolia plant («Typha angustifolia | Online Atlas of the British and Irish Flora» s.d.)

Some experiments have already be done using plant of Typha genus. The first one, used different plant including *Typha latifolia* to observed the capacity of these plants to remove copper, cadmium, arsenic or lead from industrial effluent. This article showed the best plant between Typha latifolia, Eichhornia crassipes, Salvinia molesta and Pistia stratiotes to removed arsenic, copper and cadmium was *Typha latifolia* with a bio concentration factor (BCF) greater than the other plants (*Sukumaran 2013*).

A second experiment used *Typha latifolia* to observe the capacity of the different parts of plant to remove chromium from wastewater. Firstly, this experiment show, *Typha latifolia,* remove chromium from the wastewater with a concentration of this heavy metal which is decreasing with time. This concentration passed globally to 9 mg/L after 48 hours to 3 mg/L after 164 hours. Secondly, the results showed that the roots remove more chromium that stems and leaves (*Nithiyanantham et al. 2018*).

About *Typha angustifolia*, an experiment has already been done to observe the accumulation of Cd, Cr, Cu, Fe, Ni, Pb and Zn through this plant. The conclusion of this research is that roots have a better bioaccumulation capacity for each pollutant than stems and leaves. Moreover, roots retire more Fe than other heavy metals. *Typha angustifolia* removes more Fe^{3+} with roots compared to other heavy metals (*Ugya AY et. al. 2015*).

Another experiment have be done with *Typha angustifolia* to remove copper ions from wastewater. In this experiment, result showed the plant remove 78% of copper with a concentration of 0.002 mole/L after 119 hours (*Cristescu et al. 2018*).

CONCLUSIONS

From literature data it can be said that *Typha angustifolia* plant is efficient to remove heavy metals from wastewater. Some experiments were done to observed the capacity of removing copper, cadmium, arsenic, chromium, iron, nichel, zinc or lead from industrial effluent. It was observed that the roots have a better bioaccumulation capacity for each pollutant than stems and leaves. Moreover, roots retire more Fe than other heavy metals.

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NANOMATERIALS USED IN TREATMENT OF WASTEWATER: A REVIEW
/
NANOMATERIALE UTILIZATE ÎN EPURAREA APELOR

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Keywords: *wastewater treatment, nanotechonoly, carbon nanotubes*

ABSTRACT
This paperwork presents the difference between traditional methods of wastewater treatment and nanotechnology. The advantages of using nanomaterials are highlighted in relation to the environmental impact, implementation costs and performance of those nanomaterials.

REZUMAT
Această lucrare prezintă diferența dintre metodele tradiționale de epurare a apelor reziduale și nanotehnologia. Avantajele utilizării nanomaterialelor sunt evidențiate în ceea ce privește impactul asupra mediului, costurile de implementare și performanța acestor nanomateriale.

INTRODUCTION
One of the major problem that we are facing today is water pollution. Water pollution affect environment and human health so we have varied methods to fight it. One of the advanced method is nanotehnology because nanoparticles have very high absorption capabilities and can act in depth and any location. With a very small size, nanomaterials (NMs) can achieve energy conservation that can lead to cost savings (*Deepa Madathil et al., 2013*).

Traditional techniques are generally effective (extraction, adsorption and chemical oxidation), but often very expensive. It is very important to be able to reduce toxic levels of pollutants in an efficient way, at reasonable cost. That is why intensive research is being done on nanotechnologies (*Fact sheet*, *2009*). Since the use of nanoparticles in water treatment requires high technology, the cost of using this method should be depending on the competition existing on the market (*Crane et al., 2012*). Research has been done using different nanomaterials (nanosorbent, nanocatalyst, bioactive nanoparticles, biomimetic membrane and molecular polymers MIPs) to remove toxic metal ions, organic and inorganic solvents from water.

Nanotechnology is applied to treat wastewater to detect and remove various pollutants. By applying various methods such as photocatalysis, nanofiltration, adsorption and electrochemical oxidation using TiO_2, ZnO, ceramic membranes, nanowire membranes, polymer membranes, carbon nanotubes, metal oxides, magnetic nanoparticles, water quality problems are reduced (*Karisma et al., 2015*). Nanotechnology promises an immense improvement in manufacturing technologies, electronics, telecommunications, health and even environmental remediation (*Gross, 2001; Kim et al., 2005; Moore, 2006*). It requires the production and usage of a vaste range of NMs, including structures and devices that have the size ranging from 1 to 100 nm and presents unique properties not found in traditional method materials (*Stone et al., 2010; Wang et al., 2010*). Several types of nanomaterials, such as carbon nanotubes (*Mauter and Elimelech, 2008; Upadhyayula et al., 2009)* and TiO_2 NMs (*Khan et al., 2002; Shankar et al., 2009*), have been hard studied and very reviewed.

Nanoadsorbents have a high affinity for adsorption of substances. Having properties such as high porosity, small size and active surface, nanoadsorbents have the ability to retain pollutants with variable molecular size, hydrophobicity and speculation behavior (*Pacheco et al., 2006*). Nanoadsorbents have the advantage of working fast, have pollutant binding capabilities and can be chemically regenerated after exhaustion (*Yang et al., 2007*).

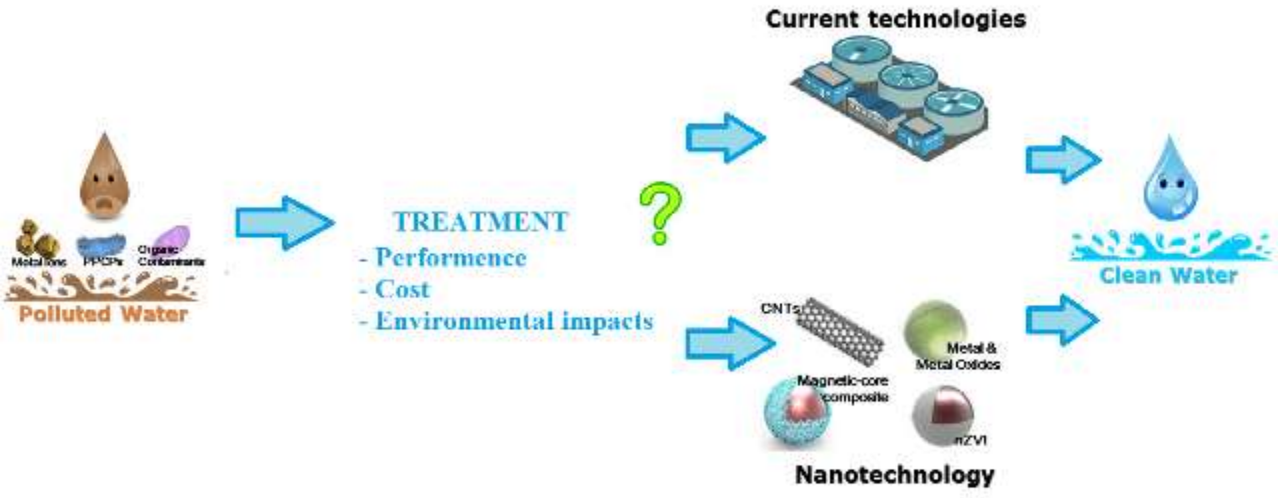

Fig. 1 - Current technologies or nanotechnology application for water treatment *(Adeyemi et al., 2016)*

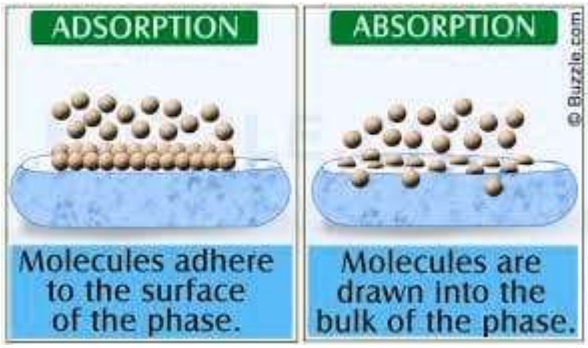

Fig. 2 - Difference between adsorption and absorption *(Komal Mehta et al., 2018)*

MATERIAL AND METHOD

Zeolites

One of the oldest and important wastewater treatment is the use of natural zeolites in the areas of their application. A major environmental problem is the appearance of heavy metals (Zn, Cr, Pb, Cd, Cu, Mn, Fe, etc.) in wastewater and their disposal by natural zeolites have been extremly studied side by side with other technologies. The main methods for heavy metals removal are chemical precipitation, ion exchange, adsorption, membrane filtration, coagulation flocculation, flotation and electrochemical methods (*Fu et al., 2011*). Nowadays, many studies are set on investigating natural zeolites as adsorbents in wastewater treatment and their properties. Multiple natural zeolites worldwide have shown good ion-exchange capacities for cations, such as ammonium and heavy metal ions. These natural zeolites can be modified by performing several methods, such as acid treatment, ion exchange, and surfactant functionalization. Those zeolites that were modifed showed high adsorption capacity also for organic matter and anions (*Wang et al., 2010*).

Properties of natural zeolites

Natural zeolites have complex and interesting structure. SiO_4 and AlO_4 tetrahedra are the primary building units (PBU) of zeolites. They connect via oxygen ions into secondary building units (SBU), which are then linked into a three-dimensional crystalline structure of zeolite. Si can be substitute by Al which defines the negative charge of the zeolite framework, which is compensated by alkaline and earth alkaline metal cations. Natural zeolites that have negative charge on the surface appear as cation exchangers. In the zeolite lattice, substitution is not limited to Si-Al substitution. Atoms of iron, boron, chromium, germanium, and titanium also can substitute silicon. We can find water molecules in voids of large cavities and chained to framework ions and exchangeable ions through aqueous ties. Clinoptilolite is the most researched zeolite in basic and applied studies. The fact that these materials are very porous with channels and cavities, that have characteristic pore sizes and shapes, represents the characteristic way of binding of PBUs and the formation of unique structural units. In the clinoptilolite structure are three types of channels, two are parallel, made of ten and eight-membered rings of Si/AlO_4, meanwhile the third one is vertical and defined by eight-membered rings. In these channels the places that the hydrated cations can occupy are: I - cation (Na- and Ca-ions) is situated in the 10-member ring channels (free diameters 0.44 x 0.72 nm); II - cation (Na- and Ca-ions) is situated in the 8-member ring channels (free diameters 0.41 x 0.47 nm); III - cation (K- ion) is situated in the 8-member ring vertical channels (free diameters 0.40 x 0.55 nm); IV - cation (Mg-ion) is situated in the channel of 10- member rings and it is situated in the center of the channel (Figure 3).

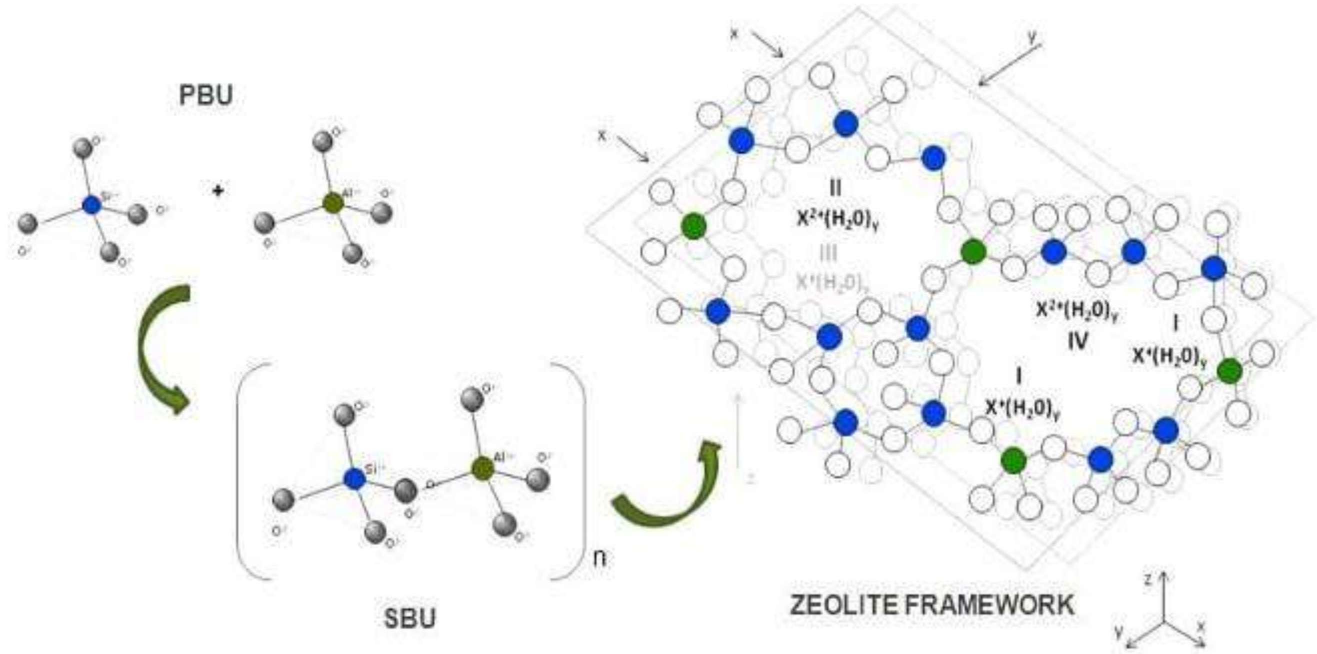

Fig. 3 - Primary building units PBU and secondary building units SBU in three-dimensional zeolite- clinoptilolite structure (*Karmen Margeta et al*.)

RESULTS

The high adsorption capacity and thermal stability is represented by carbon-based adsorbents including carbon, carbon nanotubes, fullerenes and graphene (*Santhosh et al., 2016*). From all the various adsorbing nanomaterials, carbon has been investigated as a superior adsorbent for the elimination of inorganic and organic pollutants. When carbon nanotubes (CNT) and fullerenes were discovered, these materials were widely used as effective adsorbents (*Yang et al., 2006*). Carbon nanotubes are composed of a cylindrical shape wrapped in a tube. Carbon nanotubes are two types, single-wall carbon nanotubes (SWCNTs) and multi-wall carbon nanotubes (MWCNTs), where single-wall carbon nanotubes are composed of a single sheet of rolled graphene, and multi-wall carbon nanotubes are composed of several sheets of rolled graphene. Figure 4 shows the structures of SWCNTs (a) and MWCNTs (b) (*Santhosh et al., 2016*). Carbon nanotubes have an exceptional adsorption capacity and high efficiency compared to the conventional method of using activated carbon (*Wang et al., 2008*).

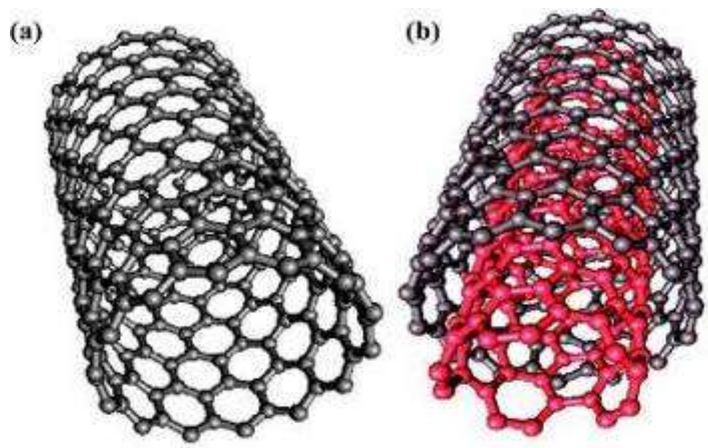

Fig. 4 - Structures of SWCNTs (a) and MWCNTs (b) *(Santhosh et al., 2016)*

Nanocatalysts

Due to their special characteristics, nanocatalysts are also very used in wastewater treatment because it enhances the catalytic activity at the surface. It increases the reactivity of contaminants. Semiconductor materials are the most used catalytic nanomaterials (zero-valence metal and bimetallic nanoparticles) for degradation of environmental contaminants such as PCBs (polychlorinated biphenyls), azo dyes, halogenated aliphatic, organochlorine pesticides, halogenated herbicides, and nitro aromatics (*Xin et al., 2011*). The catalytic activity has been showed in the laboratory for different pollutants.

Nanostructured catalytic membranes (ncms)

Nanostructured catalytic membranes are commonly used for wastewater treatment. It has several advantages such as high uniformity of catalytic sites, capability of optimization, limiting contact time of catalyst, allowing sequential reactions and ease in industrial scale up (Deepa Madathil *et al.,* 2013).

Bioactive nanoparticles

Water contamination is the main reason for lots of infectious diseases due to various contaminating pathogens. Many of the microorganisms acting as pathogens are highly resistant to antibiotics and this make them very hard to remove them from water. Recently the concept of bioactive nanoparticles has emerged which has given the alternative of new chlorine – free biocides (*Deepa Madathil et al., 2013*).

Biomimetic membrane for water treatment

Biomimetic membranes are a new and advanced way for wastewater treatment because of its specific design and fabrication. This method uses self-assembly and atomic layer deposition tuned nanopores which basically gives highflux desalination. Through this method impurities like salt and others are removed from water with applied pressure powered by electrical energy (*Deepa Madathil et al., 2013*).

Molecularly imprinted polymers (Mips)

Molecularly imprinted polymers is a new method that has emerged as one of very fine ways for various biological, pharmaceutical and environmental applications. The high selectivity of the polymers is due to its synthetic procedure where a template molecule is linked to suitable monomer(s) having functional groups by covalent, semi covalent or non-covalent bonds providing subsequent specific binding sites to the MIPs. The left imprint after the removal of template from polymer helps in recognizing properties of the MIP and are generally called binding sites (*Deepa Madathil et al., 2013*).

CONCLUSIONS

Great improvements have been made using nanotechnology for resolving water pollution problems, in the future it will have better advantages. Nanotechnology is an eco-friendly treatment that gives us a very efficient and durable approache. These methods are cheaper, less consuming for both time and energy and it has less waste generation than traditional based methods. Due to the usage of nanoparticles certain measures must be taken for human health and safety and for the environment.

Using nanomaterials should be easy implemented, cost effective and friendly. Mass commercialization of nanosorbents will be applied after 10 years of research. Certain criteria such as technical, economic and social challenges have to be defined for the success of good comercialization of nanomaterials.

The appearance of heavy metal ions and dyes in wastewater is a major problem for environment and human health. The disposal method of these ions has not reached the perfect conditions. Natural zeolites have been very studied, due to their unique properties, for heavy metals and dye disposal from wastewater because of their high surface area, low particles size which leads to high numbers of adsorption active centers.

Zeolites have their adsorption properties, high porosity and excellent thermal stability that makes them very appropriate for most applications, also in wastewater treatment. Many studies have showed that they are very good in removing the contaminants (heavy metals, anions and organic matter) from wastewater. Because of their surface binding of biological agents from water modified natural zeolites are more and more used for biological treatment of wastewater. Future studies can be focused on the improvement of the surface modification methods to increase their efficiency and to enlarge the capability of regeneration. Furthermore, detailed characterization of natural and modified zeolites is needed to better understand the structure-property relationship.

ACKNOWLEDGEMENT

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WASTEWATER TREATMENT USING NANOTECHNOLOGY
/
EPURAREA APEI FOLOSIND NANOTEHNOLOGIA

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Keywords: *Nanotechnology, wastewater treatment, nanocomposite, nonmaterial*

ABSTRACT

This research study present application of nanomaterials in wastewater treatment process. We study various approach in decontamination using nanomaterials: adsorption, separation, catalysis, disinfection and sensing in according with nanomaterials specific for every process and their characteristics.
In addition, we try to cover a larger area and present a roadmap of nanomaterial's tested in lab this days.

REZUMAT

Acest studiu de cercetare prezintă aplicarea nanomaterialelor în procesul de epurarea a apelor reziduale. Studiem diferite metode de depoluare folosind nanomateriale: adsorbție, separare, cataliză, dezinfecție și detecţia în conformitate cu nanomaterialele specifice fiecărui proces și caracteristicile acestora. În plus, încercăm să acoperim un subiect vast şi prezentam o enumerare a nanomaterialelor testate in laborator în acest domeniu.

INTRODUCTION

Continuous growing of industrialisation and urbanisation raise and bring environmental challenges in term of pollution and waste management. In last decade, we faced an unprecedented growing rate of waste, fact that leaves as with a lower marginal rate in clean and usable resources.

One of the most important resource for a heavy urbanised community is water. Since antiquity, cities are built in areas with easy access to fresh water. In our days, because of pollution, we must come up with more and more efficient ways to treat care and preserve our water supplies.

More and more regulatory initiatives are taken in order to overcome the demand of fresh water. In 2015 less than 20% of industrial water was properly treated (*WHO, 2014*). In developing country, in 2016, more than 70% of industrial wastewater was poorly treated or untreated before disposal UN (2016). In this context is very important to bring new more efficient methods, in terms of time and cost, in order to maintain our water clean.

For more than 10 years, nanoparticles are studied in this domain, and are presented as an important alternative in wastewater treatment with a high capability and potential. Three aspects are important to take in consideration. First, a lot of laboratory research have very good results especially for adsorption (*Ali, 2012*), membrane separation process (*Pendergast and Hoek, 2011*), catalytic oxidation (*Ayati et al., 2014*), disinfection and sensing (*Das et al., 2015*). Despite that, they're still concept and none of them are taken to next level, as a commercial solution. Second, in term of cost, nanoparticles production has a more and more competitive price on wastewater treatment solution market. Third, still a main reason for not using nanoparticles in wastewater treatment, are technical problem in the process: first, nanoparticles tend to aggregate reason for a lower activity and pressure drop, second, it is hard to separate nanoparticles from the treated water and third, they are some concern on the environmental impact of nanoparticles.

MATERIAL AND METHOD

Nanotechnology in wastewater treatment

Adsorption

Is the closest nanomaterial based technology to become a commercial solution for wastewater treatment. Nanotechnology adsorption have some major advantages comparing with Conventional adsorption. They have a large specific area, applicable in case of various contaminants and high reactivity (*Ali, 2012*). There are several form of nanomaterials used as adsorbent: carbon nanotubes, graphene, nanosized metal or metal oxide and nanocomposites.

MEMBRANE SEPARATION PROCESS

Is usually used to treat municipal waters and other unconventional water sources. The process of water purification with membrane is not yet an efficient solution due to the water treatment process, the separation being made strictly in terms of the size of the treated particles/molecules (*Pendergast and Hoek, 2011; Yin and Deng,2015*). Recent research in this field offers hope for using this technology in the years to come.

CATALYTIC OXIDATION

Is used to remove pathogens and microbes from contaminated waters. As with adsorption and membrane separation processes, the use of nanomaterials has increased the efficiency of this process, since the ratio between the specific nanomaterials and the classical surface is superior (*Reddy et al., 2016*).

DISINFECTION

Wastewater disinfection is a critical process in the eradication of waterborne diseases. Toxic metal ions are used to remove dangerous bacteria and microbes. These in contact with microorganisms have harmful effects on them. Compared to conventional technology, disinfecting nanomaterials have a lower secondary impact on water quality, in addition, nanoparticles can be introduced into a more fluid water decontamination system (*Li et al., 2008b*).

SENSING

The use of nanomaterials in the detection of contaminated waters brings major improvements in the field, providing increased detection capability compared to conventional ones. Nanoparticles outweigh classic capabilities that can't manage to detect micro-pollution situations in large volumes of water. It can also be an effective solution for monitoring environmental accidents, for reason that small variations detected and interpreted immediately (*Shrivastava et al., 2016*).

RESULTS

Nanomaterials in wastewater treatment

The effectiveness of nanotechnologies in wastewater treatment is largely influenced by the use of the various nanomaterials used and their characteristics. In this section, the analysis will be made according to three types of materials: carbon nanomaterials, metals and metal oxides nanomaterials and noble metals nanomaterials (*Yanyang, 2016*).

CARBON BASED NANOMATERIALS

These are generally used in three forms: Graphene, graphene oxide and carbon tubes. Both variants have good results in industrial water treatment with a high specific surface area and a high level of adsorption, depending on the type of contamination substances. One of the drawbacks of using these nanomaterials is the hard way they are extracted from the water.

Graphene has a regular hexagonal structure and have high electrical and thermal conductivity (*Avouris and Dimitrakopoulos, 2012*). Graphene oxide is part of the group of materials that abound in oxygen (Wang et al. 2013).

Graphene oxide and graphite tubes are tested for the treatment of heavy metals and their use. Another utility of graphene oxide and carbon tubes is tested for treatment of water polluted with medication from the pharmaceutical industry and for treating polluted water with anionic material.

In addition to these features, carbon nanotubes as well as graphene can have good mechanical resistance, heat resistance and good sorption performance, characteristics that make it a candidate for use in the pharmaceutical industry for eliminating diclofenac sodium and carbamazepine (*Wei et al., 2013*).

METALS AND METAL OXIDES NANOMATERIALS

Metals and metal oxides most commonly met in nanomaterials testing for water purification are zero valent iron nanomaterials, iron oxide nanomaterials, and titanium oxides.

The zero valent iron has a high capacity of industrial water treatment, using nanotechnologies it has a higher reactivity because of the large specific surface it gives (*Tosco et al., 2014*). Test results have shown that they have a high adsorption capacity for arsenic, cadmium or chromium (*Li et al., 2006*).

Iron oxide nanomaterials represent a solution for nanotechnologies used in industrial water treatment mainly due to ease of use, resource abundance and high adsorption capacity. In addition, it is important to note that the separation of treated water nanomaterials is very simple and efficient by applying an electromagnetic field (*Hua et al., 2012*).

Titanium oxides, due to its catalytic reactions, by the formation of hydroxyl radicals, anionized superoxides and peroxide, is used in the decomposition of organic compounds in the presence of UV ratiation. Due to these characteristics, it has good results in the treatment of pollutants as pesticides, dyes, polymers (*Fagan et al., 2016*).

In addition to the three types of nanomaterials, oxides of various metals are also used, among them aluminum oxide, zinc oxide, magnesium or cerium.

NOBLE METALS NANOMATERIALS

Nanomaterials of noble elements like Au, Ag, Pt and Pd are characterized by low oxidation. They are used to detect organic pollution due to their optical characteristics. Noble metals are also used in catalytic photo-purifications such as titanium oxide.

NANOCOMPOSITES IN WATER TREATMENT

Nanocomposites are being researched because of the possibility of creating new forms of nanoparticles to borrow the advantages of the two elements (*Kumari et al., 2015; Tan et al.,2015*). Nanocomposites, depending on the combination chosen, can have a dimension, specific surface, ease of use and other features, superior to nanomaterials.

NANOCOMPOSITES HAVING ORGANIC SUPPORTS

Polymer based nanocomposites are made by grafted polymers with polymers or by anchoring them to NPs. They can be produced by introducing nanoparticle directly to polymer base or by saturating polymer host with nanoparticles and then synthetized through precipitation and nucleation with specific initiator.

There are many polymer based: macromolecule (polypyrrole) (*Baig et al.,2015; Chen et al., 2015a*), porous resins (*Chen et al., 2015b; Wang et al., 2011*), polyaniline (*Bushra et al., 2015; Khan et al.,2014*), alginate (*Chen et al.,2007; Chiew et al., 2016*) and ion-exchangers (*Blaney et al., 2007; Cumbal and Sengupta, 2005a; Zhang et al., 2008b*). Most commonly used polymer is cross-linked polystyrene ion-exchanger for it unique porous structure, which make them easy to obtain. All of them are used especially in test for treat wastewater polluted with heavy metals. Organic polymers nanocomposites are easy to extract from treated water because of their large size.

NANOCOMPOSITES HAVING INORGANIC SUPPORTS

For inorganic support is it used activated carbon, carbon nanotubes, zeolite or clay-based polymeric nanocomposites, activated carbon had best result in combination with magnetite and they can be recycled by using ethanol. Carbon nanotubes nanocomposites are used as adsorbent for Pb and Cd ions. Clay-based polymer it combine organic and inorganic support, they are mechanical and chemical stable, with high specific area and heat resistance (*Zhang et al., 2016*). They are used especially in pre-treatment of wastewater.

MAGNETIC NANOCOMPOSITES

Magnetic nanocomposites have a core-shell structure, a magnetic core and polymer shell. Fe_3O_4 can be grafted or immobilized into polymer through chemical bounding or direct deposition. Core can be made of Ag, TiO_2, carbon nanotubes, graphene oxide, Pd and SiO_2 (A*n et al., 2014; Colmenares et al., 2016; Ferroudj et al.,2013; Mahmood et al., 2014*). They are easily to be separated from wastewater, the polymer protect core for oxidation and shell can be environmental friendly or have specific characteristic in order to offer new treat capabilities.

CONCLUSION

Nanotechnology is a convenient solution and a more efficient one to raise our clean water supplies. Maybe we may not fully comprehended all of the benefit or risk in using nanotechnology in wastewater treatment, but for sure we have to test and discover new nanomaterial's to overcome the gap between commercial demanding, environmental protection and infrastructure.

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TECHNOLOGIES AND EQUIPMENTS FOR VINEYARDS, IN THE CONTEXT OF CLIMATE CHANGE
/
TEHNOLOGII ŞI ECHIPAMENTE PENTRU POMICULTURĂ / VITICULTURA, IN CONTEXTUL SCHIMBĂRILOR CLIMATICE

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ABSTRACT
Under climate change, mitigating or eliminating negative effects on crops from fruit / wine plantations requires protective measures. Direct or indirect protection measures may be applied. In the present paper direct and indirect measures will be indentified, that contribute to crop protection, working technologies, and equipment for the application for these technologies. Worldwide, there are many concerns in order to protect crops in the current context of climate change, concerns about the development of new technologies in fruit growing / viticulture and appropriate equipment for the application of these technologies.

REZUMAT
În condițiile schimbărilor climatice, pentru atenuarea sau eliminarea efectelor negative asupra culturilor din plantaţiile pomicole/viticole, se impune luarea unor măsuri de protecţie. Se pot aplica măsuri de protecţie directe sau indirecte. In prezentul articol vor fi identificate măsurile directe şi indirecte care contribuie la protecţia culturilor, tehnologiile de lucru şi echipamentele de aplicare a acestor tehnologii. Pe plan mondial există numeroase preocupări în vederea protecției culturilor, în contextul actual al schimbărilor climatice, preocupări de dezvoltare a noi tehnologii de lucru în pomicultură/viticultură şi a unor echipamente adecvate de aplicare a acestor tehnologii.

INTRODUCTION
Development in horticultural productivity depends to a large extent on the mechanization of the horticultural machinery sector, but also on measures which aim to protect against extreme weather phenomens, such as prolonged drought.

Climate changes, ocurred over the past few years, require some measures to be taken, in order to maintain the qualitative and quantitative horticultural production, other than endowment with adapted technical equipment, including:

- land reclamation in accordance with the potential of the pedoclimatic conditions specific in the area;
- improving the weather forecasting capacity, protecting soil fertility, expanding irrigation systems, making efficient use of precipitation by applying agro-technical measures to conserve water in the soil, during the drought;
- protection against natural predators and limiting the use of chemical treatments;
- new orientation in the varietal structure, namely, varieties with high tolerance to high temperatures and water stress, caused by the lack of water;
- phenoclimatic simulation of the occurrence of damages in fruit / wine plantations under the influence of climate change, in order to precisely determine the likelihood of damage that may br occurring;
- attention in the selection of varieties and their genetic dowry, which can change after ten years of culture in another ecoclimatic environment;
- restructuring and conversion of fruit / vine plantations.

Hailstorms and summer destruction storms, although generally considered local, have become more common in recent years, causing damage, sometimes disastrous effects for viticulturists. The nature of the damage varies, depending on the season and intensity of the phenomenon. An early and violent fall of these phenomens may compromise the formation of the fruits for next year, more or less serious injuries occur on the green organs of the vine. Young shoots can be disarticulated, and the leaves show the torn limb. Hail in the blooming phenophase causes the grapes to grow.

Later in the summer, hail can cause open wounds and strong crushing to green beans, cracking them during growth and eventually drying them out. In classical soil-based systems, following hail damage, the beans can be infected by the *Coneyla diplodiella* mushroom. If the hail occurs after the grape harvest, the leakage of the grape can be observed and by breaking the grains, infestations with molds lead to harvesting compromisation. Besides the partial or total destruction of the harvest of the current year, the violent consequences of the fall of hail have been felt for many years.

Another climate factor that has devastating effects on crops, is frost. It can destroy 100% of the crop, so we are looking for methods to combat frost, methods that include working techniques with specific machinery, direct measures and indirect measures.

MATERIALS AND METHODS

- **Methods of protection against cast**

To prevent the negative effect of climate change, *direct methods* and *indirect methods* are now known. Among the direct methods, the fumigation method, the air heating in the orchard, the method of air ventilation and the increase of the air humidity, are widely applied.

Indirect methods also contribute to prevent the negative effects of low temperatures on flowers and are represented by crop, genetic and biochemical work.

The fumigation method is based on the principle of diminishing the effect of nocturnal radiation with a smoke screen, of limited duration, generated by a fumigant substance. The smoke curtain prevents cooling of the soil and trees, reducing the effect of nocturnal radiation. It is recommended to use substances that produce persistent smoke around the trees. Produced aerosols should be white because they have a higher reflection power and thus prevent nocturnal radiation.

a)

b)

c)

d)

Fig. 1 - Fixed Hoar destroyer

http://www.agrofrost.eu/index.php/en/products/frostguard/technical-data
http://www.ozoncompany.ro/Utilaje-Agricole/Distrugator-Bruma-Fix.html?imagini=1

Artificial smoke screens are formed by the burning of 80-100 heaps / ha, made of fumigant material (moistened straw, shavings, cut branches, sawdust), to which oil residues are added. Special pots may be used, in which a mixture of four peat parts, a pitch and a part of petroleum residue, or four parts of sawdust and a pitch is placed. Fumigation piles made from household waste are the most economical and are particularly effective, in case of short-term frosts of moderate intensity *(Păun C., 2016)*.

Air heating in the orchard can be done with special reeds, burners or infrared emitters. Heating can be carried out with fuel (oil, diesel, oil, etc.) or electricity. A medium-sized stove can heat an area of about 50 square meters, which means that a number of stove 150-200 / ha can protect the trees up to temperatures of -6 ... -7°C. The hens must be placed in zigzag. In England, an automatic heating system with a consumption of 1.20 liters of fuel per hour is used, which raises the air temperature in the orchard by 2.4-3.2°C. In Italy and France, there are many types of turbogas (hot air generators based on natural gas) and paraffin candles. Regardless of how this is done, air heating causes the formation of convection winds. The hot air rises until it encounters another layer of air having the same temperature and density, being replaced by the cold in the unheated areas. This eliminates thermal radiation inversions.

The equipment is suitable for apples, pears, cherries, cherries, peaches, apricots, plums, potatoes, vines and strawberries, artichokes, flowers and other fruits and vegetables grown at ground level.

Auto Start System, each machine is equipped with temperature and humidity sensor. It can be choosen the wet temperature at which the Revolution has to start. A built-in clock will stop the machine at a chosen preset time in the morning. The Revolution system can also be equipped with a wireless transmitter, connected to a remote station.

This allows: to start the connected machines all together or one by one by means of a transmitted message from a computer; to stop all the connected machine by the remote station, when a preset temperature is reached; to stop the connected machines all together or one by one, by means of a transmitted message from a computer; to follow all data (like burner temperature, revs of engine etc.) of all the connected machines on a computer.There is also mobile air heating equipment as in Figure2.

Fig. 2 – Antifreeze system, Mobile hoar destroyer

This machine can protect the crops, in places where no water is available, or fruit which cannot be protected with water. It can be used not only during radiation frost but also during wind frost, and a lot of farmers use the Frostbuster to improve their crop's fruit set.

The Frostbuster is a trailed machine. The powerful fan is driven by the PTO of the tractor. A gas burner heats the air up to 80 to 90° Celsius. The heated air is blown between the trees through 2 outlets (one at the left and one at the right). The total surface that can be protected, depends on the shape and the dimensions of the plot and is maximum 8 hectares.

The Advantages of the Frostbuster and FrostGuard:

• Better fruit set; • Cheap: other systems will cost at least 3 times more for the same protected surface; • Multifunctional: can be used for many applications; • Not a fixed installation but mobile so it can be used in every plot; • Low consumption therefore a low price per hour; • Low maintenance costs; • Environmental friendly : burning of propane gas; • No risk on diseases or loss of fertilizers as in case of the use of water; • Can be used to heat up plastic tunnels; • Works not only during radiation frost but also during wind frost; • No permits needed (like for construction or environment); • Easy to use. Possibility to set up and run quickly; • Fast shut down for example when the temperature rises quickly. Extra advantages of the FrostGuard: • The investment can be spread over several years; • At very low temperatures, it's still possible to get a complete protection by putting more machines closer together; • After start up, works automatically; • Ideal for smaller AND larger plots; • Available with Auto Start System

The air ventilation method consists of mixing the cold blankets in the immediate vicinity of the soil, with the hot ones, aiming at eliminating the thermal inversion. The ventilation principle is based on the observation that the radiation inversion occurs on clear nights without wind, and it exceeds 4 m / sec destroys it. Air ventilation is carried out by means of high-capacity special fans, which are installed at the end of the parcels. Fans are used in the USA (California), France, for large plantations (over 100 ha) and are fixed on 10-15 m high pylons, with a 5 m long propellers *(Păun C., 2016)*.

Vertical frost protection fan system consists of a fan mounted on a pole that creates air streams to prevent stratification. This will avoid the accumulation of cold air at the plant level.

Frost protection system with horizontal fans

It consists of a network of horizontal fans that take cold ground air and distribute it upwards. As a result, upward currents of cold air and descending hot air will be created, maintaining a higher temperature at the plant level*.*

a) **b)**

Fig. 3 - Frost protection system with air ventilation

a) with vertical fans *b) with orizontal fans*

Increasing air humidity in order to combat night frosts with sprinklers that are spraying water into the atmosphere, raises the air temperature by 2-4 °C. Spray irrigation starts a few minutes before frost (at the meteorological institute's warning). The ice layer, which will form on the branches, becomes an insulating layer, which prevents cooling of the branches while maintaining the outside temperature very close to 0 °C. Sprinkler systems are cost-effective when they can be later used to water the trees and apply fertilizers.

Fig. 4 – Frost protection system with sprinkle. StripNet Pro with compendated pressure- perfect for vineyards

They are made up of a sprinkler network that distributes water across the entire plant surface. By freezing the water, it releases heat, which is transmitted to the surface of the plants, so their temperature will not fall below zero degrees.

- ✓ Micro-sprinkler with pressure compensation (*http://www.netafim.com.ro*)
  - Micro-sprinkler with anti-freeze function;
  - Creates the cooling effect for parboiled fruit
  - Working pressure: 2.0-4.0 bar
  - Resistance to acids
  - Suitable for hilly areas and long rows of vines
  - Reduces water and electricity consumption

- Resistant to chemicals used in agriculture and weather conditions.

Indirect methods. The protection of trees against frosts and hoars can also be done by indirect methods (crop, biochemical and genetic), which aim to modify the microclimate and the vegetative cycle. (Https://www.timpul.md)

Crop works. Application of crop technology according to the exploitation specificity (rational irrigation, administration of fertilizers and inhibiting substances, in order to limit the growth, and creation of quenching conditions) ensures the trees good resistance to frost. By delaying start in vegetation and blooming, late bruising can be avoided.

The mandatory prolongation of the deep hibernation period can be caused by spraying with naphthylacetic acid, 100-200 mg / l of water, in July-August. In order to prevent frosts and hoars, the valleys in which the thermal inversion phenomena occur, must be avoided when setting up the plantations. No superintensive plantations with dwarf trees are set up in areas where cold air stagnates.

Genetic sudies. To avoid damage caused by frost, it is recommended to create and use varieties resistant to low temperatures, varieties with a long-lasting hibernation and a low vegetation period. Unfortunately, in some species (apricot) there are no known varieties that have a deep, long-lasting hibernation, and that is why the trees are surprised in full bloom by the late frosts, and the production is affected.

Biochemical treatments.

Phosphorus and potassium fertilizers increase frost resistance and excess nitrogen weakens this resistance. Phytosanitary treatments with oil or sulphate solution can delay the vegetation by 8-10 days. A delay of 14-20 days is obtained in the flowering of cherry and peach, using treatment with naphthylacetic acid or sodium salts at doses of 100-150 mg / l water applied in August *(https://www.timpul.md/)*

✓ PROTECTION AGAINST HAIL

Anti-hail and anti-flooding net

In order to reduce the impact of hail, in industrial grapes production, globally, anti-hail nets are used. Anti-hail or anti-flood net is the most important element of the protection system, therefore it must be done by using high quality materials and made with the best technique, in order to obtain a very light but durable sheet. Therefore, the quality of the yarn and raw materials used are very important as well as the tissue technique. The thread used for tissue netting has, only, a diameter of 0.31 mm: this diameter guarantees a resistance of at least 3 kg per wire. The sheet is made using monofilament with a special tissue technique; the fabric obtained with this type of processing is an eye of 2.8x8 mm which can not be deformed when the net is subjected to the weight of the hail.

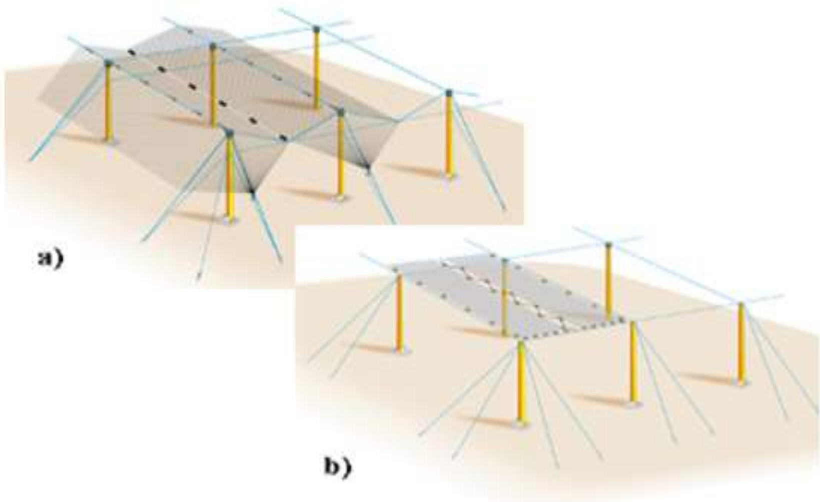

Fig. 5 - Model schemes of the anti-hail system with ridges (a) and flat (b) net

The hut-type anti-hail system (with vault and ridges)

- was the first anti-hail system used to protect plants.
- this system has a feature that can facilitate hail discharge, avoiding dangerous accumulations which can compromise stability.

The anti-hail system with ridge-shaped net, includes the following elements: concrete or wooden poles, anchors, galvanized wire or multi-fiber metal rope, anti-hail net and other materials. At the same time, depending on the construction of the anti-hail system with mesh, they can be used as a trellis for driving the hubs. The cost of installing the anti-hail system with the use of nets, varies depending on the used materials, the type of anti-hail system, the protected area, etc. The life of the carcass is up to 30 years, and the net - 3-10 years. The anti-hail system with the use of nets with a ridge, allows the hail deposits to fall into the spaces between the rows and prevent them from being stored on the nets. When using the flat system, the hail is stored on the net and gradually melts, and in this case the support elements strength (pillars, wire and anchors) must be increased.

Fig. 6 - The hut-type anti-hail system (with vault and ridges)

Flat anti-ingress system

- the flat anti-hail system needs the same type of bonding network used in the hut-type anti-hail system.
- the percentage of usage of the net is very similar to the one used in the anti-hail hull system, but the pillar's high smaller, in order to obtain the same light for the passage used by the machines.
- There are two different versions of flat anti-hail system:
  - ✓ Fixing the net through elastic
  - ✓ Fixing the net through clips

Fig. 7 - Flat anti-hail system

Two other types of anti-hail systems are used for vine plantations:

- the "Gabardine" anti-hail system
- anti-hail system "Tendone"

Fig. 8 - "Gabardine" anti-hail system

Fig. 9 - "Tendone" anti-hail system

A simpler method is the non-carcase system, with only provides the protection of the grape growing area. This method significantly reduces the cost of installing a sophisticated system for the net using only the bobbin support. This method also has a disadvantage - it does not protect for the destruction of young hail shoots, only the grape development area. At the same time, anti-hail protection nets create a microclimate suitable for the development of their grapes and their curing in a shorter time.

Fig. 10 - Protection of vineyard plantations with non-carcasses, with the protection of the grape growing area

Individual protection system

This system protects against both pests (birds, insects) and weather (hail or rain). The small-mesh net system, is installed after the pollination period and uninstalled in autumn. Treatments are done with the net lowered. At the same time, anti-hail protection nets create a microclimate suitable for the development of grapes and their curing in a shorter time. The installation of anti-hail nets is achieved by means of self-propelled equipment having platforms at a given height.

Fig. 11 - Individual protection system

- **New defense methods against hail**

The more frequent hurricanes accompanied by hail, have led to the development of new modern technologies such as sonic or anti-hail cannons.

Anti-hail cannons. Modern anti-hailing sonic launchers, launch missiles containing an explosive mixture of acetylene and air. Wave propagates at sound speeds, up to 15,000 m in the clouds above, causing a breakdown of the hail particles growth phase. The basic principle of the operation of anti-hail cannons is the fact that the high energy shock waves, positively charged, which occur in the blast chamber at intervals of 6-7 seconds, respectively the circulation caused by the waves is shocked by the effect of the Venturi - positive and negative air, thus eliminating one of the very important conditions of the hailing beans, namely stratification of air based on electric charge.

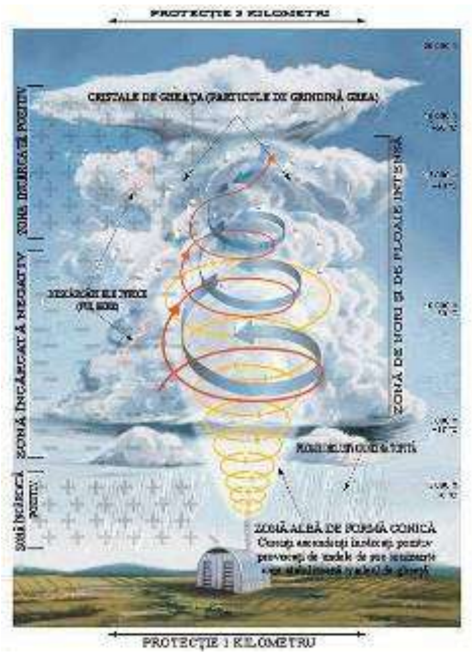

Fig. 12 - Anti-hail cannon

Globally, some wineyards rely on reducing the risk of hail by cloud mudslides. In order to make storm clouds rain, they are injected with a mixture of acetone and silver iodide thrown from planes. This leads to a fine condensation of rainfall, which triggers the rain or prevents the formation of hailstones.

RESULTS

- The application of the **frost prevention methods** presented above has resulted in the following:

- *The fumigation method* is based on a very simple principle of functioning - the burning of propane gas and has the following positive effects:

- Prevents the dropping of ice and ice crystals in plantations and orchards in cold spring nights;
- Protects the leaves and flowers of plantations and orchards from fine ice crystals, snow, chick;
- By the heat it generates in the environment it is able to keep the temperature at an acceptable level so that the future harvest is not compromised;
- Reduces moisture from the range;
- Role of reducing damage from any kind of plantations;
- Ensure a superior, quantitative and qualitative harvest of fruits and vegetables.

Air ventilation method

A fan protects an average of 4 hectares of vineyard orchard. Fans are effective in narrow valleys, where they drain cold air.

- *Increasing air humidity*

Irrigation, mainly using sprinklers, has proven to be the most efficient and economical solution to reduce the effects of frost, making the difference between minimal and total crop loss. This system can be applied to all soil types, climates and crop types.

Indirect anti-freeze methods

• avoiding the setting up of vineyards on the valleys and the slopes;

• election of south-south or south-east land with a low frequency of climatic accidents for setting up plantations;

• directioning the rows of grapevine in the north-south direction, so that the foliar wall intercepts as much light as possible, favoring the maturation of the wood;

• choosing varieties with a higher resistance to winter frosts and late decomposition: Cabernet Sauvignon, Galbena de Odobesti, Afuz-Ali;

• in the vineyards, at the foot of the slope, in depressions, unnecessary mobilization of the soil is avoided, until the frost passes;

• the hubs are made in semi-high or high shapes, placing the wood elements at a distance of 0.8 or 1.5 to 2.0 m from the ground level;

• leaving moderate fruit loads at the time of harvesting;

• the research of some authors has shown that applying green cuts to apricots, increases the resistance to cold and delays the start of vegetation. In winter it is recommended to gather and clear snow at the base of the trees. By slow melting of snow, the temperature is kept low in the roots, and the trees are late in the vegetation.

➢ Applying **hail prevention methods** can reduce the potential damage caused by these undesirable weather phenomena in a proportion of about 60-70%.

Damage produced by hail, depending on the intensity of the phenomenon and the evolution of production, can have disastrous ranging between 5-100%. Besides partial or total destruction of the harvest in the current year, hail also affects the harvest of the next year as a result of the injuries to most of the vegetative appliance of the respective crop and their deterioration in reserve of nutritive substances.

Throughout the vegetation period, hail harshly affects the foliage and slows the assimilation process. Deforestation triggers a new, rapid and strong growth after early hail (before blooming) but weak and followed by incomplete maturation after hailstones (after cessation of shellfish growth). In this case the vineyards have a poor maturing, with a poor starch deposit, generating a late decomposition and a poor growth. The negative effects of late hail last for two years. A series of parasitic fungi (hand, rot, etc.), can affect the attacked organs of the plant.

CONCLUSIONS

In the context of climate change, it is necessary to address protection measures against unwanted weather phenomena, with reference to frost and hailstorms in this article, measures that are highly effective and give farmers the peace of mind that they will not lose the harvest they expect will have, as well as the protection of crops that are set up and in operation so that they are profitable throughout the exploitation period.

All of the measures presented above have proved effectiveness and deserve to be applied at least to industrial production. Climate change requires intelligent approaches to agriculture and horticulture, and protection against destructive weather factors is the first step towards getting rich and quality crops.

ACKNOWLEDGEMENT

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STUDY ON NEW MECHANIZED HARVESTING TECHNOLOGIES IN VINEYARDS / *STUDIU ASUPRA NOILOR TEHNOLOGII DE RECOLTARE MECANIZATA IN VITICULTURA*

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ABSTRACT

Based on the needs of a constantly growing industry, researchers have been working on the development of vineyard mechanization in order to maintain the fruit quality and a good efficiency in the aspect of time, economy and productivity in the vineyards. The present paper presents the latest technologies used in vineyard harvesting, aiming to emphasize good practices in order to promote crop quality, reducing environmental impact and raising yield productivity, but also allowing the delay of some procedures that must pe done in vineyards without consequences. Studies have shown that mechanization in vineyards can achieve benefits of cost savings from hand labor, but also time saving and healthy grapes.

REZUMAT

Bazându-se pe nevoile unei industrii în continuă creștere, cercetătorii au lucrat la dezvoltarea mecanizării in podgorii pentru a menține calitatea fructelor și o bună eficiență în ceea ce privește timpul, costul lucrarilor și productivitatea viilor. Prezenta lucrare prezintă cele mai recente tehnologii utilizate în recoltarea in podgorii, în scopul de a pune accentul pe bunele practici pentru a promova calitatea culturilor, reducerea impactului asupra mediului și creșterea productivității, a randamentului, permițând întârzierea unor proceduri care trebuie făcute în vii fără consecințe. Studiile au arătat că mecanizarea viilor poate aduce beneficii privind costurile cu munca manuală, dar și reducerea timpului de lucru și o cantitate mai mare de struguri sănătoși.

INTRODUCTION

Traditionally, growers have used manpower in vineyards for many years. In time, after the increasing of labor expenses, the needs of an expanding business and lack of time, but also the increase of local or global competition, the commercial growers had to seek methods of mechanizing vineyards operations. Since the 1960's, when the first machine was used in vineyards, researchers had conducted their work in developing postharvest handling, adapting harvesters to different trellises, developing machines that mechanize canopy management practices such as dormant and summer pruning, leaf removal, shooting positioning, fruit thinning etc. The main goal is to develop systems that are able to reach every expectation of a complete mechanized process in vineyards without any loss in fruit quality and quantity *(Morris J.R., 2008).*

Mechanical harvesters quickly gained popularity in vineyards for wine grapes, but also for juice grapes. During the time of a continuous growing interest, researchers investigated the post harvesting quality of mechanically harvested grapes. Based on the fact that grapes have a rapid fermentation rates with time, the industry have established a maximum six hours interval between mechanical harvesting and processing. *(Morris J.R., 2008; Hays P, 2008).*

In time, several new generations of harvesters have been developed. Currently there are two types which beat and shake de vine, either by means of staves beating foliage, or the impulse harvester which beats the trunk and cordon. Both aim to detach the berries. The berries are then collected on a conveyor which move past a blower that removes the leaves, where after they are dumped into a bin.

Mechanical harvesters are able to work against slopes and adjustments may be made without stopping. Three basic adjustments may be effective, namely the width between the two sets of staves (pitch), the extent of the beating action (amplitude) and the speed of the beating action (frequency). Different combinations of these three factors may be used for various vineyards. The success of mechanical harvesting is ascribed 35-40% to the harvester, 30% to the operator and 30% to the vineyard. If the canopy is not suited to mechanical harvesting, the process will not be successful. *(Morris J.R., 2008, Hays P, 2008, Kaye O. 2008; https://www.wineland.co.za*).

New generation of harvester offer several new advantages such as: automatic sorting on the harvesters that presents berries without any material other than grapes, sorting of different colour berries, sorting of the grapes according to the condition of ripeness of the grapes, easy cleaning based on the fact that the success of the mechanical harvesting is largely influenced by the maintenance of the harvester (*https://www.mondomacchina.it/).*

A great area of interest revolves around the mechanization of harvesting, as testified to by the continuous arrival of new features on the market. What is not new is the idea of the selective collection of the grapes on the basis of their quality, beginning with a specific map of the site. Currently, this is now possible and becoming more and more accessible thanks to the availability of optic sensors capable of detecting in real time the phenolic, or physiologically ripe grapes, that is according to the content of grapes' anthocyanins and flavonoid. The important arrival of sensors and systems for the approach of the machine to the vines is justified by the need for precision provided for work in vineyards in which driving is often made difficult by a number of factors, such as sloping terrain, narrow rows and the length of the worksite. For this reason, assisted driving has taken on more and more interest. Thanks to GNSS (Global Navigation Satellite Systems) with real time corrections (with RTK, Real Time Kinematic systems) the tractor and machine can be positioned with precision of up to a couple of centimeters. This is of importance not only for planting cuttings and setting posts but also for making and using the prescribed maps and assisting and facilitating the work of the driver, especially when driving is complicated by combined operations. In this area, an Enovitis in the Field Technological Innovation Award was given to Spektra-Agri which, in collaboration with Fendt, came up with an AutoCombiGuide drive system which automatically controls operational sequences in the field and provides the possibility of controlling the equipment while running. These features enable work to be performed for carrying out various combined operations to reduce time and labor and entries to the field to lower stress on the operator and the soil.

There are now so many technologies and solutions for improving the quality of operations. Though the spread of agricultural mechanization in the vineyard involves in various ways nearly 30% of these vineyards for grape harvesting alone, for a total of some 2,600 machines at work on nearly 15,000 hectares harvested, it is important for manufacturers' research to continue in this direction to provide increasingly competitive and convincing solutions for agriculture (https://www.winesandvines.com).

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MATERIALS AND METHODS

Various machines are available and technology is advancing rapidly to speed up harvesting of the grapes in the case of almost all kinds of trellis systems, and to harvest more "softly" with less damage to the bunches. Bunches may already be harvested as low as 25 cm from the surface of the soil. Machines are being developed to harvest even bush vines. There are currently two types of harvesters available on the market, such as self-propelled harvesters (Figure 1) and towed harvesters (Figure 2) (*https://pellenc.com/).*

Fig. 1 - Self propelled harvester-PELLENC (*https://pellenc.com/)*

Fig. 2 - Towed harvester- PELLENC *(https://pellenc.com/)*

Many winemakers prefer grapes, especially white varieties such as Sauvignon blanc, to be harvested by hand. Much progress has been made, however, in handling berries with a softer touch. An example of this is the used of extended beaters by means of which berries are shaken off with the minimum of skin damage. Furthermore, it is a well-known fact that the quality of many white cultivars is better if the grapes are pressed cool. Therefore, night and early morning pressing by harvesting machines can even result in an improvement in wine quality.

In order to carry out the harvesting process, the vineyardists inspects the samples of grapes whit a refractometer to determinate if the grapes are ready to be picked. If the answer is positive, the process may begin. For the best results, the harvester may be equipped with several features that ensure a good efficiency of the process, with minimal impact on the grapes.

One of the best features that such harvesters present, is the continuous harvest bin system, which allows a great working efficiency with continuous harvesting bin. The harvest can be redirected directly to gondolas, valley or macro bins by using the side discharge conveyor for long rows (*https://pellenc.com/).*

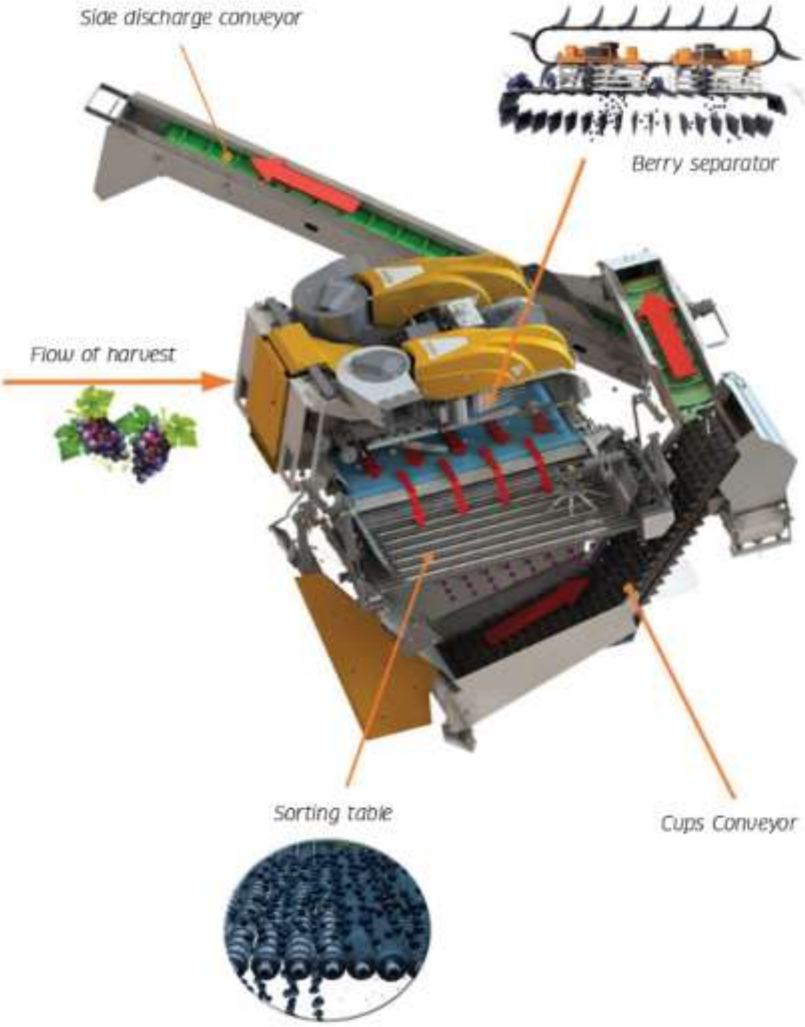

Fig. 3 - Continuous harvest bin system *(https://pellenc.com/)*

The cab is equipped with a console that allows frequency, pinch, amplitude, destemming and other settings adjustment instantly and continuous, while working, without stopping. Also, self-propelled harvesters, are equipped with position sensors that automatically align the harvesting head in the row, while an active system optimises the efficiency of shaking, without damaging the trellising and plants, The movement of the harvesting head is proportional to the working speed.

Fig. 4 - Console and sensors systems *(https://pellenc.com/)*

Harvesters are equipped with selective destemming systems, with high-frequency linear berry separator, that gently removes the berries and the stems remain intact. The linear berry separator (Figure 5) has an anti-jam feature with five long fingers, while the adjustable sorting rollers can adapt to all grape varieties. The screen rollers (1) allow the sorted berries to pass through and remove petioles and green waste. The solid notched roller feeders (2) separate small waste and route petioles to the screen rollers (Figure 6).

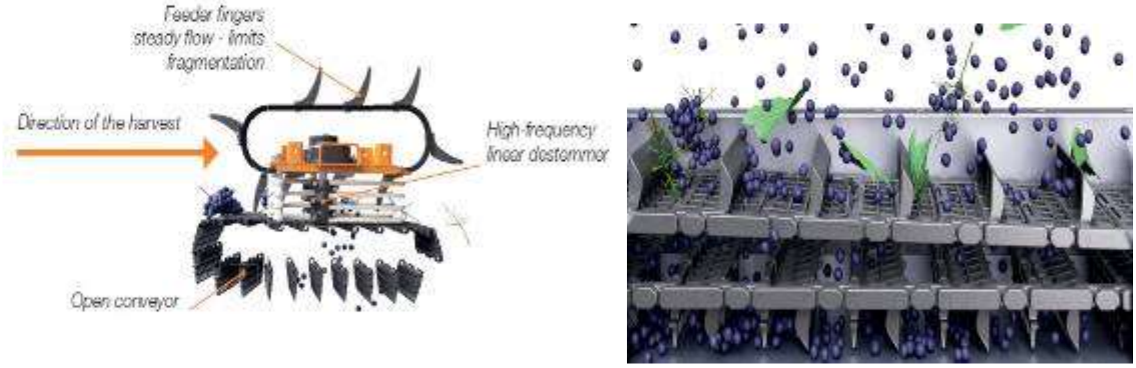

Fig. 5 - Linear berry separator- Destemmer *(https://pellenc.com/)*

Fig. 6 - Screen rollers *(https://pellenc.com/)*

Another optional sorter can be added to the mechanized harvester, that allows optimal sorting of berries, whole bunches and leaves at the conveyor output. The grid belt of the sorter catches the harvest at the output of the Flexible Sorter Conveyor. Juice and berries pass directly into the bins.

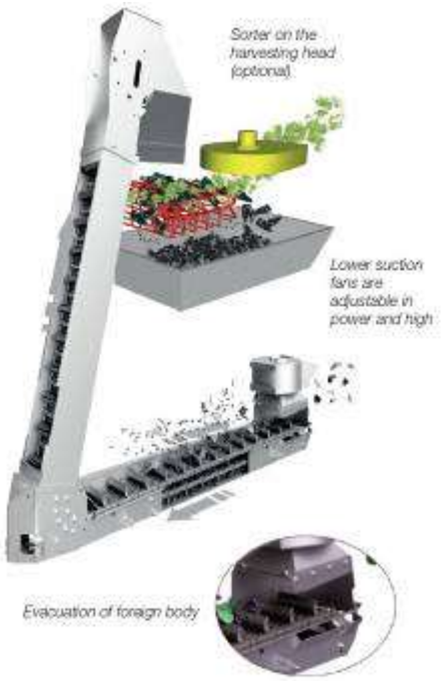

Fig. 7 - Sorting and cleaning system *(https://pellenc.com/)*

RESULTS

Most of the harvesters, have a great efficiency, with 99.82% of cleanliness rate in the bin, and 82% of good berries, 100 % of leaves are removed as well as 95 % of whole stalks, The sorting table consists of a series of feeder rollers that distribute the berries on the sorting table, and aligns waste to evacuate it. thanks to the selective process. Only grape clusters and leaves pass under the lower suction fans, less than 30 % of the harvest *(https://pellenc.com/).*

Fig. 8 - Vineyard after harvesting *(https://pellenc.com/)*

CONCLUSIONS

With all the features available in the latest generations of mechanical harvesters, the whole system of harvesting and vinery crush pad, is basically operating on wheels. Most of the machines are equipped with onboard destemming and sorting. Some machines, are now standardized with destemmers and sorting systems, while others offer optional add-on equipment Harvesters can be towed by a tractor, or self-propelled. With an efficiency of 99.82%, the ability to pick any date for the harvesting process, but also with the advantage of working during night, the cost of the harvesters is worthy. Time saving, less human power, good efficiency represent the key factor in implementing mechanized equipment and good practices in vineyards, especially for mass production and large surfaces of vineyards.

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WASTEWATER TREATMENT USING TiO_2 PHOTOCATALYST / *EPURAREA APEI CU FOTOCATALIZATORUL TiO_2*

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Keywords: *photocatalysis, wastewater treatment, TiO_2*

ABSTRACT

In this study, we present the capacity of TiO_2 photocatalyst for water treatment. TiO_2 is considered the most investigated semiconductor due to photocatalytic activity, thermal stability and nontoxicity. It is considered the most promising for the photocatalytic destruction of organic pollutants.

By using several parameters such as phase composition, aggregation degree, electronics structure, adsorption of gas molecules, nature of the solvent can determine photocatalytic activity of TiO_2.

REZUMAT

În acest studiu, prezentăm capacitatea fotocataliatorului TiO_2 pentru epurarea apelor. TiO_2 este considerat cel mai analizat semiconductor datorită activității fotocatalitice, stabilității termice și netoxicitatii. Este considerat cel mai promițător pentru distrugerea fotocatalitica a poluanților organici.

Prin investigarea mai multor parametrii precum compoziția de fază, gradul de agregare, structură electronică, adsorbția moleculelor de gaz, natura solventului se poate determina activitatea fotocatalitica a TiO_2.

INTRODUCTION

Most countries face a water scarcity, especially in developing areas because the available water quantities can not meet consumer requirements. Scientific advances following rapid industrial development, environmental pollution, water residues, global warming, causing abnormal dramatic changes, leading to significant water scarcity (*Shavisi et. al. 2014*).

The standard of living has improved significantly through technology development, but this factor threatens human health and the environment. Drinking water is essential for human health. Over 80% of diseases are due to bacterial contamination of drinking water (*Shavisi et. al. 2014*).

Along with national development, industry crunching, wastewater is becoming more and more contaminated, which leads to a debilitating process. Oily wastewater from various industries has enormous potential for environmental degradation, especially soil and water (*Diallo et. al. 2005*).

The number of poles varies both in quantity and in quality due to the number of people and industrial plants. Due to the widespread diversification of water pollution and non-biodegradable problems, a number of problems have arisen that cannot be addressed through the natural cleaning cycle (*Adán et. al. 2016*).

In the past few years, the authorities in the field have imposed stricter rules, limiting the pollution caused by these wastewaters, ensuring a more efficient treatment. New sewage treatment techniques have been introduced to ensure better cleaning, significantly reducing costs (*Luan et. al. 2009*).

Worldwide there is a significant increase in pollution with toxic pesticides, organic compounds and manure emissions. Water treatment technologies that include non-biodegradable organic compounds have a great difficulty in eliminating pollutants through existing biological treatment including coagulation, precipitation and oxidation technology (*Yi et. al. 2013*).

Coagulation and precipitation techniques employ a method that precipitates solids in suspension forming flocs after adding a polymer coagulant or anorganicide coagulants to the coagulation of pollutants to be moved by adding a series of water-soluble metals and adjusting the pH. These methods of healing or high efficiency of treatment, but the use of chemicals leads to the creation of new environmental problems.

Another efficient method for wastewater treatment is photocatalytic. This method uses semiconductor particles that effectively degrade a large number of pollutants.

Following studies for several semiconductor photocatalysts, TiO_2 has been proven to be the most efficient for both practical applications and fundamental research.

Titanium dioxide (TiO_2) is a highly studied material for various applications: electrodes used in photoelectrochemical cells, electric capacitors, solar cells, in medicine for inactivating cancer cells, photodegradation of organic compounds in water or air treatment processes. The use of this semiconductor was in the form of a suspension of nanopowders (very high surface area) and in immobilized form of thin layers deposited on a rigid substrate (*Nair et al., 2004*).

Till now has been reported the test of TiO_2 nanomaterial for photocatalytic degradation of ammonia (*Shavisi et al., 2014*) in the installation from Figure1. The photodegradation of ammonia using TiO_2 show that the photochemical reaction treats the ammonia into harmless N_2 and H_2 gases (*Shavisi et al., 2014*).

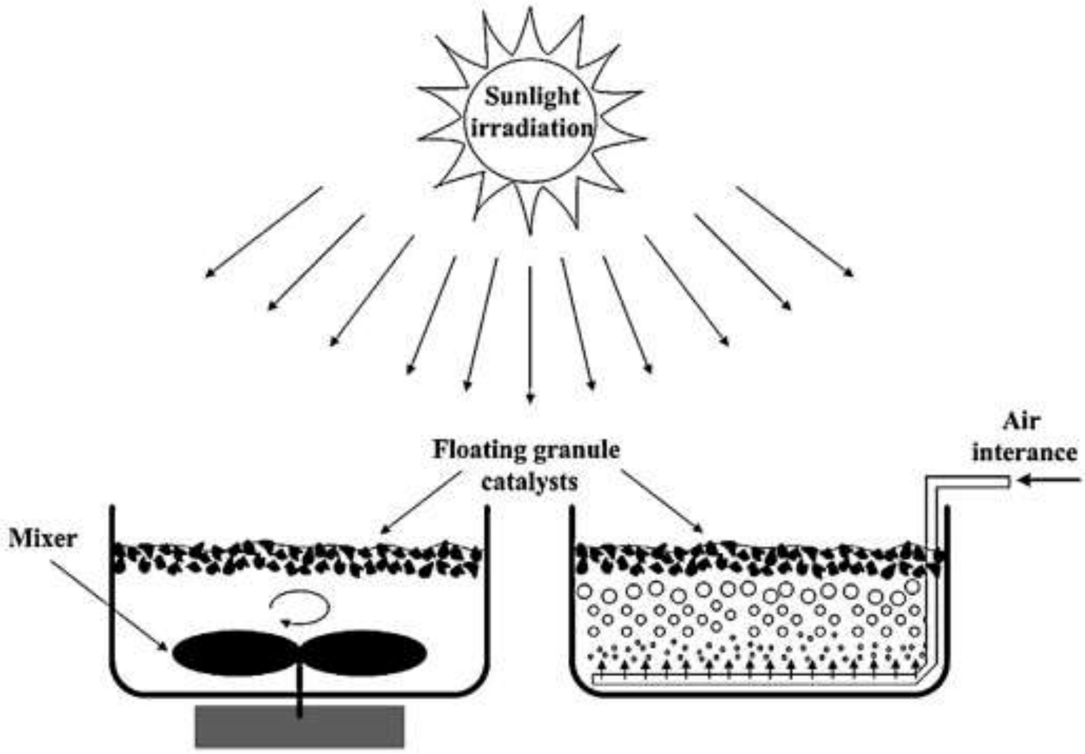

Fig. 1 - Experimental set-up for photocatalytic activity reduction of ammonia.

One of the most widely used forms of TiO_2, both at the research and industrial level, is the commercial grade Degussa P25. This is a mixture of anatase: rutile in a ratio of about 3: 1. Due to availability on the market, very good chemical stability, reproducibility of experimental results and photocatalytic activity, Degussa P25 has been suggested by several research groups as reference in photodegradation processes.

The properties of titanium dioxide that make it widely available are:

- High capacity for the production of hydroxylic alcohols in aqueous medium under UV irradiation,
- Potential to modify the prohibited band to use solar radiation,
- Inertial chemical, including in extreme conditions,
- Commercial availability at a relatively low price,
- Different and low complexity methods for laboratory preparation, both in powder and thin layers.

The TiO_2 photocatalyst is nontoxic, inexpensive, chemically and biologically inert, being an important photoreactive.

The detailed mechanism of photocatalysis varies from poult to pollutant, but a common point has been reached, namely: responses responsible for the photocatalytic effect are redox reactions. By measuring the quantum yield of products, the photocatalytic yield can be evaluated.

Oxidation treatment technology decomposes organic material because it generates radicals (OH) by way of a reaction of hydrogen peroxide and iron salts.

The technologies that use the catalytic activity of metal oxide semiconductors have been the focus of TiO_2, which is a photocatalytic technology (*Marugan Jet. al. 2006*).

Advanced technologies use TiO_2 photocatalyst to attract higher attentiation by generating OH-semipermanent, using only non-chemical photo-energy. The operating cost can be significantly reduced when using solar energy. An obstacle in using the practical energy of this water treatment technology is due to the low light efficiency of TiO_2 (*Marugan J et. al. 2006*).

The development of photocatalytic research is related to the use of solar energy. The basis of this technology is to convert solar energy into chemical energy. Conversion refers to the synthesis of chemical energy to induce a chemical reagent.

CONCLUSIONS

TiO_2 photocatalyst will increasingly be used under UV light or solar irradiation due to low cost, safety, and advanced technology oxiers for the water treatment industry. Although there is sufficient knowledge in the field to allow the application of this method, many things remain unknown. The reactivity of a catalyst depends on organic degradation.

The use of solar energy is limited by the photo-ineffectiveness of the TiO_2 catalyst. For the photocatalysis water treatment technology, it is necessary to develop a TiO_2 innovative photocatalyst.

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REPLANTING DEVICE FOR RESINOUS SEEDLINGS AND PLANTLETS SPECIFIC TO AGRICULTURAL CULTURES
/
APARAT DE REPICAT PUIEȚI DE RĂȘINOASE ȘI PLANTULE SPECIFICE CULTURILOR AGRICOLE

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Keywords: *device, replanting, plantlets, seedlings, resinous seedlings.*

REZUMAT
În lucrare se prezintă un aparat de repicat care echipează secţiile de plantat ale maşinilor specializate, în vederea repicării puieţilor obținuți la strat în paturi nutritive sau în solarii prin germinarea semințelor de rășinoase și creșterea plantulelor, respectiv a semințelor plantelor agricole cum ar fi răsaduri de roșii, de vinete, de tutun, de varză ș.a., în vederea transplantării acestora în câmp deschis și realizarea unor culturi intensive şi echipamentul rotativ de repicat care este de tip carcasă, elementele active acţionate de o camă având două variante de sisteme de prindere a plantulelor.

ABSTRACT
The paper presents a replanting device equipping the sowing sections of specialized machinery for replanting seedlings grown in nutrient beds or in solariums, by the germination of resinous seeds and the growth of plantlets, respectively seeds of agricultural plants such as tomato, eggplant, tobacco, cabbage seedlings, etc., in order to replant them into the open field and to develop intensive crops and the rotating replanting equipment, of the housing type, its active elements being actuated by a cam with two versions of the plantlets gripping systems.

INTRODUCTION
In the case of resinous seedlings (black or Scots pine, spruce, fir, larch, Douglas fir), forest technologies require several replantation operations until their development stage allows the creation of intensive crops on large surfaces.

In general, replanting (planting) devices for resinous seedlings and plantlets specific to agricultural cultures are arranged on their planting sections, inside the coulter that opens a furrow situated below ground level, at a depth equal to the height of the root system of the plantlet to be replanted, being driven from the soil compaction wheels by means of conical gears. The "clamps" drive mechanism which fixes the plantlet in a vertical-radial position for the arrangement of the root system in the ground is operated by a profiled cam type system that drives the followers that command the closing/opening of the "clamps", respectively the release of the plantlet at the moment of plant contact with the vertical of the place (moment when the peripheral speed is null) by placing it with its root in the soil. The operation is followed by bringing a quantity of soil that closes and fixes the plant in this position, then compressing the soil brought by two wheels disposed at an angle allowing the formation of a soil mound with longitudinal axis that coincides with the imaginary axis formed by the plantlets' stems.

Search engines indicate several manufacturers such as:

- For resinous trees: Super Prefer – Monosem, France; Egedal Maskinenfabric, Denmark; Damcon and Accord, Netherlands.
- For seedlings**:** Accord, Netherlands; Checchi & Magli, Italy; Sfoggia Pflanzmaschi and Grimme Schroder, Germany; Gregoire Besson; Weremczac, Poland.

The disadvantages of most of these types of planting machines are that the cam-follower mechanism is located on the inner surface of the coulter wall of the planting machine section and is exposed to weather, to soil particles entrained in rotation-elevation movement, with an injury effect on parts of the leaf system accidentally detached with the handling of the plantlets, lacking lubrication possibility of the moving parts, etc.

MATERIAL AND METHOD

The paper presents the need for replanting seedlings grown in nutrient beds or in solariums, by the germination of resinous seeds and the growth of plantlets, respectively seeds of agricultural plants such as tomato, eggplant, tobacco, cabbage seedlings, etc., in order to replant them into the open field and to develop intensive crops and the replanting equipment, with profiled cam – rotating follower mechanism, encapsulated, working in a lubricating environment, ensuring the sealing of the component parts and avoiding possible malfunctions during the working process.

Figures 1 and 2 show the replanting device, lateral view, respectively cross-section, together with the sliding bolt mechanism (Figure 3) and the preload cylindrical helical compression and torsion spring mechanism (Figure 4):

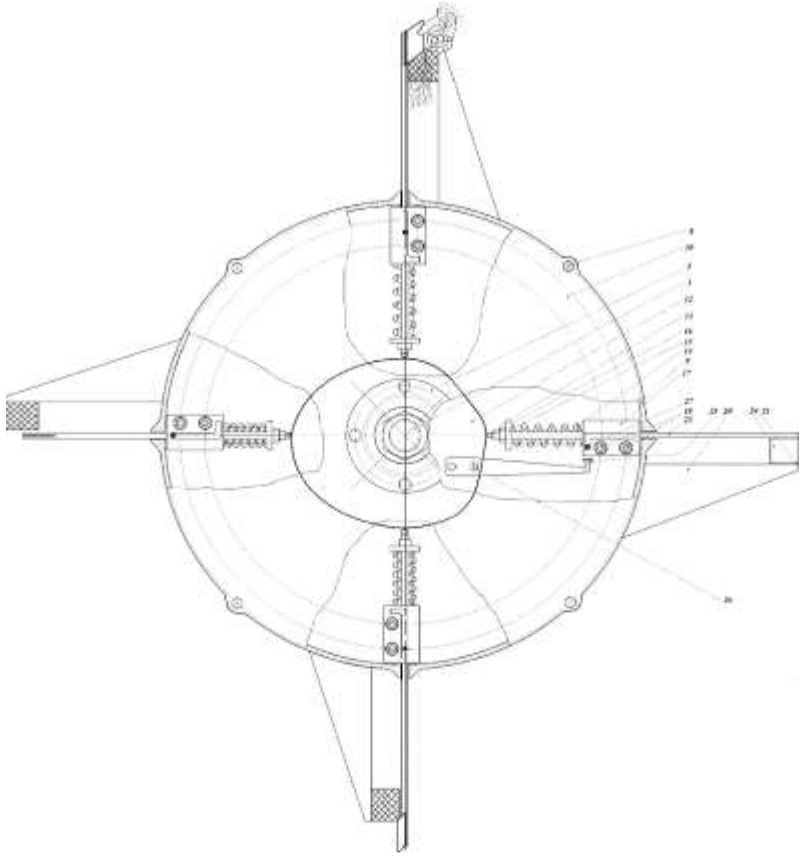


Fig. 1 - General arrangement drawing, lateral view

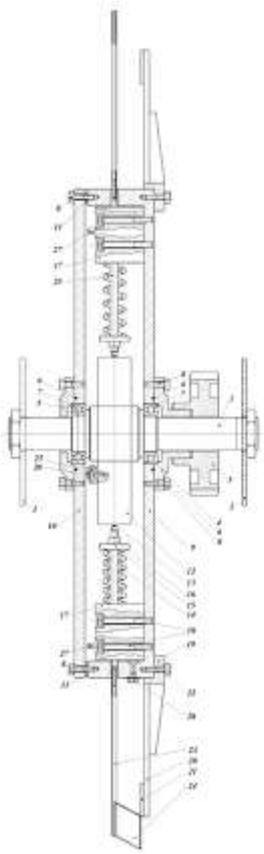


Fig. 2 - General arrangement drawing, cross-section

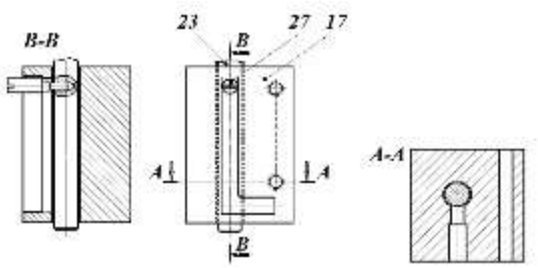


Fig. 3 – The blocking/unblocking system for the movable rod travel, respectively for the clamps gripping the plantlets

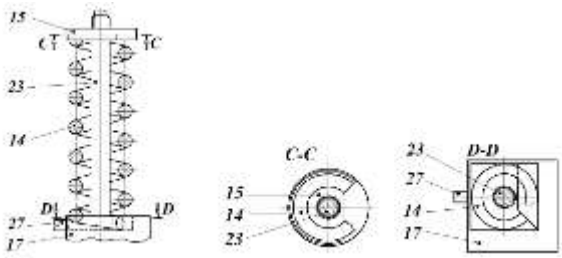


Fig. 4 - Cylindrical helical compression and torsion spring mechanism

The theoretical research involved supposed the design and kinematic analysis of the component mechanisms. Thus, during operation, considering the division of the rotating drum **9** into four trigonometric quadrants and considering the fact that the rotation movement is clockwise, it is possible to detail the working process as follows:

▪ quadrant I [*π/2, 0π*) - the working process is already begun (*π/2*) at which point the movable clamp (rotating) **24** with protection element, rotates with the second half of the travel 45^0 (the first rotating movement of the clamp occurs in the quadrant IV), over the clamp **21** disposed on the fixed vertical rod **20**, the inner surfaces thereof contact the entire surface (*π/6*), fixing the plantlet to be planted with the root system in the vertical position. The actual fixing of the plantlet between the clamps provided with protection elements occurs by copying the cam profile **12**, located between the *π/3* and *π/6* values. Note that between the values 5*π/6* (quadrant II) and *π/3* the movable clamp continues the rotation motion, the time for passing this cam portion being destined for the operator to feed the planting plant with plantlets. The point follower **13** follows the cam profile, the cam radius decreases, the spring removes stress, and the vertical rod gets a downward movement combined with a rotational movement due to the initial helical spring preload. The clamp **24** is mounted non-removable at the top of the movable rod on its generator and describes the same type of motion. The bolt **27** screwed into the movable rod is subjected to a downward movement within the *L*-shaped recess until its end, when, due to the preload of the spring, it is forced to penetrate to the small side of the *L*-shaped recess, when the rod together with the movable clamp remains folded over the rigid clamp with the fixation of the plantlet subjected to the replanting process.

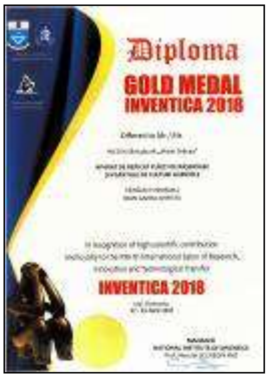
▪ quadrant IV [*2π, 3π/2*) - displacement of the point follower on its corresponding portion of the cam profile due to the limits of the quadrant IV, the clamps **21** and **24** remain in contact, maintaining the plantlet between them. To the end of the above-mentioned interval (i.e., *11π/6*), the cam profile changes in the way the cam radius begins to increase, the clamps begin to open releasing the plantlet with the root system directed downward into the groove formed by the coulter. At this point, the bolt **27** screwed into the movable rod encounters the actuator follower **25** (fixed to the cam **12**) which is driven in a retraction motion due to the twisting of the cylindrical helical compression and torsion spring **14** (tensed by twisting when mounted by 180^0) going over the length of the small side of the *L*-shaped recess, continuing the movement along the large side of the *L*-shaped recess in the fixed support **17**, allowing the spring relief by making a dual movement twisting-radial advance of the movable vertical rod **23** the travel of which is limited by bolt stopping at the end of the stroke determined by the form of the *L*-shaped recess, on the length of which the rod executes an advance motion (towards the outside of the cam) and twisting by 90^0. The clamps open, leaving at the contact point with the ground the plantlet with the roots directed towards the ground.

▪ quadrant III [*3π/2, π*) - after positioning the plantlet in the soil (with the compression of the roots by two non-shaped, compaction cylinders located in the immediate proximity of the planting device), the rod clamps fixed **21** and movable **23** remain in a parallel position (open), continuing the motion of copying the cam profile. The cam profile remains unchanged.

▪ quadrant II [*π, π/2*) - the clockwise rotation continues, the clamp **24** starts to rotate, and at the value (5*π/6*) begins to execute a radial advance and folding motion over the clamp **21** by executing the first half of the stroke by rotating the clamp with 45^0, preparing the planting phase of the plantlet subject to the planting process. At point 5*π/6* the point follower follows the cam profile, respectively its radius, which decreases, the movable rod acquires a downward movement combined with the start of the twisting generated by the spring preload, which leads to the rotation of the clamp fixing the plantlet. The device is supplied manually and the number of planting arms may vary depending on the species and the desired distance between the plants on the row.

RESULTS

The technical solution was registered with OSIM (State Office for Inventions and Trademarks) as utility model no. U-00026 / 08.06.2018 (Replanting device for resinous seedlings and plantlets specific to agricultural cultures), authors Tudosoiu Cătălin and Ganea-Christu Ioan, the holder being the National Institute for Research and Development in Forestry “Marin Drăcea”.

CONCLUSIONS

The introduction of actuating mechanisms of movable rod with point follower and fixed rod type, both equipped with clamps for clamping and fixing the plantlets, which follow a cam located in the encapsulated housing, leads to the following advantages:

- the sealing of the component parts eliminates the possibility of gripping the moving mechanical elements, resulting in increased reliability recorded during the planting process;

- with minimal constructive adaptations, the replanting (planting) device for resinous seedlings and plantlets specific to agricultural cultures can extend its applicability to various fields such as: forestry in the forestry nurseries and nurseries specialized in ornamental plant production and horticulture;

- the universality of the concept by the fact that each manufacturer can adopt its own design and constructive elements regarding the realization of the planting device;

- the possibility of adapting the planting device’s constructive elements to the biological requirements of the plantlet species subject to the replanting process.

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STUDY ON TECHNOLOGIES FOR ORCHARD MAINTENANCE
/
STUDIU PRIVIND TEHNOLOGIILE PENTRU ÎNTREȚINEREA PLANTAȚIILOR POMICOLE

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Keywords: *orchards, planting, technology, soil cultivation*

ABSTRACT

In Romania, fruit growing is mainly spread in hill areas on a surface of about 200 thousand hectares, due to the fact that there is increased rainfall and distributed more evenly, one of the vital factors for the economic success of culture. The paper presents a study on technologies for orchard maintenance. The results are intended to be a technical basis, which includes general recommendations regarding orchard maintenance for the economic agents in the IND-AGRO-POL Competitiveness Pole Romania.

REZUMAT

În România, pomicultura este răspândită cu precădere în zonele de deal pe o suprafaţă de aproximativ 200 mii ha datorită faptului că sunt precipitaţii mai ridicate şi distribuite mai uniform, unul dintre factorii vitali pentru reuşita economică a culturii. Lucrarea prezintă un studiu privind tehnologiile pentru întreținerea plantațiilor pomicole. Rezultatele prezentate se doreşte a fi o bază tehnică, care cuprinde recomandări generale privind întreţinerea plantațiilor pomicole, pentru agenții economici de profil din Polul de Competitivitate IND-AGRO-POL Romania.

INTRODUCTION

Maintenance work for orchards is one of the main links that must be taken into account in achieving sustainable, balanced, diversified and efficient farming systems that ensure cost-effective exploitation and the protection of natural resources and consumer health. [8]

In the desire to get increasing productions, man has developed soil works to exaggeration, leading in some cases to the deterioration of its features (destruction of structure, compaction, reduction of humus content, etc.) [4].

Failure to comply with technologies that provide specific nutritional conditions for orchards has the effect of achieving low yields both quantitatively and qualitatively [6].

The establishment of an orchard involves its design, which includes establishing the varieties, the appropriate choice of land, establishing a planting plan according to the pedoclimatic conditions, the processing of the land and then the planting. [5]

The proper realization of the maintenance technologies, for the efficient development of the vegetation factors in fruit growing, leads to the achievement of stable productions, at the same time ensuring favourable conditions in the evolution of soil fertility and its preservation, which is the main means of production in this field [7].

Therefore, modern and sustainable fruit growing is based on the choice of the system of soil maintenance and working, which is an important operation, on a detailed analysis of the following factors: the pedoclimatic conditions of the culture area, the culture system, the biological peculiarities of the species, variety and rootstock and technical equipment [3].

Of particular importance in orchard maintenance is the soil work which contributes to the increase of the water accumulation and retention capacity, the stimulation of the water stability of soil aggregates, the weed control and microbiological activity stimulation. All these have a great influence on the maintenance and further increase of fertility status as a whole [9].

MATERIAL AND METHOD

Among the elements of orchard maintenance technology, in the present paper we referred to the soil maintenance systems practiced in orchards in Romania.

For the elaboration of the paper we used reading sheets of the articles from the literature by consulting the scientific data bases in terms of the qualitative approach in order to present a coherent image of the conceptual and applicative practice of the technologies for orchard maintenance. For the presentation of a soil maintenance system, it was taken into account the culture technology practiced, the natural conditions of the ecoclimatic and ecopedological area, the natural fertility status of the soil and the differentiated requirements of the fruit trees according to the variety and rootstock. The study area for orchards is shown in Figure 1.

Fig. 1 – Study area for orchards in Romania

RESULTS

Every fruit tree species and within it, each variety behaves in a certain way, specific under the same ecological conditions. This behaviour (adaptive capacity) is a genetic attribute and, knowing it, one achieves superior quantitative and qualitative results by applying innovative maintenance technologies to limit the negative impact of climate change. According to biological and agrotechnical features, the species cultivated in our country are grouped in: pomaceous, drupaceous, tree nuts and berry trees.

Table 1 shows various species of fruit trees [2].

Table 1

Various species of fruit trees

Species	**VARIETY**			
Apple	Frumos de Voineşti	Mutzu	Romus 2	Granny Smith
				
Pear	Passe Crassane	Conferance	Euras	Williams alb
				
Quince	Aurii	Beretzki	De Constantinopol	Moldoveneşti
				
Plum	Diana	Centenar	D'Agen	Anna Spath

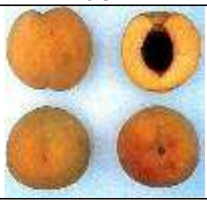
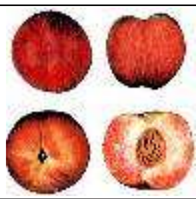
				
Cherry	Boambe de Cotnari	Jubileu	Roşii de Bistrita	Van
				
Apricot	Roşii de Baneasa	Selena	Carmela	Sulmona
				
Sour cherry	Ilva	Meteor	Morella Neagră	Nana
				
Peach	Babygold 9	Cardinal	Flacăra	Triumf
				

Table 2 shows fruit yields obtained in recent years, in Romania.

Table 2

Fruit yields obtained in recent years, in Romania

	Total production - including family gardens (thousand t)							
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
TOTAL FRUITS, of which:	1085.8	1179.2	1323	1419.6	1479.9	1128.5	1300.0	1301.4
Plums	372.6	475.3	533.7	624.9	573.6	421.4	512.5	495.3
Apples	475.4	459	517.5	552.9	620.4	462.9	513.6	513.2
Pears	62.8	52.6	66.1	60.4	66.9	54.3	66.8	
Peaches and nectarines	17.0	16.4	17.1	11.2	22.5	17.4	19.1	
Cherries and sour cherries	65.2	67.7	67.9	70.3	81.8	70.5	80.5	82.8
Apricots	27.6	32.1	32.5	23.8	33.7	29.1	28.3	
Nuts	25.5	32.3	38.3	34.3	35.1	30.6	31.8	
Strawberries	16.5	21.2	22	21.4	18.9	15.8	23.2	
Other fruits	23.2	22.6	27.9	20.4	27.0	23.9	24.2	

Source Statistical Yearbook of Romania 2013, 2014, tab 14.14, 2014, NIS, Plant production for main crops 2014

Distribution of fruit species according to the vegetation zone in Romania

The **sub-area of beech forests** - the beech forests sub-level, develops in the area of hills that are usually high, situated between 500...800 m altitude, with average annual temperatures of 6...8°C and precipitation ranging from 650 ... 900 m, on brown mesobasic soils, acid brown, etc. Dominant tree species: red currant, gooseberry, blueberry, some apple varieties.

The **sub-area of the durmast oak forests** occupies the space of the medium hills and the lower part of the high hills, situated between 300 and 800 m altitude, having an annual average temperature of 7...10°C, rainfall of 600...800 m, brown soils, brown luvic, pseudo-gleyzed luvisols. Dominant tree species: raspberry, apple, plum, sour cherry, blackberry, some pear varieties. This is the area of greatest concentration of apple plantations.

The **sub-area of Turkey oak, Hungarian oak and oak forests** occupies the northern part of the Romanian Plain and Getic Plateau and the outer hill area in the west of the country, situated between 50...500 m altitude, with an average annual temperature of 8.5...10°C and precipitation ranging from 500...700 mm, on the brown-reddish, brown-luvic soils. Dominant tree species: apple, pear, plum, quince, cherry, sour cherry, walnut, hazelnut. It is an area of high concentration of apple and plum plantations.

The **sub-area of forest steppe** occupies larger or smaller areas almost in all provinces of the country, between 50 and 500 m altitude, with average annual temperatures of 8...10°C, precipitation between 600...700 mm, on gray soils, brown reddish, brown luvic, chernozems, etc. In this area the dominant tree species are plum, pear, quince, cherry, sour cherry, walnut, hazelnut, apple.

The **steppe area** occupies the East and South part of Romanian Plane, Dobrogea, Barlad Platform and isles in Siret Plane, between 0..200 m altitude, with average annual temperatures ranging from 9 to 11.5 °C, precipitation between 400...500 (600) mm. In this area the dominant tree species are apricot, peach, almond and cherry.

Based on the information provided by the territorial structures of the Ministry of Agriculture and Rural Development (MADR) (County Directions for Agriculture), the situation of the main orchards at the end of April 2014 underlined that the total area of orchards represented 1% of the country agricultural area (158,609.74 ha).

The largest area with fruit trees was in Argeş county (20,370 ha, respectively 12.84%, figure 2), followed by Vâlcea (13,145 ha, respectively 8.29%), Prahova (9,664 ha, respectively 6.09%), Dâmboviţa (9.293 ha, respectively 5.86%), Bistriţa Năsăud (8.952.51 ha, respectively 5.64%), Satu Mare (8.780 ha, respectively 5.54%) and Buzău (8.418 ha, respectively 5.31%) counties.

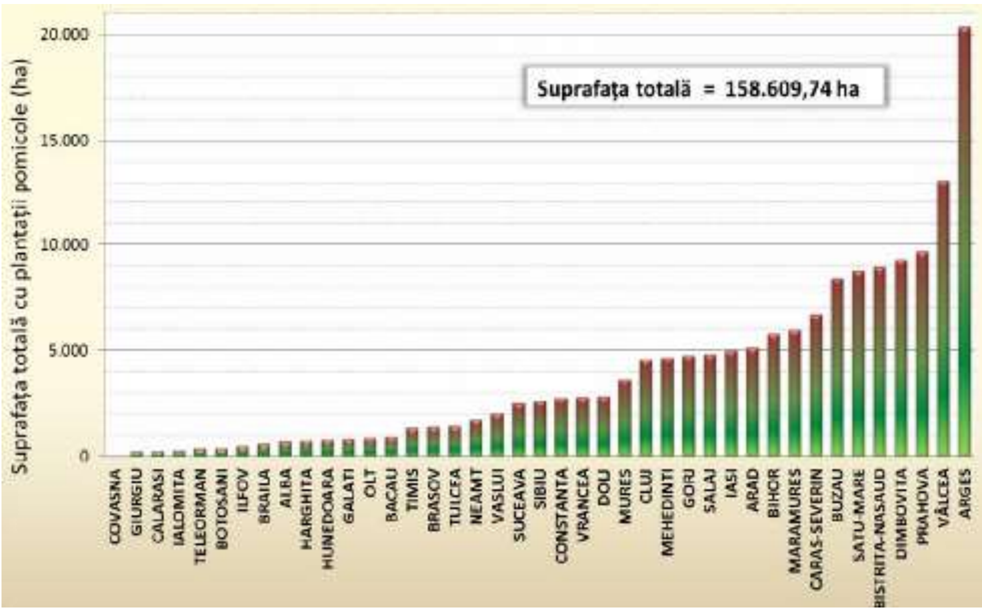


Fig. 2 – Total area with orchards in Romanian counties
(Source: MADR, April 2014)

Total area
Total area with fruit trees (ha)

Current trends in innovative techniques for orchard maintenance

Fruit tree technological systems (Figure 3) can be grouped into two broad categories: *pure crops and associated crops*.

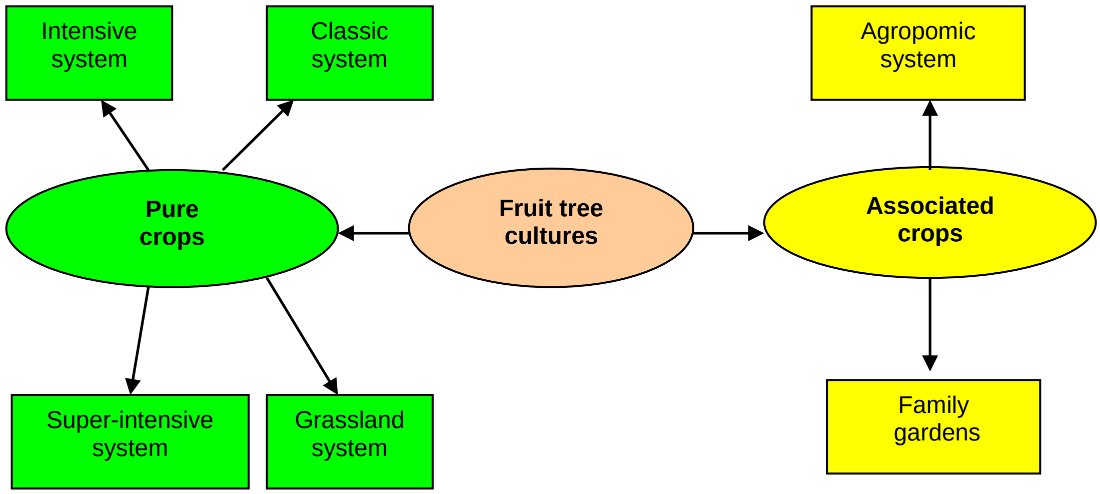


Fig. 3 – Fruit tree technological systems

Pure fruit tree crops can be classic, intensive and super-intensive.

The *classic (extensive) system* held the weight in world fruit growing until the 1950s-1960s. In this system the trees have a great force (8...10 m height), globular crowns (4…8 m in diameter) or pyramidal, are planted at great distances (7...8 to 10...12 m) resulting in a density of 150...300 trees/ha. Due to its features, there is a tendency to be replaced by modern systems: intensive and super-intensive.

The *intensive system* currently holds the weight in tree culture worldwide and in our country. This system has expanded considerably in the high hill area, being predominant for apple trees nowadays, but also for plum, cherry and sour cherry trees.

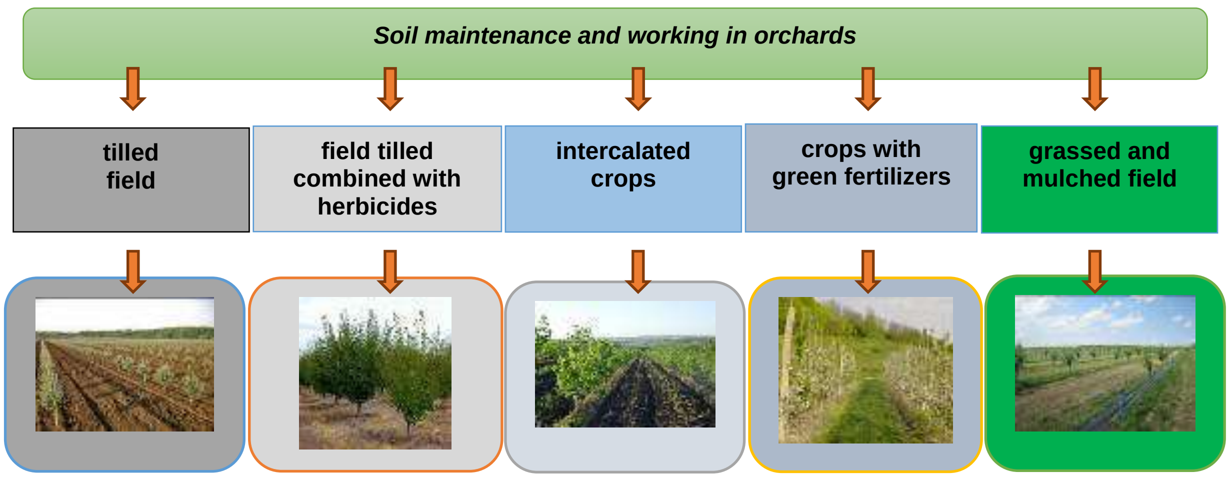
The *super-intensive system* is characterized by small force trees (1.5 ... 2 m, height), with the form of flattened crowns or globular crowns with small volume (spindle, vertical belt), small planting distances (2.5...4 m between rows and 1...1.5 m on the row) resulting in densities of 1250...3333 trees/ha and even more.

Associated fruit tree crops are the following: agropomic system and family gardens.

The *agropomic system*, applied a lot in the past but also nowadays, especially in the hilly and mountainous areas, is a variant of the classic (extensive) system. The system has a perspective only in the high areas where agritourism is developed.

Soil maintenance and working in orchards

In the orchards in our country, the following soil maintenance and working systems are frequently used: black field (tilled), black field interrupted, black field combined with chemical weeding, intercalated crops, crops for green fertilizers, temporary or permanent grassing and mulching [1].



The *tilled field* is a system used extensively in intensive and super-intensive bearing plantations, located on medium or light land, flat or with a slope of less than 6%, in areas where the precipitation is below

650 mm and has no torrential character, triggering soil erosion. In the hill-to-valley plantations, this soil maintenance system helps to eliminate excess moisture, a phenomenon commonly encountered on such land.

The tilled field has the advantage of completely eliminating weed competition and improving the heat and air regime in the soil. As a disadvantage, this system degrades the soil structure, favours deep compaction, prolongs the vegetation, thereby weakening the resistance of the trees to frost; at the same time it requires high energy and labour consumption.

Technological, biopedological and physico-mechanical disadvantages recommend this system only in arid, non-irrigated areas, etc. In order to use this system, the autumn ploughing is performed at varying depths depending on the species, variety, rootstocks and the nature of the soil. On heavier, wet and cold soils, which are characteristic of higher areas, to avoid damage to the roots, the ploughing depths will be 10...15 cm, in the bearing plantations, with surface rooting rootstocks and 15...20 cm in the case of rootstocks with deeper rooting.

During the vegetation period, 3…4 disc harrow works are carried out alternately with the cultivator. On the row of trees 3…4 manual or mechanical hoeing operations are executed by means of offsetting equipment (tillage cutter, cultivator, disc). In the hilly-mountainous areas the disadvantages of this system are amplified and consequently the tilled field must be used with great care and only combined with other maintenance systems. At the same time, the tilled field produces certain qualitative negative qualities to fruits, sensitivity to physiological diseases and a shorter storage period, etc.

The *field tilled combined with chemical weeding*. This system consists of soil tillage only during the first part of the vegetation period. In the second part of the summer, starting in July, when the torrential rain regime triggers the biggest erosion processes, the works are interrupted and the soil is allowed to grass naturally. In addition to soil protection against erosion, relatively easy access of the aggregates to the plantation is provided for the technological works. This system is indicated in intensive plantations located on the slopes with inclination of up to 14...15%. On the row of trees, the soil is tilled in spring and chemical weeding is performed.

Herbicide administration in intensive plantations of fruit trees and shrubs is generally carried out on the row of trees on a strip of 1...2 m wide, depending on the age of the trees and the width of the fruit fence, which is mechanically worked with difficulty. Application of herbicides can be done manually (on small surfaces) or mechanically. In fruit growing we use *contact herbicides* (Gramaxone, Reglone, D.N.O.C., Fusilade, Tiuran, Paraquat, Diquat etc.) or *systemic* (Simazin, Caragard, Livezin, Ustinex, Pitezin-B, Devinol, Roundup, Venzar, Betanol, Targa etc.). Chemical weeding in fruit growing must be carried out with restrictions especially in the first 3-4 years after planting all species and especially in the case of drupaceous ones (plum, apricot).

Intercalated crops consist of cultivating intervals from intensive and extensive orchards in the first 2 to 3 years after planting. In classical orchards, with distances of more than 4 m between rows, the cultivation of the intervals can take a longer period of time until the crowns are finished. In hilly-mountainous areas, where water competition is lacking, crops in high-lying areas, good results are obtained by using as green fertilizers lupin and broad bean, fertilized with NPK, sown after fruits appeared and incorporated into the soil in the second half of August, when the plants were at the end of the bloom.

The *field with green fertilizers* has both advantages and disadvantages.

As advantages we mention: it increases the soil content in organic matter; reduces soil erosion; prevents the process of weed encroachment and intensifies the activity of aerobic microorganisms; removes excess moisture; reduces temperature amplitudes; favours soil structuring and fruit yielding with superior qualities and good storage capacity.

The disadvantages of this system are: the respective crops compete with trees in water and food consumption, the cost of fruit production is higher, etc.

Partial artificial grassing is the most appropriate and most efficient system of plantations on slopes unlandscaped or landscaped as terraces in areas with precipitation over 700 mm. In intensive and super-intensive plantations of commercial type, grassing between rows protects the soil against erosion, maintains and rebuilds its structure, and assures the technological traffic of the aggregates in any period. At the same time, by reducing the number of soil works, significant fuel and labour savings are achieved. Grass mixtures made up of grasses only (*Lolium perene, Dactylis glomerata, Phleum pratense, Festuca rubra*) and leguminous plants (*Trifolium repens, T. pratense, Lotus corniculatus* etc.) can be used for grassing intervals.

The sowing of the grasses is done in spring, in well-prepared, alternative land (one year, one interval, the next year the other). Herbicides are applied on the soil of the tree rows (1...2 m) annually. The grass is mowed 4-5 times a summer when it reaches the height of 15...20 cm and is left on the interval as mulch. After each mowing it is fertilized with 20...25 kg N s.a./ha. Intervals' grassing is also of great importance for the plantations of fruit shrubs (blueberries, red currants, raspberries, etc.) from hilly mountainous areas. Unlike other fruit tree species, some shrubs, such as red currant and blueberry, have a finer radicular system and on heavier and wet soils develops in the superficial soil layer (10-40 cm).

The *total natural grassing (permanent marsh parsley)* is used in extensive plantations in high hill areas, on uneven slopes, with no landscaping possibilities or with slopes above 30...35%, as well as in the gardens of the population.

This system often justifies both the prevention of soil erosion and landslides due to excess humidity and economic considerations, as it ensures the production of fruit, animal feed, etc. At the same time, this system allows maintaining the glomerular structure of the soil and requires minimum material and labour costs. In order to exploit the production potential of the plantations on the fruit farms, this system suffered some improvements, which involved the mobilization of the soil around the trees, along with the application of organic and mineral fertilizers, and on the big slope land and the execution of the individual terraces was also performed.

Soil mulching. This system is of particular interest in shrub plantations and strawberry cultivation. More recently, this system has penetrated into super-intensive and intensive plantations. The mulch can be natural (mowed grasses, straw, cobs, leaves, etc.) or artificial (white or coloured polyethylene film). The thickness of the natural mulch is 10...15 cm. Mulching can be done in the form of strips on the plant row or on the entire surface. Artificial mulching is carried out in strips of 1.5...2 m on rows of trees and in strawberry plantations.

Mulching has certain advantages: maintains moisture in the soil; prevents the growth of weeds; reduces the temperature amplitudes by 3...6°C in summer and raises the soil temperature by 2...3°C in winter compared to the field tilled; maintains soil structure, porosity and loosening, increasing soil content in organic matter, while preventing soil erosion. In blueberry plantations, mulching with sawdust or peat improves the physical properties of the soil and accentuates acidity, a fact favourable to this species.

Trends in the construction of technical equipment for soil works in orchards

Agrosez București-Ilfov sells the plow with 3 plow bodies BPV-03 for orchards (Figure 4) and the plow with 5 plow bodies BPV-05 for orchards (Figure 5), which have the plow bodies disposed in "V" form and the lateral ones can be displaced ([11]).

Fig. 4 - Plow with 3 plow bodies BPV-03 for orchards marketed by Agrosez

Fig. 5 - Plow with 5 plow bodies BPV-05 for orchards marketed by Agrosez

S.C. Wirax S.R.L. sells the plow with a DP 18 model plow body for soil works between the tree rows in orchards (Figure 6) in aggregate with tractors with a power of at least 16 HP, irrespective of whether they have a 2 or 4 wheel drive ([13]).

Fig. 6 - Plow with DP 18 model plow body for orchards marketed by Wirax

Z&A Logistic ([14]) markets agricultural machinery from the most famous brands in the industry, including the PSTE model harrow (Figure 7), which is being developed by SPEDO in Italy. The PSTE model carried disc harrows have working widths ranging from 1.5 to 2.6 m and are designed to process soil between three rows in aggregate with tractors with powers from 55 to 80 HP per wheel ([15]).

Fig. 7 - PSTE model disc harrow marketed by Z&A Logistic

AGROLINE MECANICS ([10]) markets the EFT model disc harrow (Figure 8) for soil processing between the tree rows, which is developed by ANGELONI in Italy ([12]).

Fig. 8 - EFT model disc harrow marketed by AGROLINE MECANICS

CONCLUSIONS

- The optimal soil maintenance system in orchards takes into account optimal agrotechnical conditions, genetic, physiological factors as well as technological factors;
- Internally and externally there are concerns for the improvement of machinery and technical equipment intended for orchard maintenance technology;
- The results make it possible to draw up a useful recommendation for farmers applying orchard maintenance technology.

ACKNOWLEDGEMENT

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IMPLEMENTATION OF RENEWABLE ENERGY SOLUTIONS ON A NAVAL TRAFFIC SURVEILLANCE PONTOON
/
IMPLEMENTAREA DE SOLUȚII DE ENERGIE REGENERABILĂ PE UN PONTON DE SUPRAVEGHERE PENTRU TRAFICUL NAVAL

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Keywords: *solar panels, domestic hot water, photovoltaic, mppt charge controller, inverter*

ABSTRACT
In order for the equipment on a surveillance pontoon to operate in areas without an electrical network or to reduce the fuel costs for the generator group, renewable energy systems can be implemented. In the present case, solutions with solar panels for electricity and domestic hot water have been identified as feasible. Other more difficult to implement solutions would have been with wind and hydro turbines. The aim of the piece of work was to reduce the diesel fuel consumption by at least 20%. The paper presents the way of realizing the solar installations for a naval surveillance pontoon.

REZUMAT
Pentru a functiona in zone fara retea electrica sau pentru a reduce cheltuielile cu combustibilul pentru grupul generator se pot implementa sisteme de energie regenerabilă. In cazul de fata au fost identificate ca fiind fezabile solutiile cu panouri solare pentru energie electrica si apa calda menajera. Alte solutii mai dificil de implementat ar fi fost cu turbine eoliene si hidro. Scopul realizarii instalatiei a fost reducerea consumului de motorina pentru generatorul diesel cu cel putin 20 %. In lucrare se prezinta caracteristicile și modul de realizare a instalatiilor solare pentru un ponton de supraveghere navala.

INTRODUCTION
Solar energy is recommended as a renewable energy source for mooring and surveillance pontoons because:
- the location of the pontoon is part of the area with the greatest potential of solar radiation in Romania;
- domestic hot water (obtained with solar panels) can be produced and stored in the boiler;
- electric energy (with photovoltaic panels) can be produced and stored in the batteries;
- conversion equipment (solar and photovoltaic panels) are relatively small in size and weight and can be placed on the mooring boat as a "roof" without affecting its buoyancy and stability;

The aim of the piece of work was to reduce the diesel fuel consumption by at least 20%. In the paper are presented the characteristics and the way of realization of the solar installations for a mooring mooring and naval surveillance.

MATERIAL AND METHOD
Constructive and functional description of the solutions
The renewable energy system [1, 2] for mooring pontoons is the result of analyzes of the possibilities of using renewable energies in the area of setup, the analysis which aimed to meet the following indicators: reduction of conventional fuel consumption (diesel) by at least 20%, the reduction of electric energy consumption by supplying consumers on board the pontoon for a maximum of 5 hours per day from a power generation system and by reducing the consumption required for the production of domestic hot water through a thermal solar panel.

The mooring pontoon renewable energy system shown in Figure 1 is composed of two main components:

• The electrical component that is actually a power generation subsystem made with solar photovoltaic panels

Technical specifications:

- Number of photovoltaic solar panels: 32 pcs
- Power generation subsystem power: max 8kW
- Batteries: 12V voltage, 220Ah capacity, 100A maximum charging current, 12 pcs.

• The thermal component embodied in a thermal energy generation subsystem, integrated in the domestic hot water production system and made with thermal solar panels.

Technical specifications:

- Number of thermal solar panels: 2
- Power of the thermal energy generation subsystem: 2 kW
- Boiler capacity: 80 l.

Fig. 1 - The components of the system installed on the roof of the pontoon

Electrical Component - Electricity Generation Subsystem

The electrical component - the electricity generation subsystem, Figure 2, ensures the electricity supply to the recipient's consumers. They are classified into critical electric consumers, characterized by the fact that they have to be supplied regardless of costs and non-critical electrical consumers, where the electricity supply is subject to cost criteria. The primary sources of electricity are the generator and photovoltaic panels.

Photovoltaic panels are characterized by a non-constant power generation, depending on the time of day, month, year, and depending on the lighting conditions of panels such as fog, dust, clouds, rain.

The Quattro inverter is a device that implements the functionality of inverter and rectifier functional blocks.

The SmartSolar MPPT 250/100-MC4 charger is a device that adapts the solar cells to the battery in order to obtain a maximum power transfer [3,4].

Battery Balancer is a device that balances the battery charge current in the system. Figure 2 shows the battery balancer connection diagram.

Batteries Deep Cycle type.

Technical specifications:

- Capacity: 220Ah
- Rated voltage: 12V
- Dimensions: 522x238x240mm
- Weight: 65kg

The Venus GX controller, figure 2, provides control and monitoring of connected equipment.

Technical specifications:

- Supply voltage: 8-70 VDC;
- Communication Ports: VE.Direct, VE.Can, CAN, VE.Bus, USB, Ethernet, WiFi
- Communication protocols; Modbus-TCP, JSON.

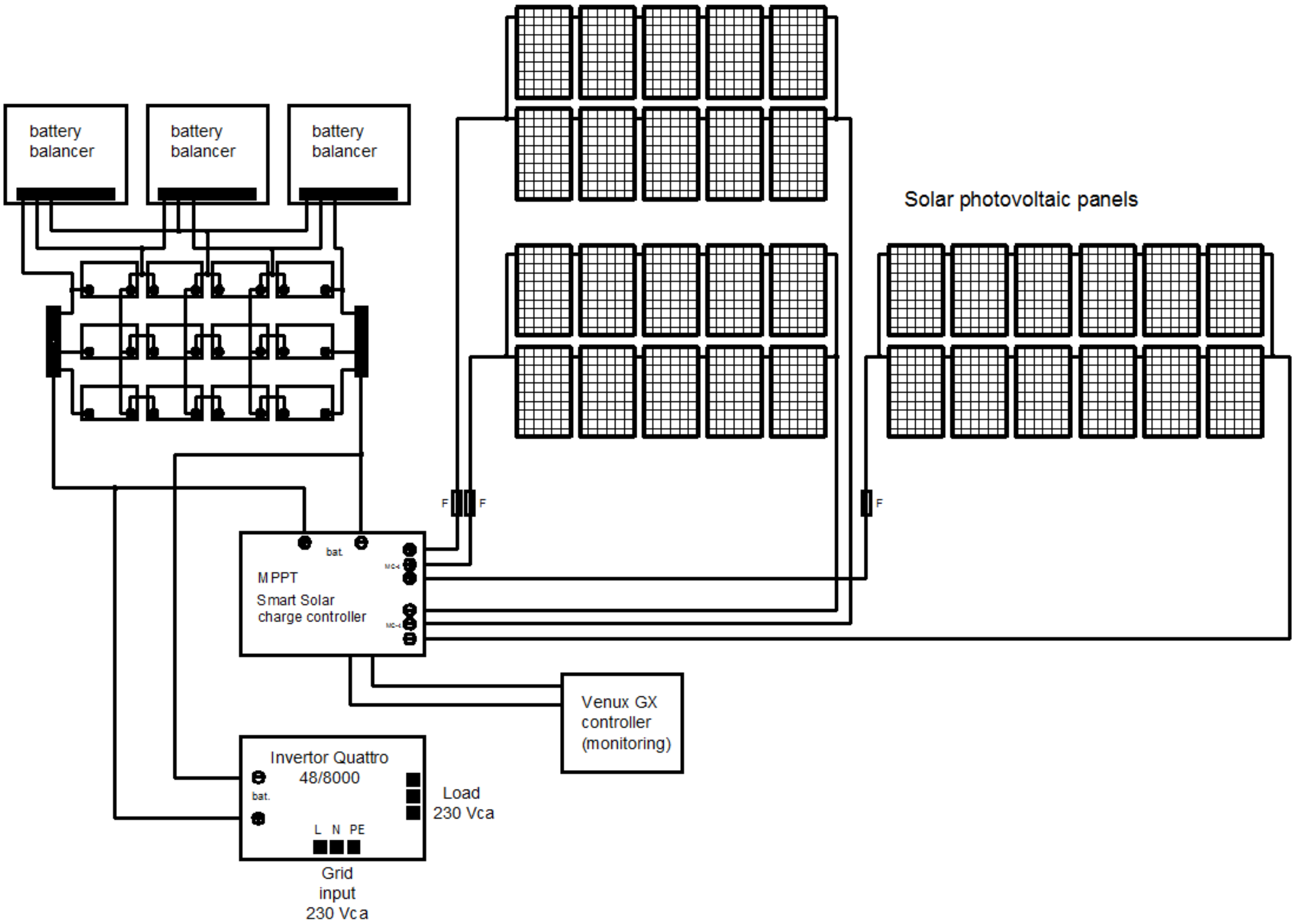

Fig. 2 – Electrical Component - Scheme of Electricity Generation Subsystem

The power supply system enables the recipient's electrical consumers to be classified as critical electric consumers and non-critical electrical consumers. The critical electrical consumers are characterized by the fact that they must be supplied regardless of costs whereas the non-critical electrical consumers are subject to cost criteria. The primary sources of electricity are the generator and photovoltaic panels.

The generator set is characterized by high operating costs both in terms of financial cost and tactical, due to the negative implications for the decrease of sensitivity of the surveillance equipment through the produced vibrations and electromagnetic parasites generated by its alternator. The photovoltaic panels do not have the operating costs of the generator, instead they are characterized by a non-constant electricity generation depending on the time of the day, month, year and depending on the lighting conditions of the panels such as fog, dust, clouds, rain etc.

In order to eliminate these disadvantages, it was necessary to equip the supply system with a group of batteries which provides a "buffer" function in the power supply of the electrical equipment in the sense that it ensures a constant supply voltage irrespective of the variations of the input voltage. Another role of the accumulators battery is to allow a discontinuous operation of the generator group which leads to a lower operating cost, Figure 3.

To ensure the conversion of DC electrical energy into AC power, it was necessary to have an *inverter* that receives the battery voltage at the input while the AC power consumers are connected to the output. The batteries are charged from two sources, photovoltaic panels via the *battery balancer* and from the generator group via the rectifier block.

Fig. 3 - Components of the photovoltaic system (accumulators, solar charger and inverter with switching unit)

Thermal component - Thermal energy subsystem

The Thermal Energy Generation System, Figure 4, consists of two solar thermal panels in which the calorifier fluid is heated, a pumping group that ensures the fluid circulation in the system, the boiler and the solar regulator.

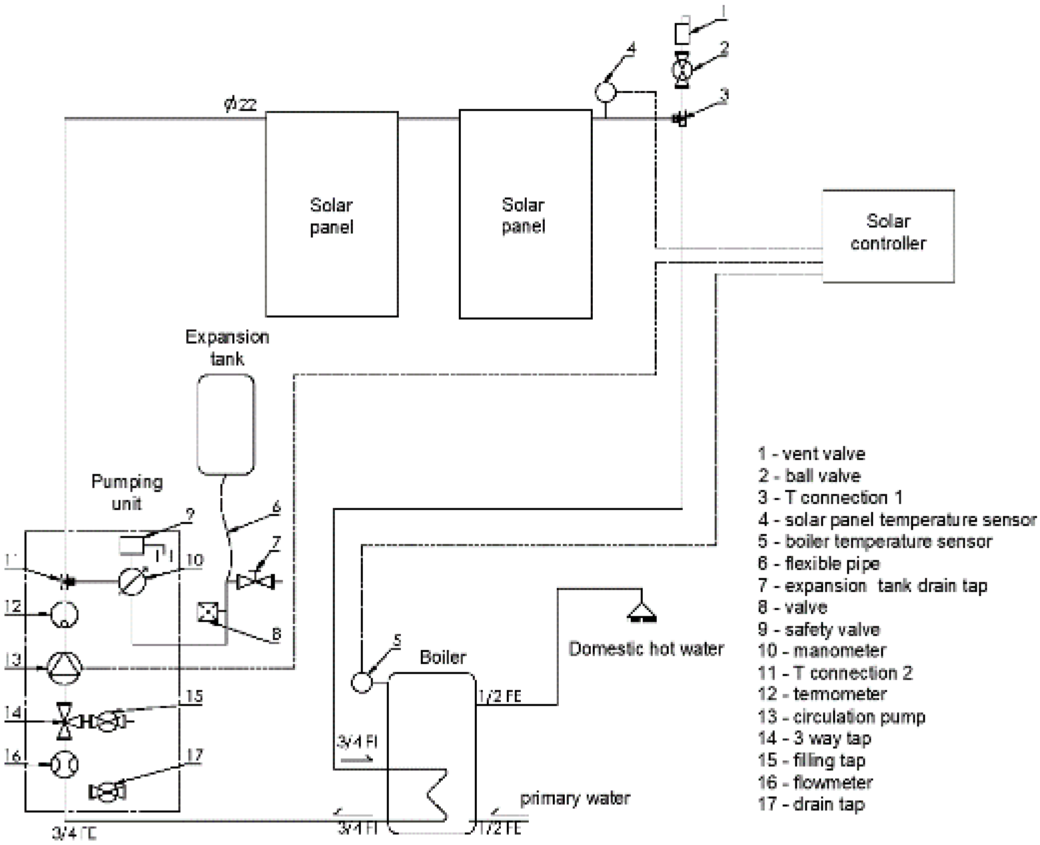

Fig. 4 – Componenta termica - Schema subsistemului de generare pentru energie termica

Thermal solar panels are solar panels with Heat Pipe technology. The vacuum tubes from this panel consist of two concentric glass tubes between which it is vacuum - Figure 5. The inner tube is surrounded by a dark absorbent surface that transmits the thermal energy to the copper pipe through which the heat agent circulates. The vacuum between the tubes minimizes convection and conduction heat losses, allowing for superior performance (yield and higher temperatures).

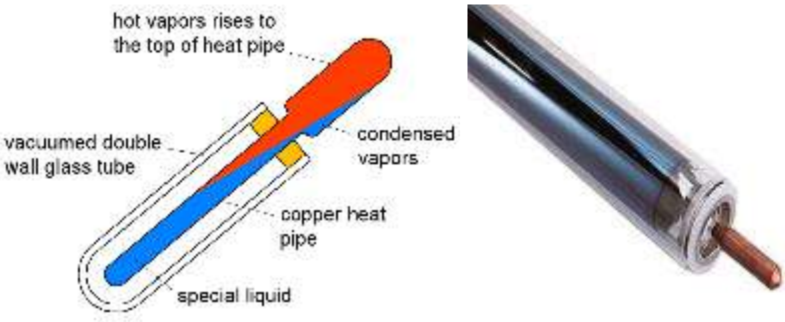

Fig. 5 - Vacuum tube

In the heat pipe the liquid [5] turns into vapors that rise to the condenser installed in the solar collector heat exchanger. Through heat exchanger, vapour are turned into liquid and returns to the lower side of the heat pipe. The heat transfer to the liquid from solar colector is conducted through copper pipe. As long as the heat pipe solar collector is heated by the solar energy, can be achieved continuous heat circulation.

The solar pump group, Figure 6, is a type of electronic variable speed pump with a flow capacity of 2-12 l / min. This passage volume can be adjusted according to the number of panels and the height at which these panels are mounted. These efficient electronic pumps replace the classical pumping groups for thermal solar installations.

Fig. 6 - Circulation pump

Fig. 7 - Solar controller

Fig. 8 - Boiler and solar pipes

The solar controller, Figure 7, provides speed control of high efficiency pumps in standard solar heating systems. It contains two PWM outputs and additionally an input for a Grundfos Direct Sensor™ VFD, which makes it possible to accurately measure the amount of heat.

The 80 liter thermoelectric boiler, figure [8], is equipped with two heating sources to bring the water to the desired temperature. In addition to the electrical resistence, ther is the possibility of using the heat transfer from the circulating thermal agent from the enameled steel serpentine coil, which is connected to the solar heater. Combined heating system (electrical resistance + serpentine coil) is the fastest way to achive the desired water temperature. The boiler has an advanced safety systems, equipped with overheating and overpressure protection devices and a thermostatat for automatic shutdown when the desired temperature is reached.

RESULTS

The yearly sum of solar irradiance that is obtained in a specific location can be calculated with formula (1) [6,7].

$$E = A \cdot r \cdot h \cdot PR \quad (1)$$

$$r = \frac{P}{A} \quad (2)$$

E - Energy (kWh)
P - Electrical power (kWp)
A - Total solar panel Area (m^2)
r - Solar panel yield or efficiency(%)
h - Annual average solar irradiance on tilted panels (1595 kWh/m^2 per year in Danube Delta)

PR - Performance ratio, coefficient for losses (0.5÷ 0.9, default value = 0.75)

$$PR = \frac{Actual\ Yield_{AC}}{Target\ Yield_{DC}} = \frac{E}{hA\eta_{nom}} = \eta_{pre} \cdot \eta_{rel} \cdot \eta_{sys} \qquad (3)$$

η_{pre} - pre-conversion efficiency

η_{rel} - relative module efficiency

η_{sys} - system efficiency

The controller installed for the photovoltaic system allows to monitor the energy production via the Internet. Statistics on energy production can be viewed by connecting to the Victron VRM server at: https://vrm.victronenergy.com/installation.

Thus, for the photovoltaic system installed on the pontoon it is possible to visualize the production of energy and how it is used in the system on days, month or year. Figures 9 and 10 show the production and distribution of consumption for a period of 6 days.

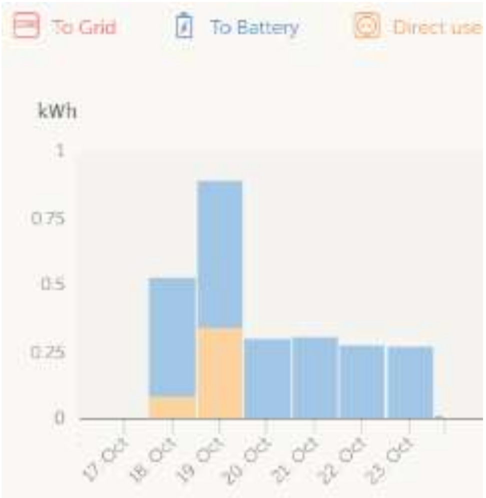

Fig. 9 - Solar production

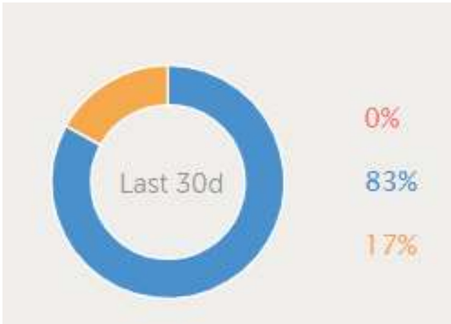

Fig. 10 - Solar yield usage

CONCLUSIONS

The system installed on the pontoon can provide energy independence on summer days or reduce the consumption of diesel from the generator in less sunny days. In areas where the electricity network is available, the cost of bills can be reduced.

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TECHNOLOGY FOR CULTIVATING SWEET SORGHUM / *TEHNOLOGIA DE CULTIVARE A SORGULUI ZAHARAT*

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Keywords: *varieties, soil, stem, bioethanol, bio-based products, compost*

ABSTRACT

Sweet sorghum is one of the four major groups of sorghum grown for its sweet stems, this plant being a possible alternative or complementary one for crops to supply raw materials to the sugar industry. The existence of a large number of varieties and especially hybrids, as well as the existence of a favourable framework for their cultivation, has led to an increase in growers' interest for cultivating this plant. The sorghum can have multiple uses for the economy; it is used to produce biofuel from the stem (bioethanol, solid fuel etc.), to obtain products for the food industry, to obtain supplements from the fruit and stem, as well as for livestock sector as feed, in direct or ensilaged form. Also, sorghum can be used as a green fertilizer or to cover crops to suppress weeds from other agricultural or horticultural crops, as a mulch product.

In the present paper we propose to present some aspects of the sorghum culture, insisting especially on the technology of its cultivation, according to the pedoclimatic conditions and the technical endowment with technical equipment specific to Romania.

REZUMAT

Sorgul zaharat este una din cele patru grupe majore de sorg cultivate pentru tulpinile sale dulci, această plantă fiind o posibilă alternativă sau complementară a culturilor, pentru a furniza materie primă pentru industria zahărului. Existența unui număr mare de soiuri și mai ales hibrizi, precum și existența cadrului prielnic de cultivare a acestora, au condus la creșterea interesului producătorilor pentru cultivarea acestei plante. Sorgul poate avea multiple utilizări pentru economie, acesta fiind folosit pentru producerea de biocombustibil din tulpini (bioethanol, combustibil solid etc), pentru obținerea produselor destinate industriei alimentare, pentru obținere de suplimente din fruct și tulpină cât și în sectorul zootehnic ca hrană pentru animale, sub formă directă sau însilozată. De asemenea, sorgul poate fi utilizat și ca îngrășământ verde sau pentru acoperirea culturilor în vederea suprimării buruienilor din alte culturi agricole sau horticole, ca produs pentru mulcire.

In lucrarea de față ne propunem să prezentăm câteva aspecte legate de cultura de sorg, insistând în mod deosebit pe tehnologia de cultivare a acesteia, potrivit condițiilor pedo-climatice și de dotare tehnică cu echipamente tehnice specifice României.

INTRODUCTION

Sweet sorghum is one of the four major groups of sorghum grown for its sweet stems. The scientific argument - the existence of a large number of varieties and especially hybrids, as well as the existence of a favourable framework for their cultivation, both for the production of biofuel (bioethanol, solid fuel, etc.) [5, 6] and for obtaining the products for the food industry and the livestock sector [3].

The economic argument - sorghum is a productive plant, unpretentious to soil fertility, drought, involves minimal expenses for cultivation and processing; it is a plant that does not produce losses, even waste is cost-effective. In this sense, the sorghum has been studied from the point of view of performance in land use, profitability of production, the possibility of using it for obtaining food and non-food products, for animal feed and last but not least for obtaining and using bioethanol [1, 2, 3, 4, 5, 6].

Ecological argument - sweet sorghum, cultivated on large surfaces, could substantially solve the problem of the air pollution, 1 ha of sweet sorghum absorbs annually from the atmosphere up to 50-55 tons of carbon dioxide, while deciduous forests absorb 16 t/ha/year of dioxide, and grains 3-10 t/ha/year. In the light of the Kyoto Protocol, Romania and Bulgaria have all the chances of winning important amounts of money only from growing large areas of sweet sorghum, or one hectare of sorghum absorbs 50-55 tons of carbon dioxide annually, releasing huge amounts of oxygen [1].

The sorghum is also used as a green fertilizer or to cover crops to suppress weeds from nursery crops through the allelochemical action of its root exudate, which has been described as a mixture of biologically active hydrophobic substances called “sorgoleone”.

In Romania, studies and researches on sorghum crops have been carried out in order to track its behaviour under the pedoclimatic conditions specific to our country [2].

Sorghum cultivation technologies are generally used both for straw cereals and weeding crops, the technical equipment being the same, the working parameters being adapted to the culture’s specificity.

In this paper we propose to review the technology of sorghum cultivation, with the identification of the works and related technical equipment, as well as a synthesis of culture parameters and conditions.

MATERIAL AND METHOD

Establishing the cultivation technology of sweet sorghum, according to pedoclimatic conditions and the technical endowment with technical equipment specific to Romania.

When establishing a sorghum crop, we must take into account all the specific requirements of an agricultural crop, as follows: location according to the geographical area, temperature requirements, moisture requirements, light requirements, soil requirements.

Also, the establishment of sorghum culture involves carrying out all the necessary agricultural works with the identification of the necessary technical equipment.

RESULTS

The agricultural works required to set up the sorghum culture are:

1. Application of fertilizers

- ***Application of chemical fertilizers and amendments***

Chemical fertilizers and amendments are applied with the specific equipment, which, in general, may be of semi-mounted or mounted type, with loading capacities between 500 and 12,000 kg.

Most of them have a disc-type spreading device, with 1 or 2 discs, as shown in Figure 1.

a) b)

Fig. 1 - Technical equipment for applying chemical fertilizers

a) – semi-mounted type [7]; b) – mounted type [8]

- ***Application of organic fertilizers***

Basic organic fertilizers that can be applied to sorghum crops are of two types: solid such as manure, composts and liquid or semi-liquid (urine, manure must).

Solid organic fertilizers are applied with manure application equipment, of which the most commonly used are those with horizontal or vertical application rotors, Figure 2, a.

Liquid or semi-liquid organic fertilizers are applied on the soil surface, foliar or incorporated into the soil and this operation is carried out with technological trailers for urine application.

In Figure 2, b is a tank trailer for applying liquid or semi-liquid organic fertilizers with their incorporation into the soil.

Fig. 2, a – Equipment for applying solid organic fertilizers [9]

Fig. 2, b – Equipment for applying liquid or semi-liquid organic fertilizers [10]

2. The basic soil works and seedbed preparation

The soil works are aimed at loosening it for improving the water, air and nutrients regime, incorporating vegetal debris, levelling the soil, controlling weeds and ensuring plant growth.

- ***Basic soil works - Plowing***

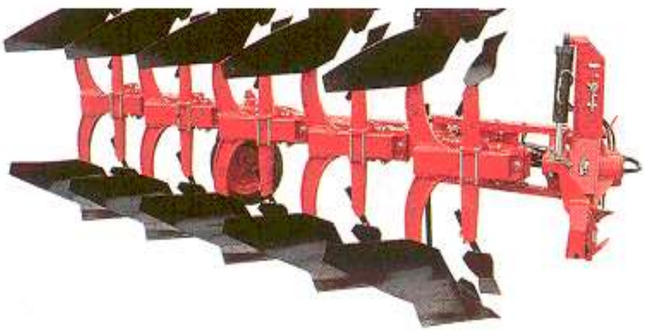
The basic soil work is plowing, which is executed immediately after the land is cleared. Plowing depth for sorghum is set between 20 - 30 cm, on the zonal soils and 15-18 cm on the salty and sandy soils, the deeper work being necessary on the soils with important weed encroachment or on those with large amounts of vegetal remains and on compact soils.

On superficial soils, the plowing depth is limited to the thickness of the humus layer. On sloping land, the plowing is executed in the direction of the contour lines.

Plowing is done with the plow, which can be of the normal reversible type, Figure 3.

The plows can be equipped with a number of plow bodies that can vary from one to 11, on a case by case basis, using tractors with power ranging from 45 to over 300 HP.

On salt soils it is recommended to replace the plowing with the work without turning the furrow with the chisel, Figure 3, b.



a)

b)

Fig. 3, a, b, – Equipment for basic soil works [11, 9]

- ***Seedbed preparation***

This operation is intended for soil levelling, weed destruction and preparing a soil layer loosened and ground on the sowing depth. Seedbed preparation is done by a small number of works that scrape the soil as little as possible, in order to reduce the loss of water by evaporation.

The last work for seedbed preparation is done on the seeding day or the day before, with the combinator, in order not to favour weed encroachment of the field before the emergence of the culture.

Seedbed preparation is carried out with equipment generally called harrows, which depending on the working parts can be with discs, fixed or rotating teeth, helical, stellar or combined, Figure 4.

Fig. 4 – Harrows [11]

3. Seeding

- ***Seeding methods***

Several seeding methods are known, which differ from each other in terms of seed distribution on the soil surface, as well as of the soil surface profile.

Depending on the nutrition space to be provided to each plant and correlated with the need to achieve a density on the surface unit, in practice, for the seeding of straw cereals, several seeding methods are used, namely:

- regular row seeding (10-15 cm) is almost generalized in our country for crops with high and very high densities. Seeding is performed at 12.5 cm between the rows using the universal seeders, Figure 5;
- close (dense) row seeding 7.5 - 8 cm between rows and 1-7 cm between plants per row. It is the best seeding method for crops that are currently seeded in regular rows, especially for those with very high densities (over 1,000 germinable seeds/m^2). In this case, the universal seeders are equipped with double coulters. The land must be well levelled, without vegetal remains or lumps.

Fig. 5 – Universal seeder [12]

- distanced, equidistant row seeding at 25 - 100 cm between rows, which is practiced for medium-density crops (80-100 seeds/m^2) and small density (3-10 seeds/m^2), is performed either with universal seeders, which distribute evenly the seed along the row, or with the precision seeders, which distribute the seeds to the final place, in holes, along the rows, Figure 6.

Precision seeders can perform fertilizer application together with seeding.

Fig. 6 – Precision seeders [11,12]

4. Crop maintenance and irrigation

- ***Maintenance works***

In order to maintain the sorghum culture clean in the first 45 - 50 days after the emergence is the condition of expressing the production potential and quality of the hybrids and varieties due to the favourable effect of eliminating competition for nutrients and water caused by weeds and stimulating the favourable microbiological activity from the active horizon of the soil by loosening it. Integrated weed control is achieved through non-chemical agrotechnical methods and by using herbicides.

Hoeing is the work that is executed mechanically between the plant rows and manually on the row, with the help of technical equipment for mechanical hoeing, called cultivators, Figure 7. Hoeing is carried out after the plants' emergence, when weeds appear, observing the quality agrotechnical requirements.

Fig. 7- Cultivators [12, 13]

- ***Crop irrigation***

Irrigation systems are intended for irrigation of high crops (corn, sunflower, hemp, etc.), medium (wheat, barley, rye, soybean etc.), low (sugar beet, medicinal plants, lucerne etc.).

The most used are: reel drum irrigation system, Fig. 8 and the ramp and mobile pivot irrigation system, Figure 9.

Fig. 8 - Reel drum irrigation system [14]

Fig. 9 - ramp and mobile pivot irrigation system [15]

5. Chemical control of weeds, diseases and pests

Curative treatments in vegetation - are necessary for the attack of diseases and pests that occur during the vegetation period. Tee-jet nozzles will be used to guide the solution on both sizes of the leaf limb and the growth cone of the plant and it must be ensured the sealing of the tank and the hoses taking the solution to the nozzles.

The treatments are carried out with specialized equipment, equipped with ramps and spray nozzles, of various capacities and constructive types, respectively, self-propelled, trailed or mounted, Figure 10.

Fig. 10 – Equipment for phytosanitary treatments [8]

6. Harvesting

The quality of sweet sorghum depends largely on the time of harvest. Cultures of sorghum for juice and sugar must be harvested when the maximum amount of sugars is found in the plant, with the highest percentage of sucrose. As the plant advances in maturity, juice quality improves by increasing the percentage of sucrose and decreasing the glucose one. Increasing the percentage of sucrose offers the possibility to obtain sugar, besides syrup, from this plant.

Harvesting in the case of grain sorghum is done at the full maturity of the grains, using the cereal harvesting machine. Grain sorghum is harvested at the full maturity of the grains, when their humidity is low, because there is no danger of shaking.

The silo culture is harvested in the milk-wax or wax phase of the grains, and when mixed with soybean at the end of the sorghum flowering.

Harvesting of sorghum for silos or bioethanol can be done with different machines, by chopping (Figures 12 and 13).

Fig. 12 – Harvesting with machines specialized for sorghum [16]

Fig. 13 – Harvesting with self-propelled machines for silo corn [17]

RESULTS

Table 1 summarizes the technology of sorghum cultivation, with the identification of the works and related technical equipment, as well as the crop parameters and conditions.

Table 1

Sorghum cultivation technology

No.	Name of the work	Working equipment	Pedoclimatic and technological conditions	Working parameters
1	**Application of fertilizers** - chemical	- equipment for applying chemical fertilizers and amendments: trailed, semi-mounted, mounted. - equipment for applying solid organic fertilizers with horizontal or vertical	- not to be applied on strong wind - well-composted manure is used, which is incorporated under the	- norm: 24 kg of nitrogen, 9 kg of phosphorus and 8 kg of potassium for 1 ton of grains or for 8 to 10 t of green

	- solid organic - liquid organic	spreading pipes. - tank trailers for liquid fertilizers, applying them on the soil surface or incorporating them into the soil.	autumn plowing.	mass - 15 - 20 t/ha on zonal soils, 20 - 30 t/ha on salt soils and 15 - 20 t/ha on sandy soils.
2	**Basic works** - plowing - minimum works	- normal or reversible plows - chisel, combined aggregate		- depth: 20 - 30 cm, for zonal soils and 15-18 cm for the salt soils and the sandy ones
3	**Seedbed preparation**	- harrows (with discs, fixed or oscillating teeth, helical, with tooth rotors, stellar) - combinators	-the last work for seedbed preparation is done on the seeding day or the day before, with the combinator	-processing depth: 10 - 12 cm.
4	**Seeding** - on regular rows - on distanced rows	- universal seeder with crop coulters or with discs - precision seeders	- in spring when the soil temperature reaches 10 - 12°C, at 10 cm depth.	- the average depth is 3-4 cm on heavy soils and 5-7 cm on light soils. - distance between rows 12.5 cm for close row seeding or - for distanced row seeding, 25-100 cm between rows
5	**Maintenance works** - hoeing - irrigation	- cultivators - reel drum systems or ramp and mobile pivot systems	- the first hoeing when the plant has 3-4 small leaves - the second hoeing when the plant has 6-7 leaves - the third hoeing when the plant has 9-10 leaves	-working depth 6-8 cm. - the water demand of sorghum is 3000 - 3800 m^3/ha of which the rainfall covers about 55 - 70%
6	**Chemical control of weeds, diseases and pests**	- spraying equipment self-propelled, trailed, semi-trailed or mounted	- seeds are being treated - soil treatments - curative treatments in vegetation (Treatment will be done on dry weather, when plants lack dew)	- application dose – see the recommendations of the substance manufacturers
7	**Harvesting**	- self-propelled harvesters for grain sorghum harvesting. - self-propelled harvesters for harvesting sorghum chopped stems. - self-propelled harvesters for harvesting silo corn. - trailed harvesters for harvesting silo corn.	- for grains it is made at the full maturity of the grain - for silo, it is harvested in the milk-wax or wax phase of the grains - for syrup it should be harvested when the grains are in the soft dough phase	

CONCLUSIONS

- The sorghum can have multiple uses for the economy; it is used to produce biofuel from the stem (bioethanol, solid fuel etc.), to obtain products for the food industry, to obtain supplements from the fruit and stem, as well as for livestock sector as feed, in direct or ensilaged form.

- Sorghum can also be used as a green fertilizer or to cover crops to suppress weeds from other agricultural or horticultural crops, as a mulch product.

- As a result of the multiple possibilities of using sorghum, scientists and plant growers have turned their attention to this culture, trying to research and implement various cultivation and processing technologies.

- Sorghum cultivation technology involves the realization of agricultural works, as follows: application of fertilizers; basic soil works; seedbed preparation; seeding; crop maintenance and irrigation; control of weeds, diseases and pests; harvesting fruits and stems.

ACKNOWLEDGEMENT

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[17] 17. CLAAS harvester prospects.

HOW WE HAPPEN AND HOW TO USE THE THERMAL ENGINE TOUR / *CUM APRECIEM ȘI CUM FOLOSIM TURAȚIA MOTOARELOR TERMICE*

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Keywords: *crankshaft speed, engine load, engine thermal regime, energy indices*

ABSTRACT

Motor vehicle rating parameters are expressed using features that are graphical representations of sizes that make it possible to compare with other similar engines and establish behavior in service. For motor vehicle dynamics, the engine speed or external characteristic speed characteristic is used, which represents the actual power variation curve and the actual moment depending on the engine speed or angular speed. At present, standards on engine testing methods vary from country to country, with regard to no. engine mounts during the tests, the volume of test work and the working conditions. As a result, for one and the same engine, it is possible to obtain different speed and load characteristics, depending on the standard or the tests performed. It has been found that the increase in the speed above the maximum allowable value, the engine power is considerably reduced due to the worsening of the filling of the cylinders with the fuel mixture and the mechanical losses in the motor. For these reasons and in order to avoid the high dynamic loads it is recommended that at maximum speed the displacement max. do not exceed the maximum power speed by 10 ... 20%.

REZUMAT

Parametrii de apreciere ai motoarelor de autovehicule sunt exprimati cu ajutorul unor caracteristici care sunt reprezentari grafice ale unor marimi ce permit compararea cu alte motoare similare si stabilirea comportarii in exploatare. Pentru studiul dinamicii autovehiculelor se utilizeaza caracteristica de turatie la sarcina totala a motorului sau caracteristica externa, care reprezinta curba de variatie a puterii efective si momentul efectiv in functie de turatia sau de viteza unghiulara a arborelui motor.

In prezent, standardele privitoare la metodele de incercare a motoarelor difera de la o tara la alta, in ceea ce priveste numarul de agregate anexe ce sunt montate pe motoare in timpul incercarilor,volumul lucrarilor de incercare si conditiile de lucru. Ca urmare, pentru unul si acelasi motor, se pot obtine caracteristici de turatie la sarcina totala si partiale diferite, in functie de standardul dupa care sau efectuat incercarile. S-a constatat ca prin cresterea turatiei peste valoarea maxima admisibila, puterea motorului se reduce simtitor din cauza inrautatirii umplerii cilindrilor cu amestec carburant si sporirii pierderilor mecanice din motor. Din aceste motive si in vederea evitarii solicitarilor dinamice mari se recomanda ca la viteza maxima de deplasare tutatia max. sa nu depaseasca turatia corespunzatoare puterii maxime decat cu 10...20%.

INTRODUCTION

In addition to the characteristic values of maximum engine power indications, the maximum torque and the specific fuel consumption of the tractor engines are particularly relevant for the variations of these parameters depending on the operating mode and, in particular, the speed and load, variations that are appreciated by the proper engine characteristics (*Ionel I., 2015*).

The curves of the total engine speed characteristic of an engine can be plotted using the following relations:

- for actual power:

$$P_{ex} = P_{emax} .* [a\frac{nx}{np} + b\left(\frac{nx}{np}\right)^2 - \left(\frac{nx}{np}\right)^3] \quad [Kw] \qquad (1)$$

- for specific consumption:

$$C_{ex} = c_{ep} .* [c- d\frac{nx}{np} + k\left(\frac{nx}{np}\right)^2] \quad [g.Kw.h] \qquad (2)$$

- for engine torque:

$$M_{ex} = \frac{3*10^4}{\pi} * \frac{P_{ex}}{n} \quad [Nm] \tag{3}$$

where:
P emax, Pex represents actual power and momentary power;
pin, c ex - fuel consumption at maximum and nominal power;
nx / np ratio between momentum and maximum power;
A, b, c, d, k, coefficients depending on the type of engine

MATERIAL AND METHOD

For the study, a John Deere 4-cylinder engine equipped with agricultural tractors was used. The engine characteristics are shown in Table 1. The method used is presented in the literature (*Bobescu B., 1998; Năstăsoiu and Sărăcin, 2000; 1999*).

Table 1

Engine features

Features	**CELTIS 446**
Number of cylinders	4
Type of injection	Mechanical [rotary pump]
Cylinders capacity [cm^3]	4530
Normal power according to ECE R24 [kw]	66
Speed at maximum power [rot / min]	2100
Specific consumption at maximum power F[g/KW.h]	229
Power mode at [rot / min]	540 la 2111 [rot/ min] engine
	1000 la 2118 [rot/min] engine

The operating mode of the engine is characterized by the effective power P e, which is the main parameter, which in turn depends on the motor torque Me and the crankshaft rotational speed ω or the speed n, expressed by:

$$Pn = Mn * \pi n/30 \ [kw], \tag{4}$$

Where:
M e is expressed in N·m, n in min-1

During operation, both engine torque and crankshaft speed vary greatly due to the variation of the tractor's resistances and speeds. The minimum stroke is circumscribed by the stable engine operating conditions and the maximum of the gas change process qualities the thermal loading of the main parts, the increase of inertial forces, the increase of mechanical losses, as well as a number of factors defining the durability and reliability of the engine. (*Chiriac, 2011; Constantin, 2006*).

The operating conditions can be represented graphically by a limited area of a power variation curve; or engine torque on a type chart:

$$Me = f(n), \quad P e = f'(n). \tag{5}$$

The engine's operating mode is characterized by the intersection of a power curve developed by the engine and a power curve needed to overcome the tractor's resistance. The operating conditions as a whole are highlighted by power and economy indicators, by thermal, mechanical and other stresses, which characterize the engine's operating regime.

There are three fundamental dimensions that influence the operating mode of an engine defined by:
- crankshaft speed;
- engine load;
- engine thermal regime.

The following categories of indicators are used to evaluate the engine's downturn:
- energy indices;
- economic indices;
- exploitation indexes, including functional ones.

Grouping of operating modes is done in several classes. Thus, the operating regimes in relation to the time variation of the sizes defining them, are divided into (*Sârbu I., 2011*):

- permanent regimes;
- non-permanent schemes.

The permanent regime, also called stationary or stabilized, is characterized by load, speed and thermal and mechanical stresses of constant values within narrow limits of variation due to regulation systems.

The non-permanent regime, referred to as transient or unstable, is characterized by the wide variation of the factors mentioned.

It ensures transition from one permanent regime to another, as well as the startup and shutdown operations of the engine.

Depending on the engine running time, it is distinguished:

- continuous operation regimes;
- intermittent operation modes.

The continuous mode of operation is that in which, at any speed, the engine continuously develops the highest effective power, the highest effective motor torque, the highest effective average pressure, provided that the technical and economic indicators Reliability to remain unaffected (*P ec, M ec and furnace*).

The intermittent mode of operation is that in which the effective power, actual engine torque and effective pressure are higher than Pc, M ec, and furnace for short intervals without seriously affecting the durability and dirtiness of the engine. The maximum power, engine torque and average pressure values that the engine develops under intermittent operating modes are called intermittent blinking power, intermittent motor torque and intermittent mean pressure.

From all the variation processes of the parameters that characterize the engine's operating regime, while reducing the fuel flow per cycle, the low duration of the axle o has the variation in the rotational speed of the crankshaft (*Salvadore Mugurel Burciu, 2015*).

In general, the variation in the operating index of the thermal motors, such as power, engine torque, time and specific fuel consumption, can be studied and represented according to operating mode parameters such as speed, load, etc.

The characteristics that determine the power variation (Pe) and the specific consumption (ge) according to the fuel hourly (Gc), the excess air (λ) or the injection feed angle (θ inj) are the characteristics of engine setting.

The adjustment features can be traced for both total load (maximum injection) and partial loads. The raising of these features is necessary to determine the optimal operating conditions of the engine in relation to the above mentioned factors and the appreciation of the perfection of the engine settings.

For Diesel engines, the amount of fuel injected at a constant speed depends on the injection pump whose flow exceeds, in most cases, the maximum flow required.

Excess fuel injected may worsen the combustion process, causing the economy and efficiency of the engine to decrease.

RESULTS

Studying the curve altitude (Figure 1) it is observed that the maximum power is reached for degraded mixtures:

$$(\lambda\, Pmax = 1{,}05 - 1{,}1) \qquad (6)$$

The variation in fuel hour consumption is achieved by displacing the injection pump load gauge and keeping the speed constant by changing the load.

Increasing fuel hour consumption leads to enrichment of the mix, resulting in increased power. For optimum dosage, specific fuel consumption reaches the limit value. Then the specific fuel consumption increases, due to the worsening of combustion due to lack of air, the engine runs smoke, increases the temperature.

The maximum fuel flow of the pump pumps is adjusted so that the Climate Time Limit Consumption is not exceeded. This mode of operation is called the Maximum Limit Power Mode.

In the power regime, a more economical operation with lower thermal and mechanical stresses and acceptable ecological parameters is ensured.

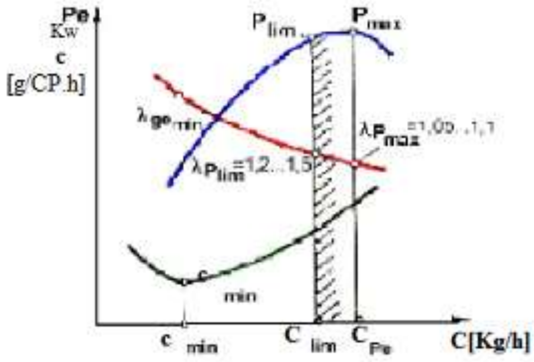

Fig. 1 - Adjustment feature depending on the composition of the mixture

In practice, the consumption characteristics are determined for different speeds, determining the optimal setting for each speed.

Since cmin is performed at values λ = 2 - 3.5 sometimes, in the case of Diesel engines, air valves are introduced which limit the suction air flows to lower partial loads.

Tractor engines during operation, for the most part, operate at partial loads when the power deliberately drops at a steady speed. The evaluation of the engine in such operating modes is done by economic efficiency, by raising the load characteristics, which determines the dependence of the Cc hour consumption and specifies the fuel charge of the motor at a constant speed (Fig. 2).

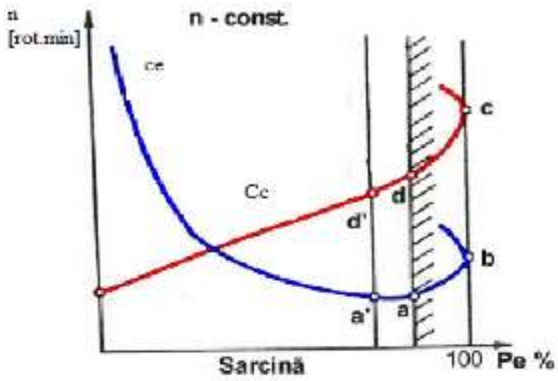

Fig. 2 - The MAC load characteristic

The speed characteristic features energy ratios and de-economics of the engine according to the speed. The speed characteristic represents the variation of the effective power P e, the engine torque M e, the time consumption Cc and the specific fuel depending on the engine speed n, at constant load.

The speed characteristic (Fig. 3) is the speed variation curves of the known parameters and corrected parameters (actual power and lobe torque - dotted curves).

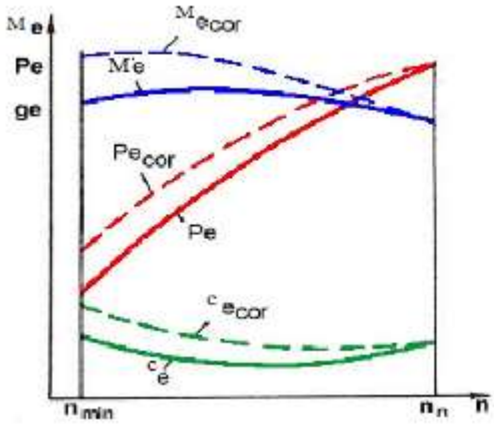

Fig.3 - Correcting the speed characteristic

It is noted that the torque reduction which equals the decrease of the torque is obtained due to the rising speed. The maximum idling speed depends on the destination of the engine and varies within the limits

$$n_{mq} = (1{,}06 \ldots 1{,}1)n_n. \quad (7)$$

The characteristic curves extend over the entire speed range, regardless of speed, and are approximately parallel. This is explained by the fact that the filling degree of the cylinder remains virtually invariable depending on the constant bending load.

Estimating the dynamic performance of an internal combustion engine can be done by analyzing the torque and power characteristics. These characteristics represent the variation of torque and power depending on engine speed. If we are only interested in dynamic performances and less in consumption, we have the characteristics of torque and power at full load (Fig. 4).

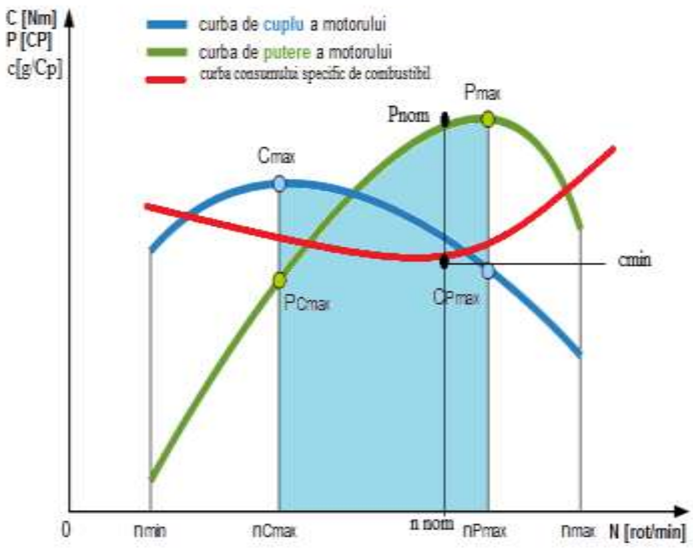

Fig. 4 - The torque and power characteristic of a thermal engine

The interdependence of several engine functional parameters, generally including the variations of a functional parameter, (engine torque) depending on a mode parameter (speed) over which the isometric curves of interdependent sizes (specific fuel consumption) overlap represented by the complex features.

Since the minimum specific fuel consumption is achieved at a single speed and torque regime, the complex feature gives a representative point of economic significance.

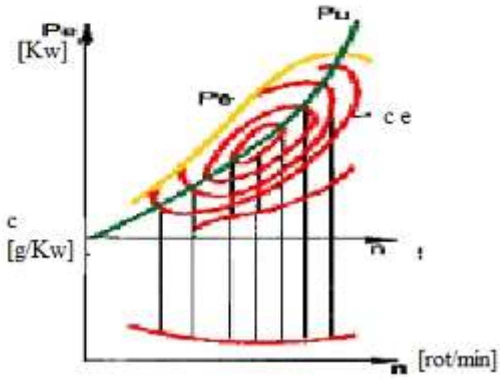

Fig. 5 - Complex torque characteristics and specific consumption depending on the speed

The closest approximation of the economic pole of this complex characteristic of the power curve or their superposition (Fig. 5) and the arrangement of the respective pole at the average speed, most frequently used in operation, increase the engine's economy.

CONCLUSIONS

There are three fundamental dimensions that influence the operating mode of an engine defined by: crankshaft speed; engine load; engine thermal regime

Since the minimum specific fuel consumption is achieved at a single speed and torque regime, the complex feature gives a representative point of economic significance.

Estimating the dynamic performance of an internal combustion engine can be done by analyzing the torque and power characteristics.

These characteristics represent the variation of torque and power depending on engine speed

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INNOVATIVE TECHNOLOGIES TO REDUCE THE NEGATIVE IMPACT OF CLIMATE CHANGES IN VEGETABLE CROPS
/
TEHNOLOGII INOVATIVE PENTRU REDUCEREA IMPACTULUI NEGATIV AL SCHIMBĂRILOR CLIMATICE ÎN CULTURILE LEGUMICOLE

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Keywords*: climate changes, vegetable crops, agriculture, innovative technologies*

ABSTRACT
Vegetables are an important source of food that has been affected in recent years by climate change which causes substantial reductions in the quantity and quality of legume yields. In this work is presented the project "Innovative technologies to reduce the negative impact of climate changes in vegetable crops", which will analyze and develop ways to reduce the negative impact of climate change.

REZUMAT
Legumicultura constituie o sursă importantă de hrană, ce a fost afectată în ultimii ani de schimbările climatice care produc diminuări substanțiale în ceea ce privește cantitatea si calitatea producției legumicole. În această lucrare este prezentat proiectul ”Tehnologii inovative pentru reducerea impactului negativ al schimbărilor climatice în culturile legumicole” în care se vor analiza și dezvolta modalitățile pentru reducerea impactului negativ al schimbărilor climatice.

INTRODUCTION
Romania is one of the European countries with the greatest potential in the agricultural sector, having the sixth largest agricultural area in the EU countries (*Finance Newspaper 2017*). Romania has an agricultural area of 14.8 (61.8% of the total area of the country) million hectares, of which only ten million are occupied with arable land (*madr.ro*).

Based on the estimates presented in the Fourth Global Climate Change Assessment Report (AR4), prepared by the Intergovernmental Panel on Climate Change (IPCC) in Romania, in the next period will increase temperatures similar to the whole Europe compared to reference period 1980-1990.

The study aims at developing technologies to reduce the negative impact of climate change on agriculture crops in the domain of sustainability in agriculture because this is one of the most exposed sectors to climate change because it is dependent on weather conditions (*European Commission, 2009*).

Climate change has severe effects on agriculture and most probably, in the near future, climate change will increase irrigation needs, which will be constrained by reduced runoff, demand from other sectors, and by highly economic costs (*Kovats, R.S. et al., 2014*). Effects on the water are represented by the quantitative decrease of the surface water courses and the deepening of the groundwater basins. Soil is affected by processes of degradation of its structure and fertility; by the drought phenomenon which has increased in frequency and intensity, with important consequences on the agriculture sector. About 2% of the total agricultural area of Romania is affected annually by extremely severe drought, in this case the plant cultivation not being possible without irrigation, while on 38% of the total agricultural area, the irrigation has the role to complete the precipitation for ensuring the water demand for agricultural crops (*Nicolescu C. et al., 2007*); and the climate is affected by extreme temperatures, alternation of dry climate with wet climate, aridization and desertification tendencies. All this leads to instability of crops, calamities, restriction of agricultural lands and assortment of cultivated species, reduction of water sources (*Nicolescu M., 2014*)

Cultivation of vegetables is an important sector of agriculture, which is an important source of food for the majority of Romania's population (*Soare E et al. 2016*). This has recently been affected by the extreme phenomena caused by climate change, so measures must be taken in order to prevent and combat them, or vegetable production will decline by a third in the second half of this century, according to statistics (*Scheelbeek P. 2018*).

Through research done so far, the partners in the consortium can resolve some of the problems created by climate change, more specifically about the growing of the aggressiveness of diseases and pests, because they have new ecological means of technological intervention that can be integrated in the practical sustainable crops with the production of quality vegetables satisfying the requirement of consumers for healthy products with superior organoleptic properties. There will be the possibility to start developing some branches related to the production of biological agents of ecological protection (beneficial microorganisms) and to capitalize on natural resources (diatomite deposits). In order to combat the effects of climate change, the main measures to be taken are the creation of new varieties resistant to thermo-hydric stress, the ecological control of weeds and pests, the improvement of vegetable cultivation technologies and the modernization of plant shading systems.

The work is structured in three projects with different activities in order to find solutions to three of the problems caused by climate change in vegetable crops, the occurrence of climate extremes has become more and more important when referred to intensity of this events. The knowledge of the patterns and changes during time, contribute to understand their nature and the impacts they can have on socio-economic activities (*Ciobotaru N. et al., 2017*), through the collaboration of seven research institutes with extensive experience in the field. Complex studies will be carried out on the effects of climate change on onion, bean and pepper crops from the Vegetable Research and Development Station Buzau germoplasm collection.

The first project is represented by the scientific substantiation regarding the technologies for maintenance and protection of the vegetal crops in the context of the climate change, which aim at applying methods and means in the crop technology, testing of varieties and mechanisms and their integration into the sustainable crop management system vegetable**.** Ecological weed control technologies in vegetable crops, represent a part of the second project, which aims to design an experimental combined equipment for ecological weed control using the hot water method to protect the environment so that herbicides are not used. In the last project will be developed an eco-sustainable technology for the prevention and reduction of diseases, aggressions and pests in crops by develop an experimental model of ecological technology for the sustainable protection of vegetable crops (onions, beans, peppers) against climate change.

MATERIAL AND METHOD

In the first project, ”The scientific substantiation on the technologies for maintenance and protection of vegetable crops in the context of climate changes”, the overall objective is scientifically substantiated by determining the quality and quantity of production under conditions of protection of crops in the context of extreme climatic conditions; the application of innovative technologies and the creation of new varieties resistant to these conditions. The specific objectives are the application of some methods and means in crop technology, the testing of varieties and mechanisms and their integration into the sustainable management system for vegetable crop. Climate changes that have occurred in recent years have led to substantial reductions in the quantity and quality of leguminous production. Among the most aggressive phenomena are the very high temperatures that produce sunburn, fruit baking, and high aggression of diseases and pests. Solutions to combat the effects of climate change and the quantitative and qualitative increase in vegetable production are plant shading systems, the creation of varieties resistant to thermo-hydric stress, the ecological control of weeds and diseases and pests and the improvement of vegetable cultivation technologies.

In order to reduce the impact of climate change on vegetable crops, will be analyzed the negative effects on bean, onion and pepper crops. There will be created two varieties of peppers, a variety of beans and will be performed the rehabilitation of a variety of onion, as well as the use of an electrically operated sowing distributor. The varieties will have distinctiveness, uniformity and stability, with increased resistance to harsh environments, but improved due to protection systems, will be homologated and patented. The electrically operated sowing distributor is designated to ensure plant density for optimal nutrition. For this equipment, the patent application is registered.

In the second project „Technologies for the ecological control of weeds in vegetable crops” the main objective is to develop equipment for the ecological control of weeds, since this has become a major challenge in organic farming. Applying herbicides to achieve maximum *legume yields*, requires a more effective and environmentally friendly method for weed control. The most suitable for organic crops, the thermal method of combating weeds (with flame or hot water), has the advantage of being used before and after crop planting. The effects of this thermal control method are: weakening and diminishing nutrient deposition, protein coagulation and cell compression, causing wilt and easy destruction of weeds with heights of 2-5 cm.

The weed control method in our country is less used, and the use of hot water is not used at all. Under these circumstances, and due to the need to maintain the crops it is necessary to develop an ecological weed control technology in plant cultures by developing innovative equipment for this purpose.

The scientific and technical novelty of this project is represented by using the thermal method treatment of weeds from vegetable crops, based on the patent application no. A-01000 / 12.12.2016 (Patent Title: Ecological Weed Control Equipment). Hot water will be obtained by recovering the heat of the gases emitted during the operation of the tractor, the equipment being provided with an automatic system for monitoring and controlling the temperature and pressure of the water as well as the distributed quantity. The action of hot water on weeds between the rows of vegetables will be combined with the use of active organisms of friendly plants, which will act in their vicinity /proximity without damaging them. Through experience in developing innovative crop maintenance machines, the National Institute of Research - Development for Machines and Installations Designed to Agriculture and Food Industry will design and produce combined equipment for organic weed control in vegetable crops. Ensuring a friendly environment with the technology will be verified by National Institute for Research and Development in Environmental Protection experts.

In the last project "Sustainable eco-technologies to prevent and reduce disease, aggression and pests" the main objective is developing an experimental model of ecological technology for the sustainable protection of vegetable crops (onions, beans, peppers) and their integration into the vegetable crop management system for adaptation to climate change. Development of new methods and means of intervention in crop technology for increasing the resistance of plants to aggressiveness; testing new methods and means and integrating them into the sustainable crop management system of vegetables. The proposed experimental technology model is based on the use of non-chemical ecological means applied to seeds, soil and plants, which by their beneficial intake will simultaneously achieve the biological fortification of seeds and plants, the creation of hostile conditions for pathogens and pests in soil, mechanisms of plant resistance to diseases and pests and mechanical protection of plants. The increased aggressiveness of diseases and pests to vegetable crops, caused by climate change, is reflected in the quantity and quality of vegetables, which is determined by the pest control system. The experience of research consortium partners through research can help address the challenges of climate change and the aggressiveness of diseases and pests because they have new ecological means that can be integrated into sustainable crops by producing quality vegetables that satisfy consumers. It will be possible to base the development of some branches related to the production of biologic ecological protection (microorganisms) and to capitalize on natural resources (diatomite deposits).

RESULTS

By accomplishing these objectives of the project to solve the problems caused by climate change on vegetable crops, the main result expected is to create innovative technologies to reduce the negative impact of climate change in vegetable crops.

In the first project „The scientific substantiation on the technologies for maintenance and protection of vegetable crops in the context of climate changes" the expected results are represented by studies on how to cultivate onion, pepper and bean crops environmentally, methods of maintaining the quality of processing and storage of a crop, and the creation of two varieties of peppers, a variety of beans and the rehabilitation of onion varieties. Studies on fertilization, irrigation and complete weed control, methods for preventing and combating diseases and pests in the context of climate change. The technical execution plan of the experimental model and the elaboration of the method of verification in terms of friendliness for the environment and the behavior of new varieties created at climate change.

In the second project „Technologies for the ecological control of weeds in vegetable crops" the expected results are represented by a database of weeds in vegetable crops and ways of verifying the methods of combating environmental protection, the technical documentation of the equipment's execution and the testing of the effects on the environment and on the quality of the vegetables. Testing of the experimental model for control, evaluation and verification from an environmental standpoint and experimental reports on the control of the beans from the onions, beans and pepper crops.

In the last project „Sustainable eco-technologies to prevent and reduce disease, aggression and pests" the objectives are represented by studies with methods and ecological means of prevention of disease and pest reduction; methods and techniques of sampling and analysis of diseases and pests; quality assessment methods; processing and preservation of the crop; methods of treatment for the prevention, reduction of diseases, aggressiveness and soil pests, seeds and plants; technologies for the treatment of onions, beans and peppers, quality assessment, harvest processing and preservation.

CONCLUSIONS

Since the impact of climate change on vegetable crops is not fully understood, this paper aims to analyze its effects, in order to develop new and efficient technologies to reduce some of the negative consequences that manifests more and more aggressively in the last years. This aggressiveness affects directly vegetables yields and also the health of the population, having in the same time drastic outcome in economy field. The work is done through the collaboration of seven research institutes. Studies will be carried out on the onion, bean and pepper crops from the germoplasm collection of the Buzau Research and Development Plant for Vegetables.

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MECHANIZATION TECHNOLOGIES FOR VINEYARD PRUNING
/
TEHNOLOGII DE MECANIZARE PENTRU TAIERILE IN PLANTATIILE DE VITA DE VIE

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Keywords: *pruning, viticulture,mechanization, discs, rotating knives, counterknife*

ABSTRACT

Pruning the vine is among the most complex works, but also the most important in viticulture, the quality of the grapes and the produced wine depending on it. This paper presents the main mechanisms of mechanization of pruning the vine, both green and dry.

REZUMAT

Tăierea viței de vie este printre lucrările cele mai complexe, dar și cele mai importante din viticultură de ea depinzând calitatea strugurilor și vinului produs. In lucrarea de fata se prezinta principalele tehnologii de mecanizare a lucrării de taiere a vitei de vie, atât in verde cat si in uscat

INTRODUCTION

Agricultural engineering applied in bearing vineyards must include: choosing the pruning system, canes directing ways and cutting types; pruning; the works and operations when green; soil works, application of herbicides and fertilizers; vineyard irrigation; controlling diseases and pests.

For each viticultural area, cultivated varieties, the specific technology is adapted to capitalize as well as possible the vine variety and the area where it is grown. Depending on the natural conditions offered by the area (climatic, edaphic, orographic, slope conditions), the machine system is adapted to support the performance of the specific technology (chosen) works with maximum efficiency.

The choice of technologies must take into account the vineyard age, the working age, the purpose for which the work is done, and finally, as a result of all the previous elements, the need for machinery for carrying out the works is established.

According to the literature *(Bucur,2011; Dobrei, 2003; Namolosanu et. al., 1990)*, the pruning regulates the growth and yielding power of the vines, facilitates the application of agrotechnical works, improves the quality of the fruit; it reduces the vegetative mass for the purpose of rational use of the nutrients absorbed from the soil, ensures the better illumination of the fruits in order to mature and ripen them faster, gives the shape of the vines and rejuvenates the plantation.

According to the period when they are carried out, they can be: “dry” pruning, applied during the vegetative rest period and “green” pruning, applied during the vegetation period.

In terms of equipment prunings are carried out with, there are manual, semi-mechanized or mechanized prunings.

Pruning involves the cutting of some shoots, but under certain conditions: the fruit elements come from one-year-old canes formed on wood for two years; replacing the canes that yielded fruit with new ones every year; the cut must be smooth so, the scissors must be positioned with the blade towards the vine. Wood should not be crushed but cut; the cut is perpendicular; if the cut elements have a thickness of more than 1 cm, fungicide treatments may be necessary *(Dobrei, 2003; Namolosanu et. al., 1990)*.

Here are some rules for vine pruning:

- when pruning is carried out, bearing canes with a thickness between 6 and 12 mm are left;
- shortening the canes is made just above the node;
- prunings are made only on one side of the multiannual wood;
- canes suppression is done 2-3 mm above insertion points;
- the replacement spur must be in the lower position than the cane for fruit bearing, as close as possible to the multiannual wood.

MATERIAL AND METHOD

It is known that leaving the vine free, without pruning, being a liana, under the influence of polarity, it tends to raise its vegetation to the top from year to year and it becomes empty at its base *(Osloberanu et. al., 1980, Bucur, 2011)*. As a result, the vegetative mass develops excessively at the expense of yielding fruit, the production being affected because the grapes that are formed remain small and accumulate small amounts of sugar. That is why in the vineyard culture a primordial role is played by prunings when dry, which is a basic plant-science work in the vineyard technology.

The main goals or objectives (according to *Martin and Oprea,1988; Oslobeanu,1980*) which are followed by vineyard pruning are:

- the realization and maintenance by means of annual prunings of a certain form (low, semi-high, high), given to the vine by pruning in the first years since planting (formation pruning) which is to be maintained over the entire exploitation period of the plantation;

- adjusting fructification processes by maintaining a balance between growth and fruition;

- conserving the production potential and keeping production at a constant level, avoiding the natural production alternation (yielding periodicity). The pruning is aimed at ensuring the fruit elements necessary for the production of grapes in the current year, the fruit yielding wood for the next year's harvest, ensuring the life of the vine as long as possible;

- ensuring productions of high quality, balanced in terms of quantity (large, uniform grapes) and quality (sugar content, acidity);

- facilitating performance of other agrophytotechnical works (phytotechnical works, phytosanitary treatments, etc.)

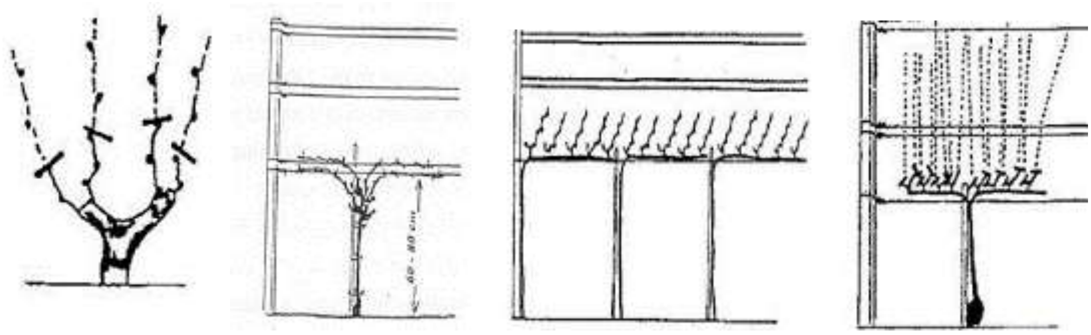
The types of pruning are a combination of a cutting system and a certain form of directing, plus some features of the supporting means or a certain direction given to the elements of the vine *(Bucur,2011; Dobrei,2003; Dobrei and Iova, 2001; Grecu et. Al.,2000)*. Pruning types used in Romania are:

- "Teremia" type, which leaves 4-6 fruit spurs in vegetation and is used for the less vigorous varieties specific to this wine-growing centre;

- Guyot type simple, double, multiple, with arms replaced periodically, on the stem, on the semi-trunk. This type of pruning is based on fruit bearing strings (3-4) placed on the vines directed in the low form or on the stem;

- "Cazenave cordon" type presents a single or bilateral cordon, on a 70-80 cm semi-high stem, on which 6-8 fruit bearing strings are left;

- "Spur cordon" type–on the single or bilateral cordon fruit spurs of 1-2 nodes are left.



a) b) c) d)

Fig. 1 –Pruning types

a)Teremia pruning; b)double Guyot; c) Cezenave cordon pruning; d) Spur pruning

Another work that is carried out in viticulture and requires mechanized intervention is that of ***pruning*** the shoots. This consists in suppressing the tips of the shoots on the vine, when the grapes start ripening (beginning of August). The work favours the lighting and better ventilation of the vine; determines the increase of table grapes production, speeds up the maturing of wine varieties (by 4-6 days); causes a higher accumulation of sugars; reduces acidity in grapes.

Mechanized pruning in vineyard also expands as a necessity dictated by the lack of labour and the reduction of production costs. After 2-3 years of mechanized pruning it is necessary to intervene by means of manual pruning, by which the vines are cleaned from the accumulated dry wood. Unnecessary multiannual wood formations are removed, balancing the volume of wood mass that has been formed in the meantime on the vine (correction pruning).

RESULTS

Mechanized prunings are executed with special cutting devices: discs or cutter bars that are mechanically operated from the power take-off of the tractor. They may be non-selective, called “hedge” type prunings; or selective, observing the pruning systems and directing patterns.

For mechanized prunings in viticulture, numerous constructive variants have been developed worldwide. They may have discs or rotating knives, can cut only on the side or top, or simultaneously on both sides of the row, as well as at the top or at the bottom. This equipment can be used successfully in the trellis plantations.

Disc pruners

Disc pruners are generally used for large thickness of the branches but not only. Pellenc - Australia sells viticulture and fruit growing pruners of different construction that ensures fast and efficient execution of the work and requires easy maintenance. The working speed of the equipment varies between 3 and 10 km/h for an optimal work, depending on the model, even in the case of dense vegetation. The equipment has a low hydraulic flow (3.8 l/min) and the cutting near the cordon is made by precisely adjusting the distance between the two lower disks. Each stack of discs is adjustable relative to each other to optimize cut quality and improve branch removal.

Fig. 2 –Disc pruner-Pellenc
(http://pellenc.com/za/produits/disco-pre-pruner/)

Fig. 3 - Equipment with optional lateral cutter bars
(*http://pellenc.com/za/produits/disco-pre-pruner)*

Fig. 4 –Disc pruner-Rinieri
(https://www.rinieri.com /downloads/prodotti)

The equipment can be provided withlateral cutter bars (60 cm high) to cut hanging branches. This option saves substantial amounts of time when pruning. Automatic detection of posts and cordon tracking by machine vision.Disc drive shaft can receive 5 to 9 pairs or 17 pairs with spacing of 50 mm.Working comfort of the driver: when working at night, in the rain, under the sun.The removing of the shoots is executed without damaging the wires. The bypassing of the pole is controlled by the operator with the electrical control and electrovalve with reduced pressure.

Another type of disc pruner suitable for orchards and vineyards is an L type machine designed by Rinieri-Italy. The frame has 4 hydraulic movements acted by a joystick and it can mount 1 or 2 saw disc bars which work with branches up to Ø cm 8-10. The machine with 2 bars cuts the side and the top in the same time. It is standardly supplied with an independent hydraulic kit with oil cooler which provides the right oil flow for the cutting bars.

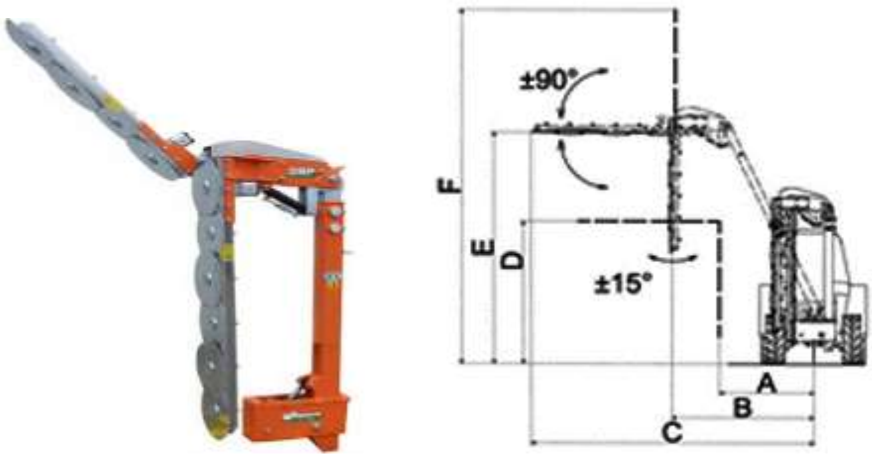


Fig. 5 – Pruner with “L”positioned discs
(https://www.rinieri.com/en/p/orp.html)

Table 1

Characteristics of Rinieri ORP equipment

TYPE	A cm.	B cm.	C cm.	D cm.	E cm.	F cm.
ORP 6	130	250	-	220	400	-
ORP 6+4	130	250	390	220	400	540
ORP 6+6	130	250	450	220	400	600

Pruning machines equipped with cutting knives

Another type of pruner for vineyards is the one with rotating knives or with knives and counterknives, where the cutting is done by an alternating rectilinear motion. It is mounted on a support device attached to the front of the tractor, the operator having a good visibility of the work done. It is hydrostatically driven.

Pruning machines equipped with cutting kniveshave better performing inclination of vertical bars which makes them suitable for use in hilly areas. Mostequipmenthas got the ability to adjust hydraulically the vertical bars at different heights to perfectly match the needs of plants situated in soils with side slopes. Standard machines are equipped with hydraulic distributor or with joystick on/off (depends on model) and side displacement is always on bearings and therefore very durable and solid.

The available cutting systems are: double blade with double blade - tooth movement that allows cutting off the shoots also thicker without compromising the speed of work, and with stainless steel rotating knives with cutting performance up to 15km/h with low maintenance.

These machines are mounted on vineyard tractors at row spacing between 1.8-2.2 m and general purpose tractors at rows spacing of 3 – 3.4 m. The field of use of aggregates for shoots pruning is limited to plantations on horizontal land or land with small slopes (up to 6-10%), parcels without large bumps of the soil on the intervals, equidistant rows and vertical trellis, with even height of poles and well-taut support wires.

With “L” pruners, cuts can be made on one side of the vineyard or on both sides and the gauge can be adjusted according to the row spacing.

Fig. 6 - Pruning machine with double blade Rinieri Vision 1 CRL I
(https://www.rinieri.com/en/p/crl-tower-1-l.html)

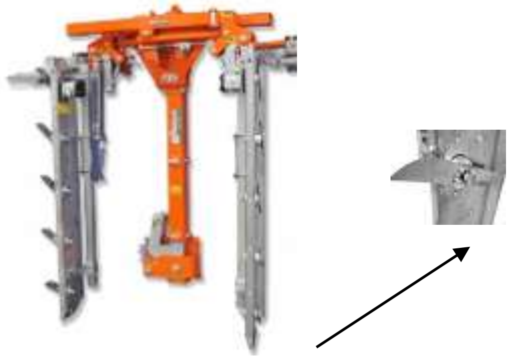
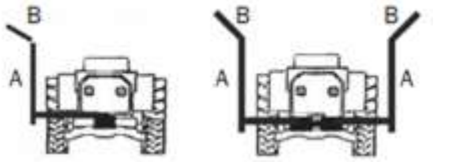
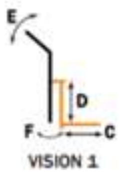
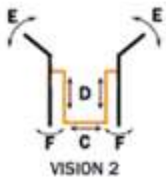


Fig. 7 - Pruning machine with rotating knives Rinieri Tower 2 CRVL
(https://www.rinieri.com/en/p/crv-tower.html)

Fig. 8 – "L" shape pruning types*(www.rinieri.com)*

Table 2

Characteristics of Rinieri CRL and CRV"L"model equipment

			TYPE	C, cm	D, cm	E	F
TYPE	A, cm	B, cm		31	60	90°	+/- 20°
CRL	150 180 210	80		HYDR. 25+25 MAN. 20+20	60	90°	+/- 20°
CRV	3-105 4-140 5-175 6-210	1-45 2-75 3-105					

There is equipment on the market that can simultaneously perform pruning on the 3 sides of the row: up/down and sideways. The equipment is mounted on the front axle of the tractor and allows for good visibility to the driver. Cutting knives are durable, made of stainless steel and don't need to be changed frequently.

Fig. 9 - "U" pruning equipment with rotating knives

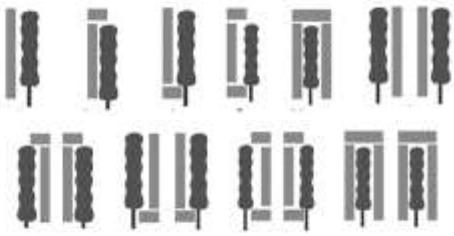
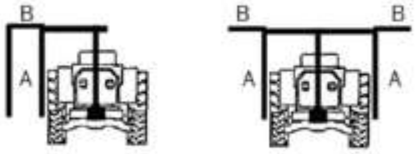


Fig. 10 –Pruning types performed with Tower 1CRV U equipment (www.rinieri.it)

Table 3

Characteristics of Rinieri CRL and CRV "U"model equipment



TYPE	A, cm	B, cm
CRL	150 ; 180; 210	80
CRV	3-105 ; 4-140; 5-175 ;6-210	1-45 ; 2-75; 3-105

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CONCLUSIONS

Pruning is one of the most important works applied during the rest period, whereby a large part of the vine canes (about 80-85%) are removed annually; size of the remaining elements is reduced and their relative position is changed in order to regulate the growth and fructification processes.

From the researches carried out on viticulture pruners it is to be noted that there is a large variety of constructive solutions adapted to the existing support systems.

They may have discs or rotating knives; they can cut only on the side or top, or simultaneously on both sides of the row and on top. The active working parts are made of hard materials with a long life span.

Viticulture prunersare mounted on vineyard tractors that can move on the intervals between the rows 1.8-2.2 m and general purpose tractors at rows spacing of 3 – 3.4 m. The field of use of aggregates for shoots pruning is limited to plantations on horizontal land or land with small slopes (up to 6-10%), parcels without large bumps of the soil on the intervals, equidistant rows and vertical trellis, with even height of poles and well-taut support wires.

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IDENTIFICATION AND EVALUATION OF THE MAIN CLIMATE FACTORS AFFECTING FORESTS ECOSYSTEMS
/
IDENTIFICAREA ȘI EVALUAREA PRINCIPALILOR FACTORI CLIMATICI CE AFECTEAZĂ ECOSISTEMELE FORESTIERE

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Keywords: *temperature, precipitation, forest ecosystems*

ABSTRACT
The present paper presents the main climate factors and their impact on forest ecosistems, as well as the forestlands role in climate adjustment. Climate change affects all natural systems, particularly by decreasing the contribution of forests to mitigate their effects by reducing the rate of growth and degradation of forestland areas. Based on the data and methods used, the results of the mapping of forest ecosystems are analyzed and presented using GIS techniques to obtain information on their spatio-temporal and qualitative evolution, the evolution of temperature and rainfall on the territory of Romania in the present climate, the analysis of the situation that generated the heat wave from 15-24 July 2007 and the atypical weather during 2010, as well as the projections/ forecasts regarding the future evolution of the temperature and precipitation regime on the territory of Romania compared to the reference period 1961-1990.

REZUMAT
Lucrarea de față prezintă principalii factori climatici și impactul acestora asupra ecosistemelor forestiere, precum și rolul celor din urmă în reglarea climei. Schimările climatice afectează toate sistemele naturale, diminuând, în special, contribuția pădurilor la atenuarea efectelor acestora, prin reducerea ratei de creștere și degradarea zonelor forestiere. Pe baza datelor si metodelor folosite sunt analizate si prezentate rezultatele cartării ecosistemelor forestiere prin utilizarea tehnicilor GIS pentru obținerea informațiilor cu privire la evoluția spațio-temporală și calitativă a acestora, evoluția temperaturii și precipitațiilor pe teritoriul României în climatul prezent, analiza situaţiei care a generat apariţia valului de căldură din perioada 15-24 iulie 2007 și vremea atipică pe parcursul anului 2010, precum și proiecțiile privind evoluția viitoare a regimului temperaturii și precipitațiilor de pe teritoriul României comparativ cu perioada de referință 1961-1990.

INTRODUCTION
Globally, climate change occurs in the form of higher temperatures than climate norms, as well as by intensifying extreme weather events, causing increased incidence of weather-related disasters, such as floods, droughts, vegetation fires, heat waves, cold in many areas. Forest ecosystems play an important role in soil protection, climate adjustment, absorbing anthropogenic carbon emissions, water purification and retention, flood protection, erosion and landslides, support and protection of biodiversity, wood production, fiber, biomass, participation in the definition of cultural identities and spiritual values, as well as a framework for recreation *(Greenpeace 2016)*. Although they play an important role in tackling the impacts of climate change, forest ecosystems are not spared by the effects of climatic factors, being vulnerable to the stress they exert. In order to mitigate the effects of climate change, it is necessary to manage forestlands as well as to know the climatic factors with impact on them.

According to the latest report by the Intergovernmental Panel on Climate Change (*IPCC, 2007*), global warming has increased considerably since 1950, a phenomenon quantifiable especially by increasing the number of tropical nights. Globally, according to the World Meteorological Organization (WMO) (*WMO, 2011*), the global average temperature increased by up to 0.46 °C compared to the 1961-1990 reference period. At the level of the northern hemisphere, the European continent is affected by climate change, a phenomenon observed especially by the amplification of extreme phenomena such as drought and floods.

At national level, the signal of climate change is predominant in regions like Dobrogea, Bărăgan, southern and eastern Moldova, southern Oltenia, etc. *(ANM, 2010)*, where the afforestation rate is small

(<5% of the country's surface). In Romania, the floods recorded in the spring and summer of 2005 resulted in significant material losses, when thousands of homes were damaged due to the excess of precipitations recorded. Another good example is the extremely warm winter of 2006/2007, or the heat waves in the summer of 2000 and the summer of 2011. Another example is the summer of 2007, which was highlighted thermally as extremely severe. The summer of 2012 was also extremely hot, with a deviation of 4.5 ° C in July from the 1961-1990 reference period.

In the following, the paper consists of presenting the data and methods used to identify the impact of the main climatic factors on forest ecosystems, the results obtained from forest ecosystems mapping using GIS techniques to obtain information on their spatio-temporal and qualitative evolution , the analysis of the situation that generated the heat wave from 15-24 July 2007 and the atypical weather during 2010, the evolution of the temperature and precipitation on the territory of Romania in the current (1961-2013) and future climate (2020) as well as the projections regarding the future evolution (2040-2080) of the temperature and precipitation regime on the territory of Romania compared to the reference period 1961-1990 and the conclusions of the study.

MATERIAL AND METHOD

The information used for mapping with GIS techniques, in order to obtain the areas of forest ecosystems in Romania (the main types of forests and the evolution of their areas during the period 1990-2012, the density of afforestation at national level, the deforested areas reported in the counties in 2001-2016), were extracted from the Corine Land Cover database.

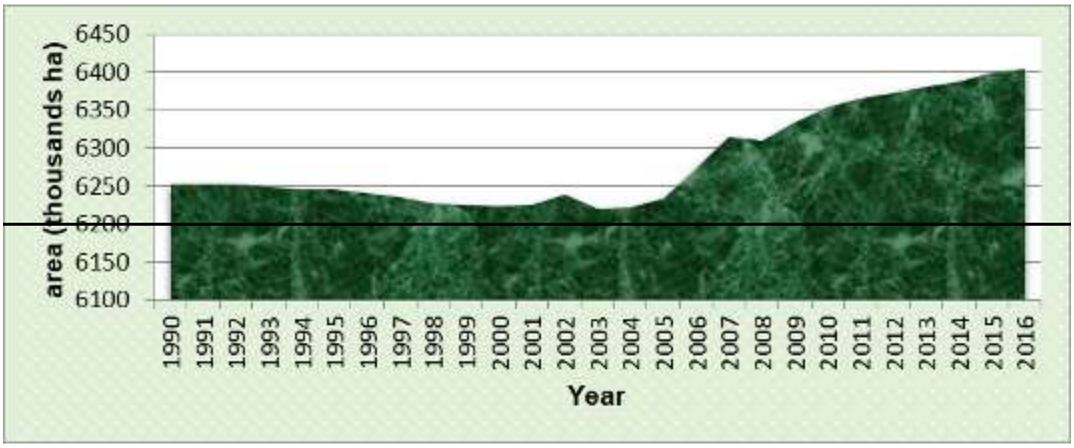
In order to highlight the evolution of the main climatic parameters (temperature and precipitation) at national level, were used data sets available from the ROCADA database for the current climate (time period 1961-2013) and WorldClim for the future climate (period 2041-2060). For the ROCADA database, the spatial resolution is 0.1º (≈10 km), using all stations with complete range of database of the National Meteorological Administration.

Available data model is represented by Global Climate Models (GCMs) projections for four representative concentrations of greenhouse gases (RCPs). These were established on the basis of the decisions adopted by the IPCC in its fifth Assessment Report (AR5) 2014 (IPCC, 2013) replacing the Special Report on Emission Scenarios (SRES) published in 2000. In this case the output data of the global HadGEM2-ES climatic model, developed by Met Office Hadley Center, England, at 20 m spatial resolution for the 2.6 RCP (under this scenario, global annual greenhouse gas emissions, measured in CO_2 equivalents, are projected to peak in 2010-2020), RCP4.5 (under this scenario, greenhouse gas emissions peak around 2040, after which they begin to decline) and RCP 6.0 (under this scenario, greenhouse gas emissions peak around the year 2080, and then begin to decline).

At European level, was used data represented by baric topographic maps, based on which, were made analyzes regarding the evolution of temperature and precipitation on the territory of Romania in the current climate. At the national level, two extreme years were analyzed regarding pluviometric and thermal regime, year 2007 on one hand, which was characterized by a very hot winter and summer and 2010 on the other hand, during which precipitation has been exceeded in almost all months. For this purpose, synoptic maps were available from the Wetterzentrum Meteorological Center archive in Germany, as well as maps from the archives of the National Meteorological Administration and the National Institute of Hydrology and Water Management.

RESULTS

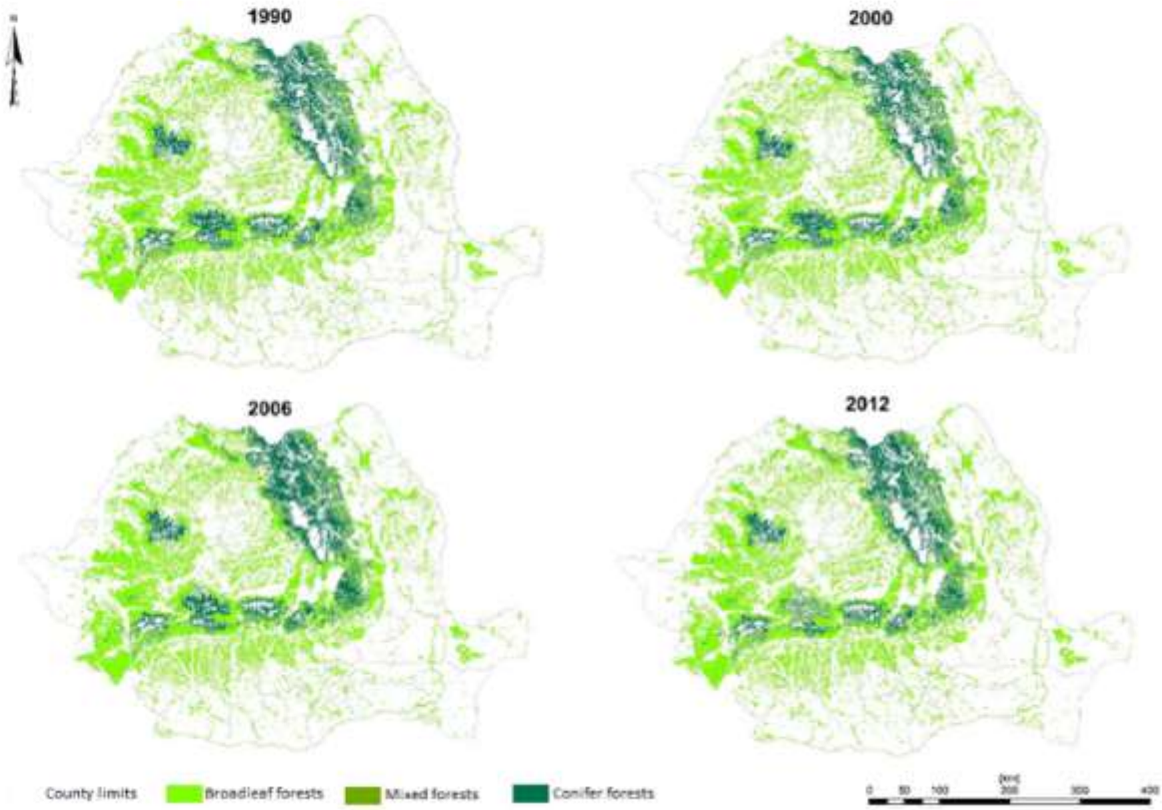
Romania forest land area in 2016 was 6.559.000 ha, according to National Institute of Statistics. From data processing (Fig. 1) can be observed a growing trend of afforested lands starting 2006.



(data source: INS 1990-2016)

Fig. 1 - Evolution of forest areas in Romania

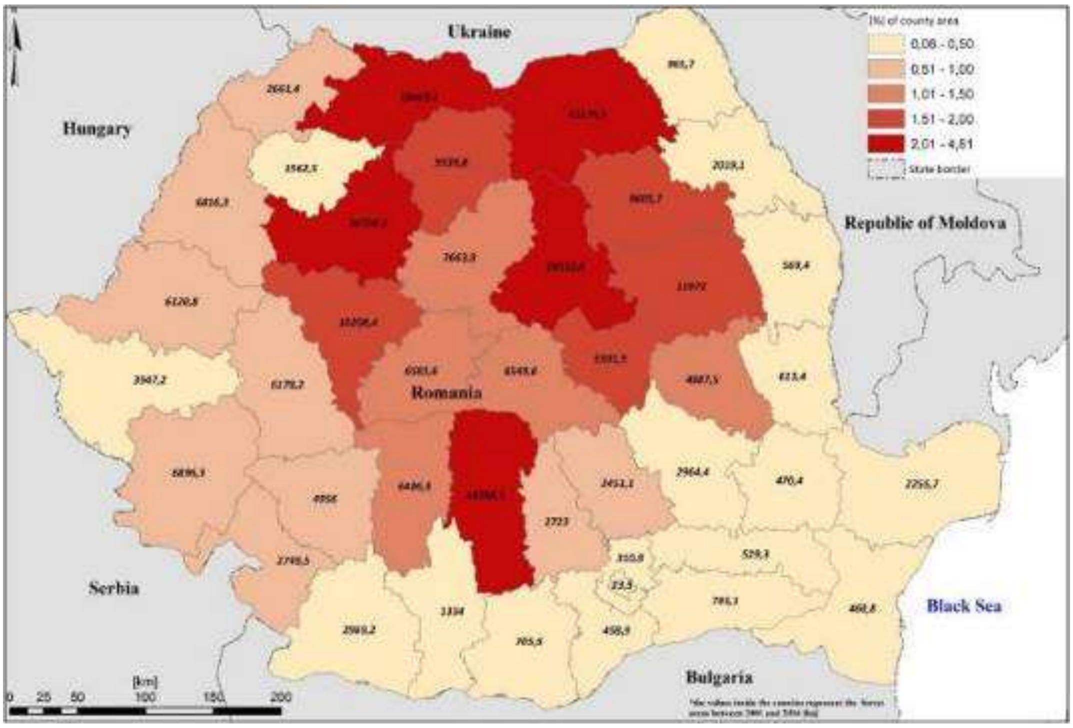
According to the methods used, the highest afforested density at the national level is along the Carpathian chain, presenting at the same time the altitude distribution of different types of forests (Fig. 2). The altitude limit between broadleaves and coniferous forests ranges between 600-1300 m, depending on the relief, substrate and microclimate. From the cartographic representation between 1990 and 2012, no significant change in the density and distribution by type of forests at national level is observed.



(data source : Corine Land Cover)

Fig. 2 - Localization of forest types at national level (1990-2012)

At national level (Fig. 3) are revealed the highest values of the deforested areas located in the central and northwestern parts of the country, following the Carpathian arch and the Transylvanian Depression, mainly the northern part of the Eastern Carpathians, as well as the Argeş County.

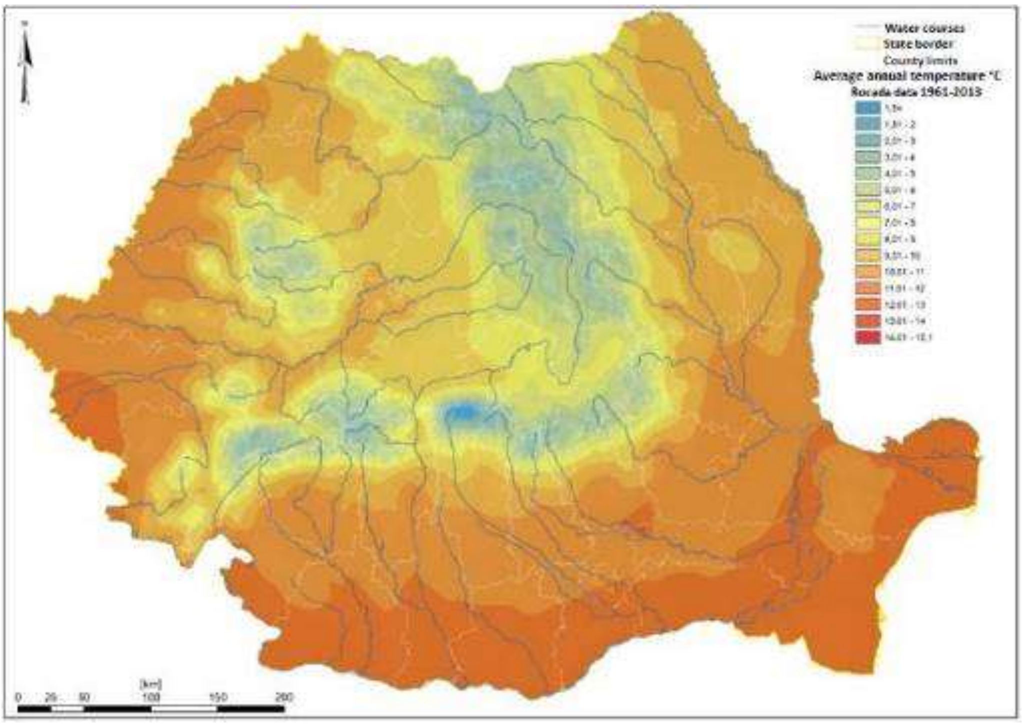


(data source: Hansen)

Fig. 3 - Areas where national deforestation has been recorded (2001-2016)

The following are the climatic factors and how they affect forest ecosystems:

The average annual temperature values for the current and future climate (RCP 2.6) presented in Figure 4 shows that significant increases are expected for all areas of the country, with values reaching and exceeding 15 °C in areas of the Romanian Plain and the Western Plain. Moreover, it can be seen from Figure 5, in the RCP 4.5 and RCP 6.0 scenarios, that in more extensive areas of the country, values reaching and exceeding the 15 °C threshold are recorded.



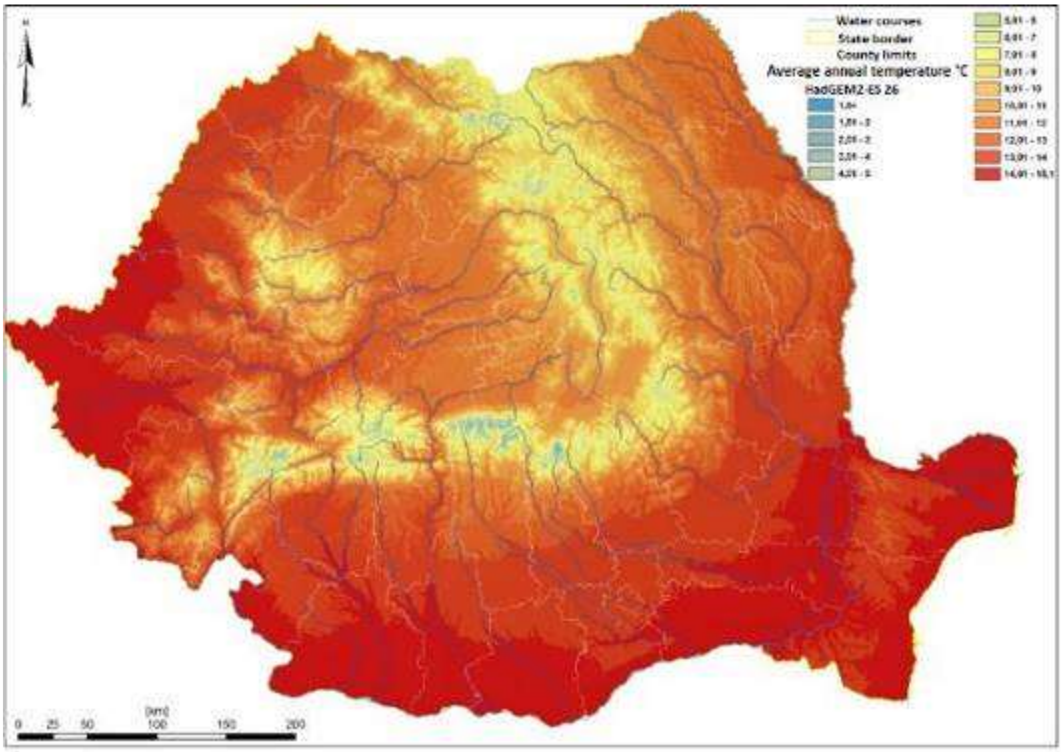
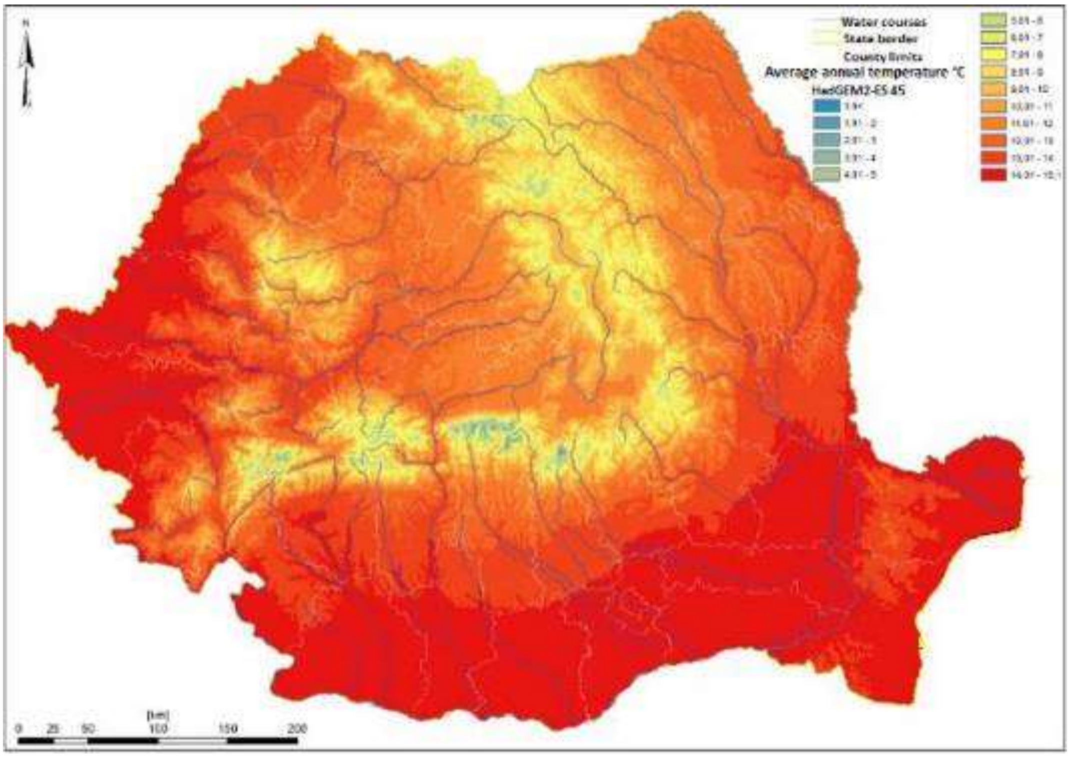


Fig. 4 - Annual average air temperature values in present and future climate (RCP 2.6)



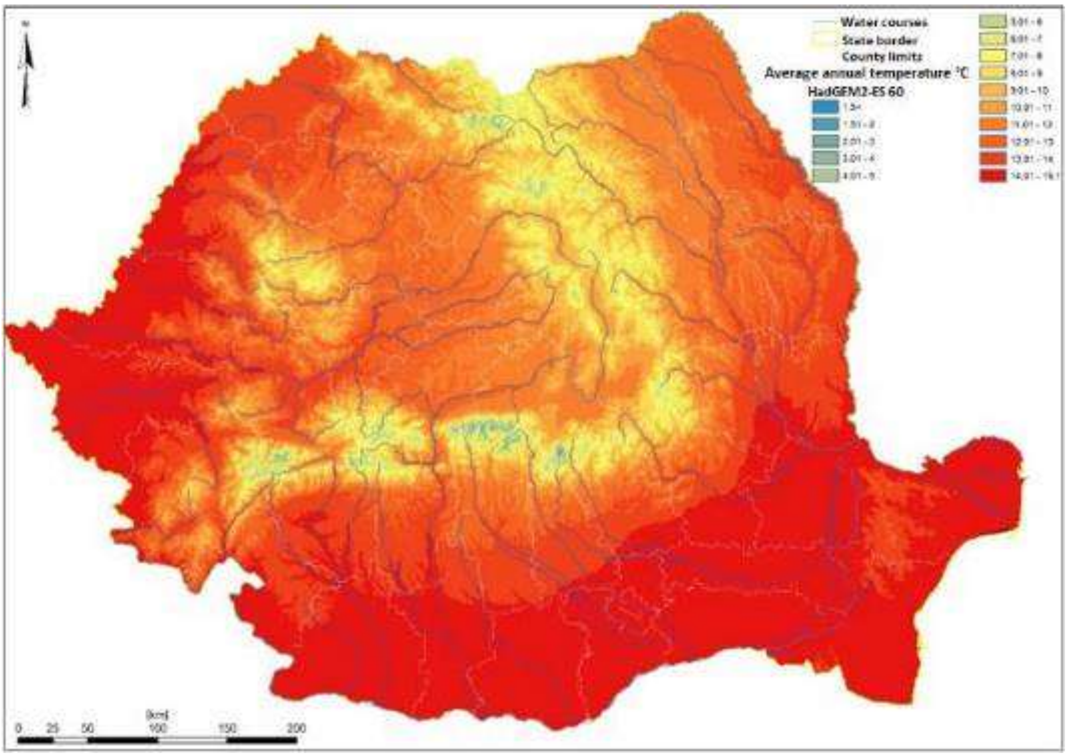
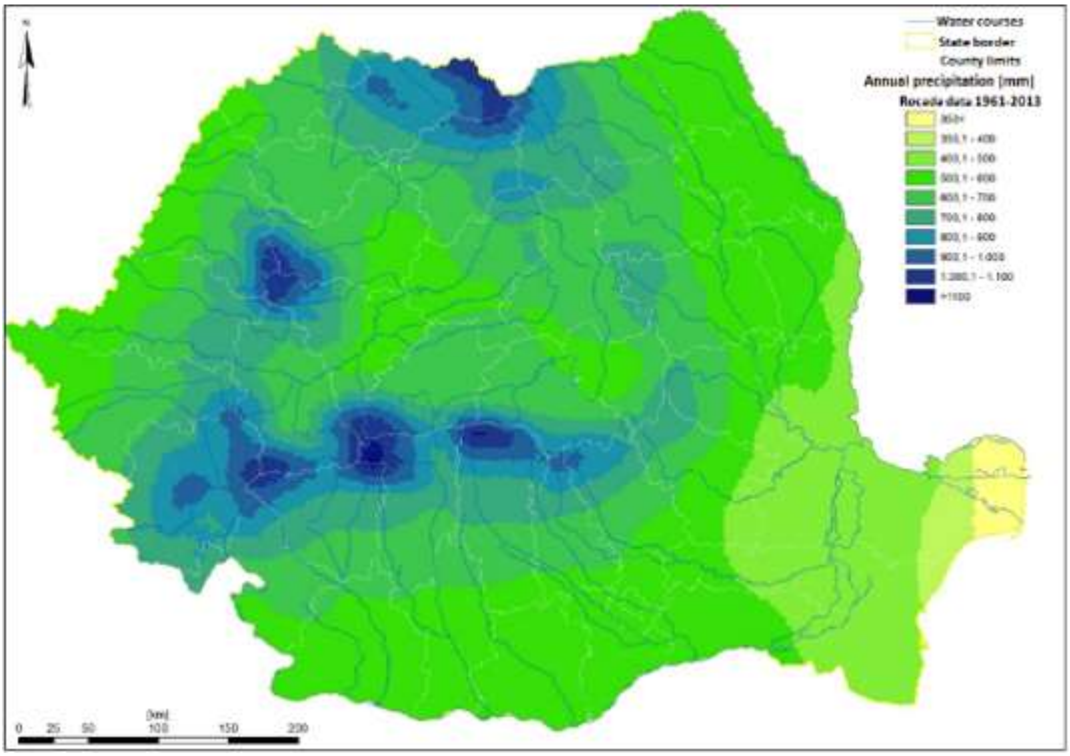


Fig. 5 - Average annual air temperature projected for the future climate (RCP 4.5 and RCP 6.0)

Regarding the average annual precipitation regime (in mm), for the current climate (Fig. 6), it can be noticed that in the mountain area the quantities exceeding the threshold of 800 mm are concentrated, while in Dobrogea there are quantities below 350 mm. For PRC 2.6 scenario (figure 6), the spatial expansion of rainfall over 800 mm is reduced, with most of the country being recorded between 400-700 mm. For RCP 4.5 and RCP 6.0 scenarios (Fig. 7), precipitation projections show that concentrations over 600 mm are not concentrated in much of the country.



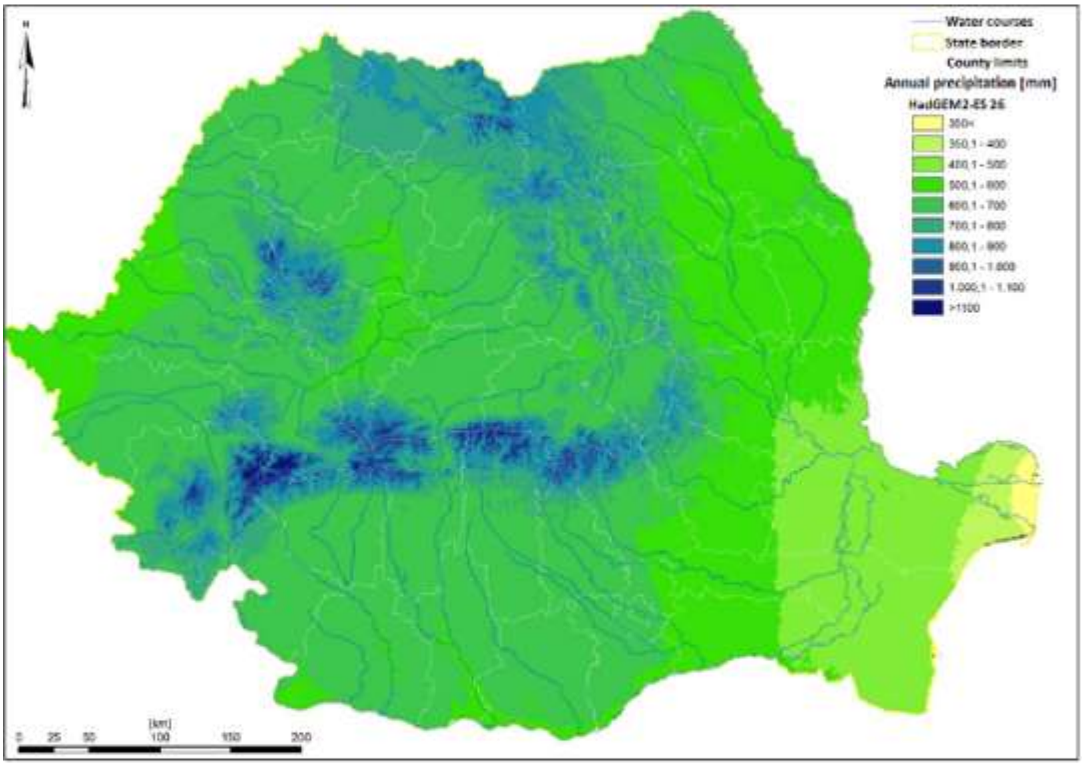
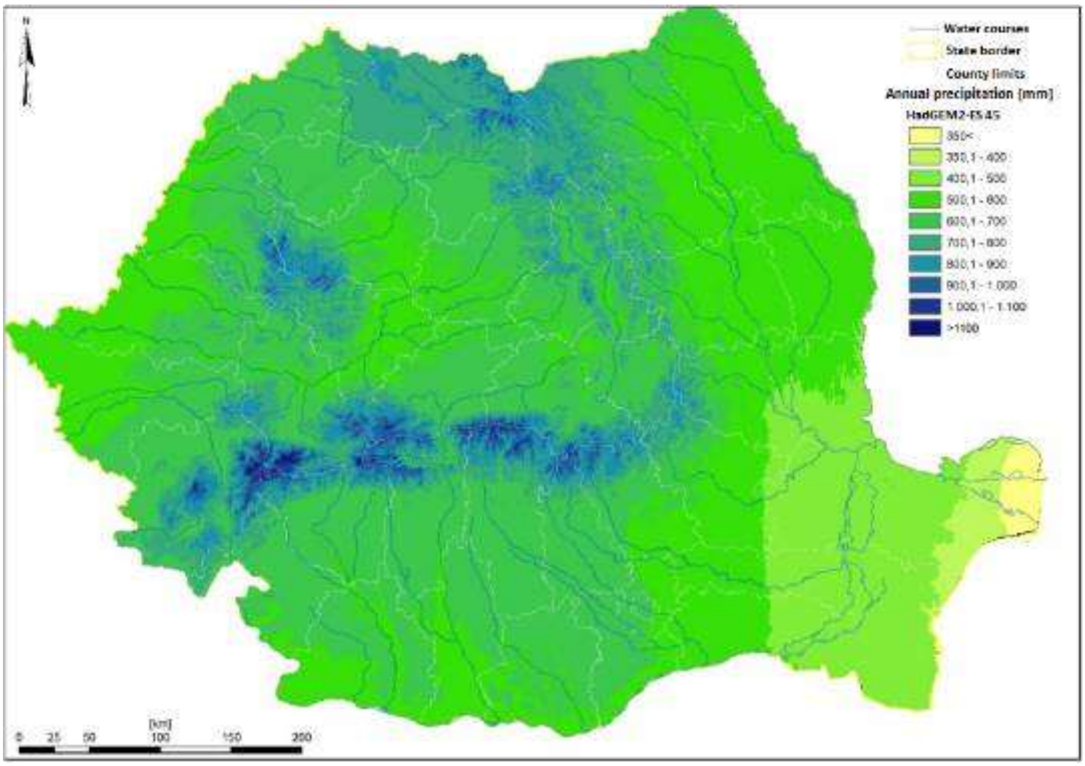


Fig. 6 - Annual mean rainfall values in present and future climate (SPC 2.6)



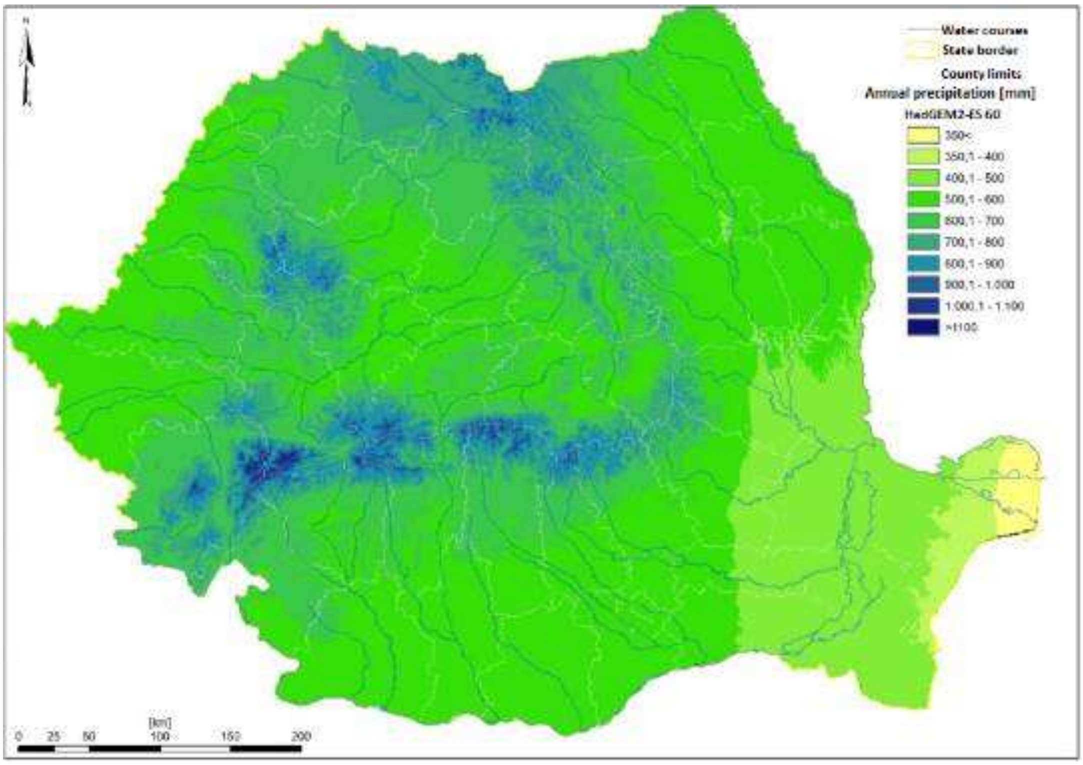
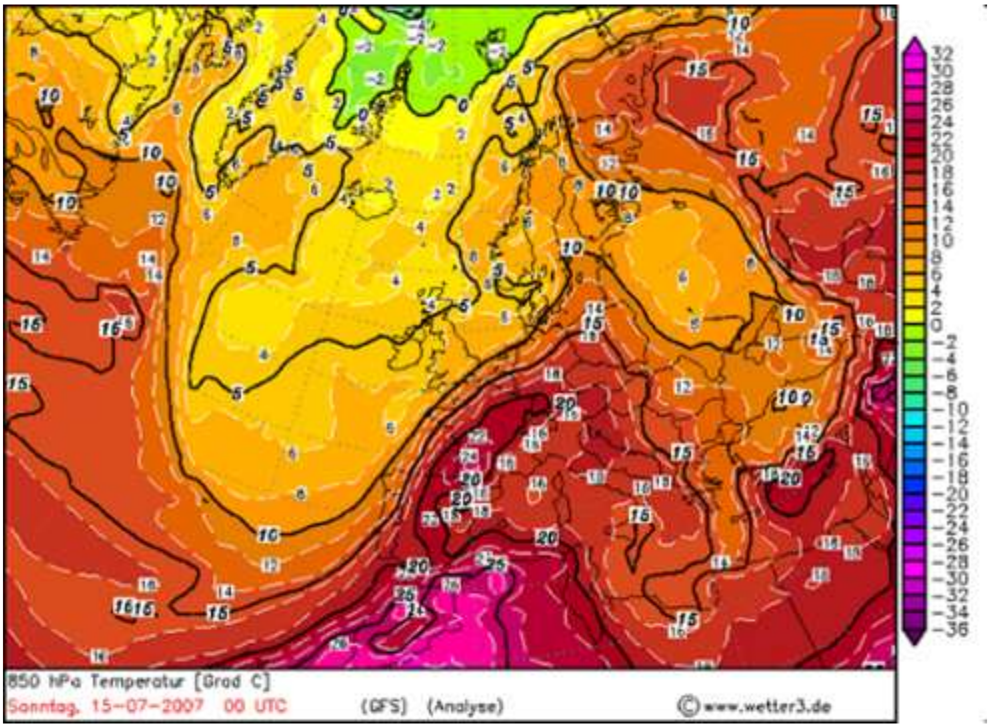


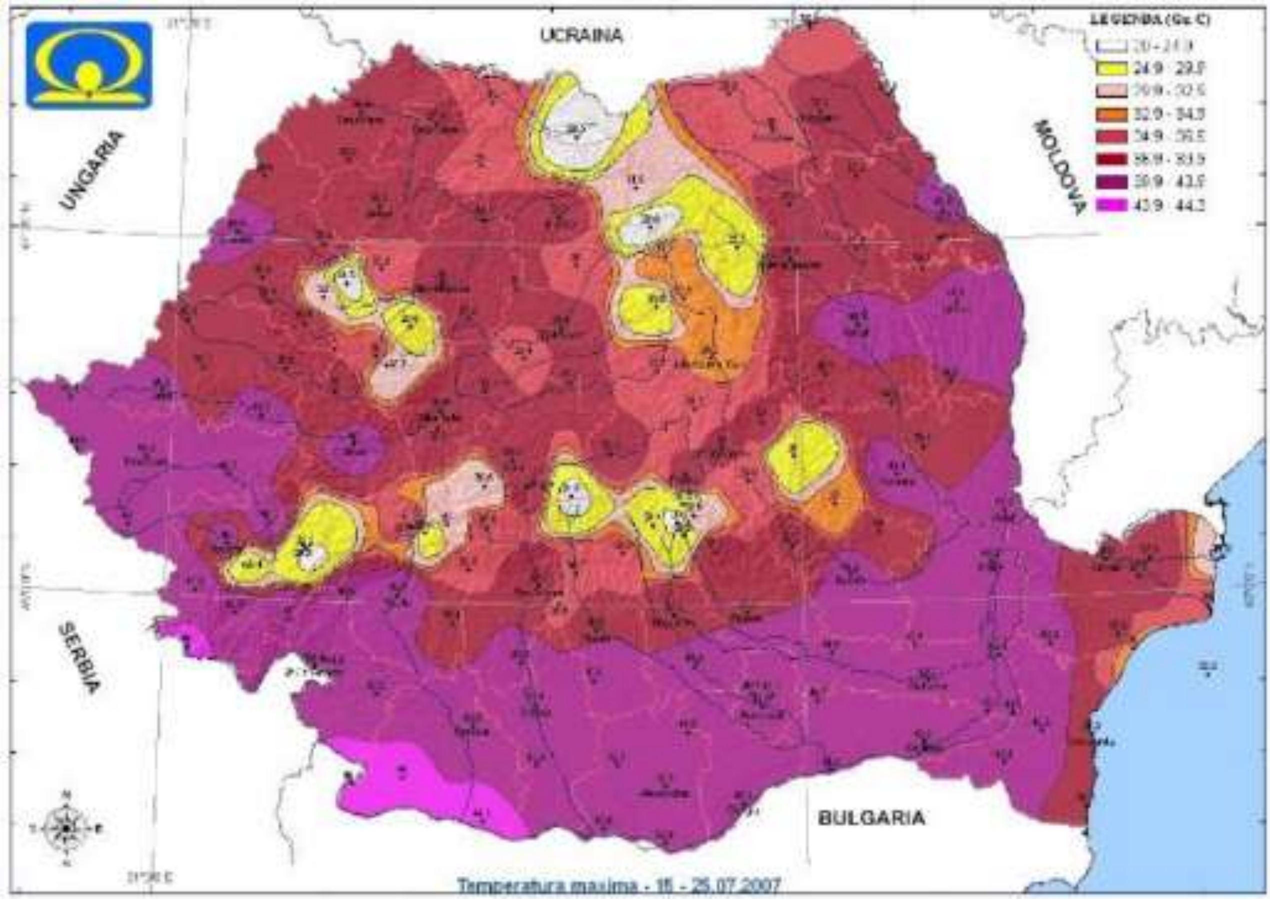
Fig. 7 - Projected annual mean rainfall values for the future climate (RCP 4.5 and RCP 6.0)

As far as 2007 is concerned, in Europe, temperatures in the isobaric temperature range of 850 hPa were between 20-24 °C, a starting heating process, more precisely on 15.07.2017 (Fig. 8), which is felt at national level when temperatures in the south and south-east have reached values above 40 °C (Fig. 9).



(data source: www.wetter3.de)

Fig. 8 - The thermal field at the isobaric surface of 850 hPa, on 15.07.2007 hour 00 UTC at the initial heat wave



(data source: National Meteorological Administration)

Fig. 9 - The maximum temperature recorded between July 15-25, 2007 at national level

CONCLUSIONS

Based on the analysis, it can be concluded that the forested areas at national level registered a growth trend compared to the period 1990-2006, even if there were significant deforestations.

Given the role of forest ecosystems in climate adjustment through carbon sequestration, it is very important to manage them properly, in order to adapt to the different climatic conditions that are predicted for the future.

Taking into account the results presented above, it can be noticed that Romania fits in the European context of the projected changes in temperature and precipitation so that climate models estimate a pronounced increase in the annual average air temperature, especially in the summer seasons and more than 90% of the models forecast a poor precipitation regime, which can cause severe droughts in Romania, especially in the south and south-east areas, like the heat wave that affected the country in 2007 when temperatures reached values above 40 degrees.

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THE INFLUENCE OF MC22 HAMMER MILL FREQUENCY ON SALIX *VIMINALIS* CHIPPING
/
INFLUENȚA TURAȚIEI MORII CU CIOCNE MC22 ASUPRA TOCĂTURII DE SALCIE ENERGETICĂ

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Keywords: *hammer mill, salix viminalis, rotor frequency;*

ABSTRACT

Choosing functional and structural characteristics of the equipment on the technological of any biomass processing unit influences the material degree of processing. The paper presents experimental research data regarding hammer mill MC 22 rotor frequency influence on energetic willow chippings using a sieve with orifices diameters of ϕ 16 mm and mills hammer with a triangle edge.

REZUMAT

Alegerea caracteristicilor funcţionale şi constructive ale echipamentelor de pe fluxul tehnologic al oricărei unităţi de prelucrare a biomasei influenteaza gradul de prelucrare al materialului. În lucrare sunt prezentate rezultatele unor cercetări experimentale privind influenta turatiei morii cu ciocane MC 22 asupra tocaturii de salcie energetica, folosind o sita cu dimensiunea orifciilor ϕ 16 mm si ciocanele morii cu muchii tip triunghi.

INTRODUCTION

Considering all concerns in the last decade regarding global warming scientists have tried to obtain the necessary alternative energy from agricultural biomass to substitute fossil fuels thus protecting the climate and the environment *(***http://www.miscanthus-rhizome.at/englisch.htm; ***http://ec.europa.eu/eurostat/web/europe-2020-indicators/europe-2020-strategy)*. In this context, lignocellulosic biomass has gained increasing research interests because of their renewable nature. Lignocellulosic materials including agricultural wastes, forestry residues, grasses and woody materials have great potential for bio-fuel production *(Anwar et al., 2014*).

Willow (*Salix Viminalis*) is one of the most popular plants that is used for energetic purposes. Lately, biomass produced by fast-growing *Salix* and *Populus* species, is considered to be the optimal alternative source of renewable energy *(Orynycz et al., 2017; Przyborowski et al., 2012)*.

Biomass pretreatment includes the physical process such as milling, chemical treatment by alkali, acids, or cellulose solvents; biological pretreatment (by white-rot fungi or lignin-degrading enzymes), or a combination of these processes (*Karimi and Taherzadeh, 2016*). Each pretreatment presents some advantages, disadvantages and efficiency level.

Generally, mechanical pretreatment is viewed as the most important and promising preliminary pretreatment step for biomass conversion to biofuel *(Siti et al., 2014).*

Size reduction of woody biomass is necessary because large-size woody biomass cannot be converted to biofuels efficiently with the current conversion technologies. Size reduction is the first step in obtaining biofuels from woody biomass. It is usually performed using milling machines and the particle size is controlled by the size of the sieve installed on a milling machine *(Zhang et al, 2012).*

Biomass particle size reduction was studied by researchers in order to better understand and optimize the grinding process and the equipment used. As shown in paper *(Drzymala Z.,1993)* biomass size reduction process changes the particle size and shape, increases porosity and bulk density, generates new surface area. Moreover, mechanical grinding of lignocellulosic biomass is the most applied treatment who leads to a fine particle size, various particle shapes, high specific surface area, and sometimes low cellulose crystallinity, depending on the energy and grinding mechanism applied as well as the grinding conditions and raw material properties *(Karinkanta et al, 2018)*.

The size distribution of biomass is influenced by the grinder type and the process parameters (residence time, velocity of the grinder tools). The biomass milling can influence the operations and the yield of conversion in bioenergy (*Mayer-Laigle et al., 2018).*

Hammer mills are recognized as technology capable of finely grinding the greatest variety of lignocellulosic biomass and have a wide application in material size reduction because of their simple design, ruggedness and versatility *(Yancey et al., 2014)*. In the present paper is presented the influence of MC22 hammer mill frequency on *Salix Viminalis* chipping.

MATERIAL AND METHOD

Miscanthus biomass was harvested from experimental field from INMA Bucharest. The harvesting process was done by shredding the stalks on the field and collecting the hash in bags. The shredded material was afterwards subjected to grinding process with the help of a hammer mill MC 22, with a sieve that had the orifices diameters of ø16 mm, a triangle edge hammer.

The hammer mills rotors frequency was 50 Hz (2.940 rpm); 47.5 Hz; 45 Hz; 42.5 Hz and 40 Hz. Shredding process took place by hitting and shearing the samples between hammers mounted on the hammer disk, and counter knives.

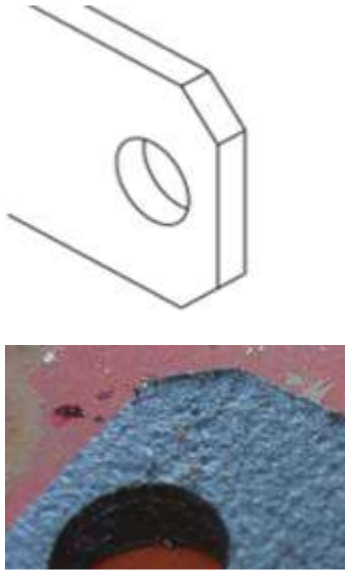
a.  b. 

Fig. 1 – a. Hammer mill MC 22; b. Triangle edge hammer used for testing

In this paper, experimental data was interpreted based on literature which presents similar test done on different types of biomass.

RESULTS

The experimental data which characterize the chipped material quantity for each dimension is presented in Table 1. Samples subjected to size reduction process had 10 g.

Table 1

Experimental data obtained during testing

Sample no.	Chipped salix viminalis size/quantity for each dimension				Rotor frequency [Hz]
	< 5 mm [g]	5÷10 mm [g[	10÷16 mm [g]	> 16 mm [g]	
1	1,4909	3,3245	3,2175	1,8385	50
2	1,865	3,2952	2,7455	2,0223	47.5
3	1,573	3,1845	3,1242	2,0393	45
4	1,5275	3,5315	3,2038	1,662	42.5
5	2,7835	3,1396	2,7444	1,2595	40

With the Microsoft Excel program, the experimental results were interpreted by applying regression analysis for each specific particle dimension obtained after chipping process. The influence of rotors frequency on grinded material quantity was shown by using variation curves. Also, in Figure 2 the grinded material distribution for each rotor frequency is shown for a sieve with orifices diameters of ø16 mm and a triangle edge hammer.

Fig. 2 - Sample distribution after material screening

Variation curves resulted are presented in Figure 3.

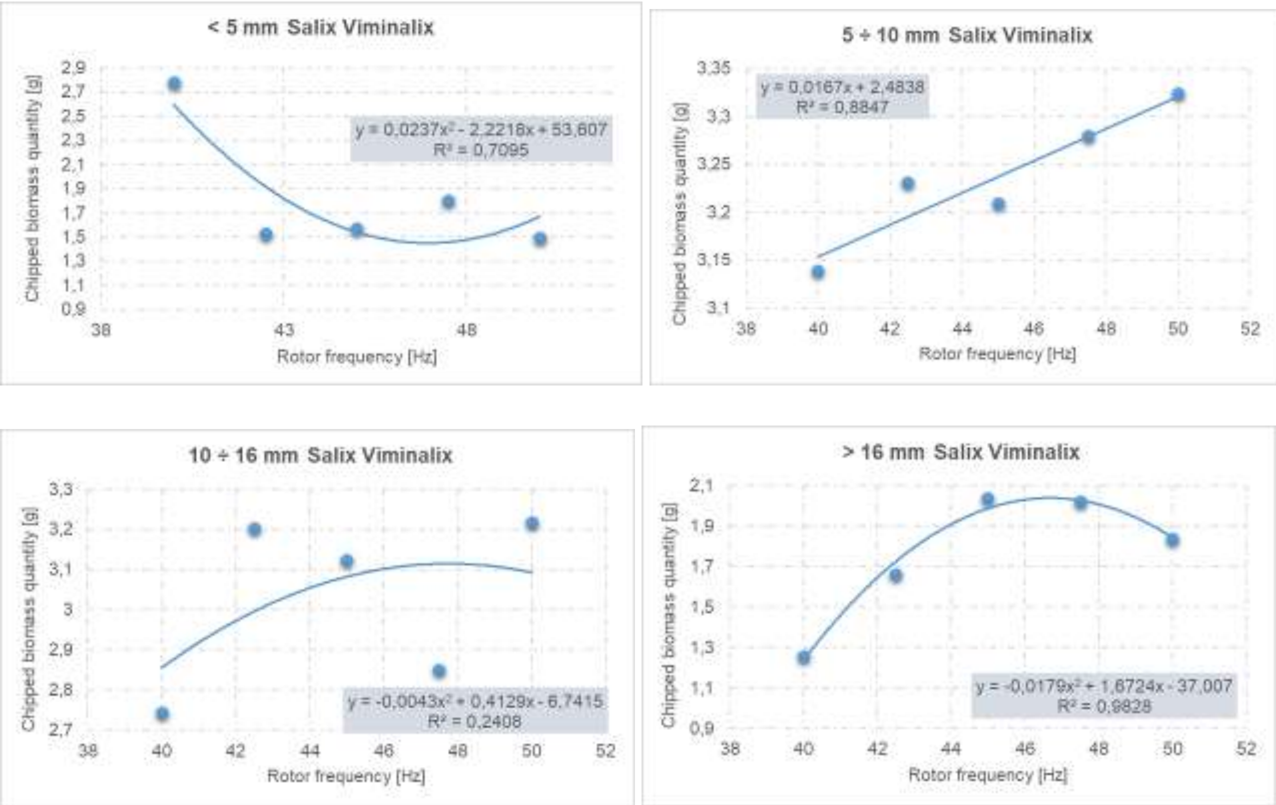


Fig. 3 - Variation curves between speed of revolution and chipped material quantity

If Figure 3 in closely analysed, the variation curves between the rotor frequency and the salix viminalix chipped quantity show different correlation coefficients from the lowest value of 0.2408 for the particles of 10 to 16 mm and the highest value registered for grinded material larger than 16 mm (R^2=0.98). For all the categories we applied a regression analysis that was a polynomial regression. In the case of 5 to 10 mm the regression analysis that best fit the experimental point was linear regression, the difference between linear regression and polynomial regression correlation coefficient for the same group was of 0.0001.

Also, as it can be seen from Figure 3 it can be observed that the tendency for both 10 to 16 mm chippings as well for chippings higher than 16 mm is similar except that in the last case the curves fits best the variation and in the first case is can't be applied.

If we consider the amount of chipped material it can be said that:

- For salix viminalis chippings under 5 mm the lowest material quantity was registered for a 50 Hz frequency;
- For salix viminalis chippings between 5 ÷ 10 mm the lowest material quantity was registered for a 40 Hz frequency and the highest quantity was registered for 50 Hz rotor frequency;
- For salix viminalis chippings between 10 ÷ 16 mm the lowest material quantity was registered for a 40 Hz frequency and the highest quantity was registered for 50 Hz rotor frequency, but as it can be seen the correlation between studied parameters is weak;
- For salix viminalis chippings above 16 mm the lowest material quantity was registered for a 40 Hz frequency and the highest quantity was registered for 45 Hz rotor frequency, and as it can be seen from the variation curves the correlation coefficients resulted has the highest value;

When assessing the material quantity for each chipped material quantity there were some loses registered for each rotor frequency. As is ca be observed in figure 4 the highest quantity was registered for 42.5 Hz frequency and the lowest loss was registered for a rotor frequency of 47.5 Hz.

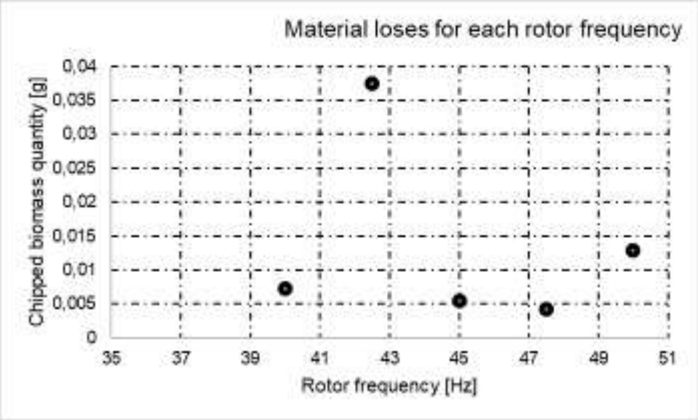


Fig. 4 - Loses of chipped material quantity for each rotor frequency

CONCLUSIONS

Experimental research regarding the biomass processing are conducted by scientist in order to better understand the implications and design better equipment's. In this paper just, the grinding process process was analysed from the entire biomass processing steps, by using a MC 22 hammer mill. The influence of rotor frequency on chipped material quantity was shown by drawing variation curves.

Also, the most common regression analysis function applied was second degree polynomial regression function except for chipping material between 5 and 10 mm where the type of regression was linear regression analysis.

Considering the values resulted for the correlation coefficient it can be said that the correlation between rotor frequency and the quantity of chipped material is good and designers need to consider these parameters connection when designing equipment's. Thus, keeping in mind the future usage of the grinded material, designers need to fulfil the end users' needs and create a better equipment with a better design which can be obtained through experimental research.

ACKNOWLEDGEMENT

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WASTEWATER TREATMENT BY FLOTATION WITH NANOMATERIALS
/
EPURAREA APELOR PRIN FLOTAŢIE CU NANOMATERIALE

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Keywords: *flotation*, wastewater *treatment, nanomaterial*

ABSTRACT

This study shows the possibility of improving the wastewater treatment process through nanomaterials acting as a foam stabilizing agent. So far, important results have been achieved in flotation wastewater treatment, but the future is the use of nanomaterials.

For this purpose, the nanomaterial of magnetite was used (Fe_3O_4), having the role of stabilizing the foam in the process of wastewater treatment by flotation. To assess the applicability of magnetite nanoparticles (Fe_3O_4) in the process, the indicators below were followed: yield of wastewater treatment, Stability of foam.

REZUMAT

Acest studiu prezintă posibilitatea de îmbunătăţire a procesului de epurare a apei prin intermediul nanomaterialelor cu rol de agent stabilizator al spumei. Până în momentul de faţă, s-au obţinut rezultate importante în ceea ce priveste epurarea apelor prin flotaţie, dar viitorul este folosirea nanomaterialelor prin intermediul flotaţiei pentru epurarea apelor.

Pentru acest scop a fost folosit nanomaterialul magnetită (Fe_3O_4) având rol de stabilizator al spumei în procesul de epurare a apelor prin flotaţie. Pentru evaluarea aplicabilităţii nanoparticulelor de magnetită (Fe_3O_4) în acest process s-au urmărit indicatorii de mai jos: randamentul de epurare şi stabilitatea spumei.

INTRODUCTION

Sustainable water management remains an astringent, constant and extreme concern due to climate change and population growth. Drinking water quality directly affects the health of the population and global agricultural production.

According to UN and World Health Organization statistics it is estimated that the lack of access to drinking water and sanitation is the major cause of deaths in developing countries, especially among children.

Although it exists more processes which are used globally for the treatment of wastewater, do not have either high efficiency or high costs.

Among the best-known water treatment techniques is flotation. This is a process that is widely used.

Flotation is the passage of air under pressure through wastewater. Thus, air will form bubbles that will adhere to nanomaterials, they will be transported to the surface where they will be removed, the water is cleaned. (*Habibzadeha and Gurbanov, 2010; Farrokhpay, 2011).* An overview can be found in Figure 1.

Over time, it has been sought to identify methodologies with increased efficiency and effectiveness to remove pollutants from wastewater. But, recent research in the field, are oriented towards the expansion of nanotechnologies which can enable the development of high performing, versatile and cheap materials. The effectiveness of water purification by flotation through nanoparticles as foam stabilizing agents is given in particular by the effectiveness of the foaming phase and the ability to transport the particles to the surface.

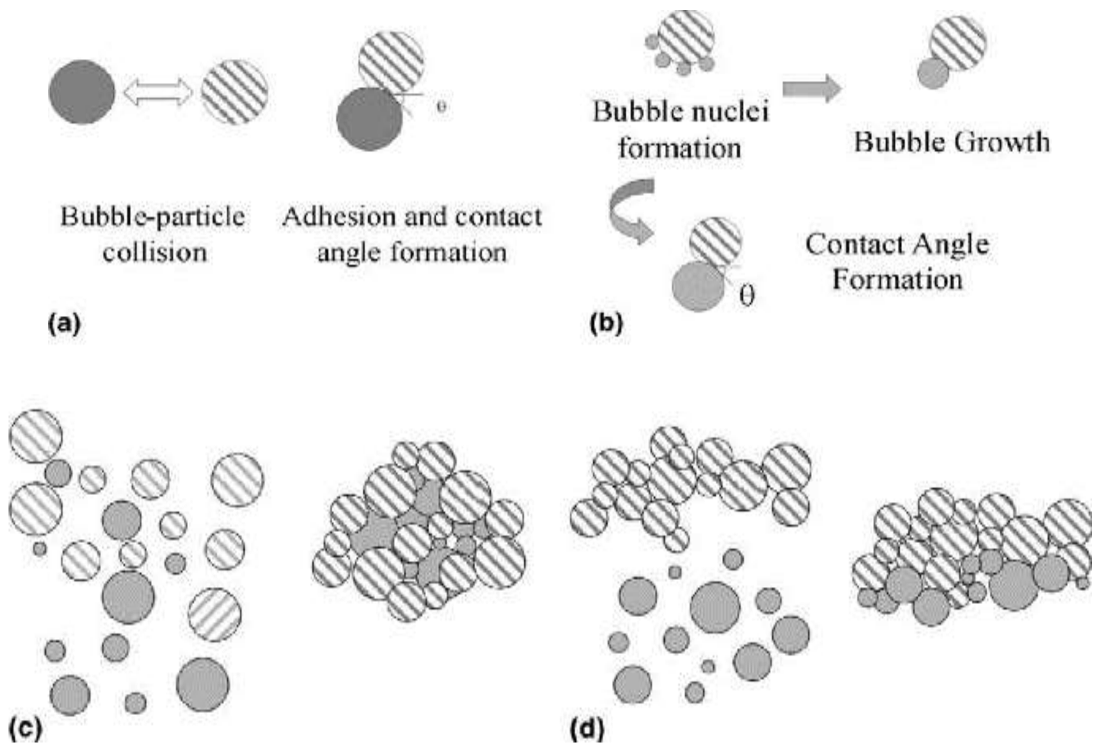

Fig. 1 - Bubble-particle mechanisms in dissolved air flotation (*Rubio et al., 2002*)
(a) particle-bubble collision and adhesion; (b) bubble formation at particle surface; (c) micro-bubble entrapment in aggregates; (d) bubbles entrainment by aggregates.

The effectiveness of the flotation process in water purification is due to the stability and structure of the formed foam and its ability to transport the particles to the surface of the liquid solution. Therefore, separation efficiency and selectivity of the floating process is directly reflected in foam stability, bubble adhesion and size distribution (*Cilek and Karaca, 2015; Farrokhpay, 2011*).

The ability of nanoparticles to contribute to foam stability has been studied by many researchers (*Binks, 2002, Du et al., 2003, Dickinson et al., 2004, Horozov, 2008, 2010, Yu et al., 2011*). In the scientific literature, there are studies showing the ability of nanoparticles to act as emulsion stabilizers (*Dickinson et al., 2004, Liu et al., 2010*). Stability and foam formation depends on particle size, type of surfactant and concentration (*Paunov et al 2002; Saththasivam et al.2016 Wang LK et al., 2010; Zech O. et al., 2012*).

The paper relates to wastewater treatment by flotation through nanoparticles as foam stabilizers.

The experiments were carried out on synthetic wastewater, which contains a 34% oil concentration, in the presence and absence of the nanomaterial Fe_3O_4. The dissolved air flotation system contains 5% anionic surfactant and 5% amphoteric surfactant (*Covaliu et al., 2010*). During the tests, was observed that the using of magnetite nanomaterials conducted to the following observation: reduction of the wastewater treatment time from 10 min to 2.5 min, increasing foam stability through nanomaterials from 40 min to 6 h, the obtaining of a the wastewater treatment efficiency of 100% (*Covaliu et al., 2017*).

CONCLUSION

The using of nanomaterials in the wastewater treatment by flotation has a great potential. Till now the study of using Fe_3O_4 nanomaterial. in flotation has shown that the main advantages are: reducing the time required for water purification and increasing foam stability. The results support further research on the subject by investigating different types of nanoparticles with different morphologies.

ACKNOWLEDGEMENT

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PARAMETERIZATION OF AN AGRICULTURAL DRONE FOR CONDUCTING THE SOIL MAPPING OPERATION
/
PARAMETRIZAREA UNEI DRONE AGRICOLE ÎN VEDEREA REALIZĂRII OPERAȚIUNII DE CARTARE A SOLULUI

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Keywords: *drone, soil mapping, agriculture, parameterization*

ABSTRACT

Precision agriculture implies using technology to streamline costs in agricultural production, constantly collecting and analysing crop-related information before, throughout and after the process it has been completed to obtain clear and accurate information, thus maximizing the results obtained in the field. The paper presents a method of parameterization of an aerial mapping system in order to obtain multispectral maps on the basis of which, vegetation indices of the monitored culture can be obtained.

REZUMAT

Agricultura de precizie presupune folosirea tehnologiei pentru a eficientiza costurile în procesul de producție agricolă, culegerea și analiza constantă a informațiilor legate de cultură atât înainte, pe parcursul procesului, cât și după ce acesta a fost finalizat pentru a obține informații clare și exacte, astfel maximizând rezultatele obținute în câmp. In lucrare este prezentată o metodă de parametrizare a unui sistem aerian de cartare în vederea obținerii hărților multispectrale pe baza cărora pot fi obținuți indicii de vegetație ai culturii monitorizate.

INTRODUCTION

If most farmers are only interested in protecting work and crops, precision farming brings the farmer's attention to the environment and the market in which he operates. Farmers practicing precision farming use modern management technologies to get detailed, real-time information on managed crops and are mindful of optimizing all the resources involved (*Kahn et al, 1999; Luculescu M. C., 2017*)

The collected and analysed images taken by the drones can offer real maps of the land surfaces, this way being possible to follow various general interest parameters regarding the agricultural activity, mainly related to the management of information in the view of obtaining results *(Hunt et al., 1989; Kim et al, 1994)*. Practically, by using drones, farmers can rapidly visualize the variations in plant height, colour changes at the level of leaves, the degree of soil dryness etc., without loosing time to travel to the inspected areas and more importantly, obtain in a very short time a complete perspective of the evolution of the entire agricultural exploitation and can precisely delimit the parcels where it is necessary to intervene (*Myneni and Williams, 1994; Cai et al, 2014*)

Each new functionality brought increases the level of complexity of the use, meaning that, besides the initial investment when acquiring the device, farmers need to allocate time to learn how to manoeuvre the drone, but also to invest in the acquisition of equipment and software solutions capable to extract relevant and directly actionable information from the data collected by the drones (*Arjomandi et al., 2006; Bencini et al, 2009*). In agriculture, remote sensing is an analysis instrument for the Earth's surface allowing to extract, through specific means, the biophysical parameters of the planet's coverage in the purpose of providing absolute values on the vegetation developing status, correlated with the identification of water and soil properties as elements conditioning agricultural productions (*Ashraf et al., 2011*; *Borhan M.S., 2004*).

MATERIAL AND METHOD

Agricultural drone type aerial mapping systems are used in the agricultural and forestry field to conduct vegetation assessment flights in the infrared spectra in the purpose of early highlighting the changes in the health status of plants, before becoming evident in the visible spectrum.

Fig. 1 – Agricultural drone type aerial spectral monitoring system

An agricultural drone aerial monitoring system is characterized by:

- Maximum flight time, without load, until battery wear-out;
- Useful load comprised of:
  - ✓ Imagine stabilizer;
  - ✓ Multispectral camera for agriculture with incorporated GPS;
  - ✓ Video soil transmission system with on-screen telemetry (OSD);
  - ✓ Camera command system;
- Maximum load;
- Maxim flight time;
- Control distance without obstacles;
- Telemetry on laptop with the possibility to program the trajectory and the stationing points;
- Telemetry link;
- Multi-standard GPS;
- Recommended weight in flight with battery and load;
- Working temperature;
- Maximum horizontal flight speed admitted;
- Maximum ascensional speed;
- Maximum altitude.

Prior conditions and actions: 1-2 days before the monitoring work, the following are checked

- Drone batteries charging;

Fig. 2 – Drone battery charging

- Remote control battery charging;
- Drone motors;
- SD card with 16 G minimum available space;

- Through the means of Google Maps / Google Earth, the terrain where the flight will take place, not to be state border, airport, military units. The maps and pre-set trajectory are saved;
- Through the means of the flight planning software, the mission's altitude profile compared to terrain in order to avoid the collision with higher areas;
- Tool box for the trajectory, charger, invertor, remote control, telemetry.

Conditions and actions at the place of beginning the activity of monitoring crops
The integrity of the drone during after transportation:

- ✓ Integrity of the propellers and cables;

Fig. 3 – **Propellers of the agricultural drone type aerial spectral monitoring system**

- ✓ Planarity of the drone's propellers;
- ✓ Magnetic interfaces;
- ✓ Stability of the live ground video reception system with telemetry on screed (OSD);
- ✓ Integrity of the telemetry antenna, as well as the one of the GPS antenna;
- ✓ Antenna system (all headed down).

The battery is fitted on the drone, the tension of each 4.2 V battery cell. The battery will pe fitted with the LIPOCECKER connected;

The multispectral camera with incorporated GPS is mounted, verifying the firm grip of the multispectral camera in the brushless image stabilizer on 2 axes with vibration damping.

Fig. 4 – Multispectral camera gripping on the image stabilizer

The drone is started without being moved in order to achieve the calibration of the gyroscope and of the multispectral camera;

The GPS signal – 3 DLOCK signal is verified;
The positioning on the laptop / parameters on FPV are verified;

Before enforcement, a minimum 5 m perimeter is delimited around the drones, a perimeter where no human / physical perimeter is allowed. The flight is not done over crowds of people, in areas with photo interdictions, close to airports, under high voltage poles, close to massive metallic structures, over borders, penitentiary or military units, etc.

The drone is enforced, to verify the remote control's configuration and the flight modes. Is stopped and the station is closed in order to verify the failsafe. The station is restarted.

A test picture is taken;

After conducting these steps, the drone is prepared for flight.

If on the flight period, on the monitor or on the laptop, warning messages appear (with red), they should be taken into consideration;

During the flight, telemetry parameters, tension, consumed electric energy, motors' power are monitored.

Conditions and actions when finishing the crop monitoring activity

A minimum 5 m drone landing perimeter is ensured;

The motors are stopped and drone shut down is performed from the remote control;

The integrity of the agricultural drone type spectral monitoring aerial system is checked.

Persons present during the crop monitoring action using the agricultural drone type spectral monitoring aerial system should occupy positions behind the pilot so that during both take-off and landing for avoiding any incidents.

An agricultural drone type spectral monitoring aerial system is composed of the following components:

- Photo camera stabilizing support;
- Photo camera with incorporated GPS;
- Agricultural drone;
- Multispectral camera radio commanded shutter;
- Digital radio station;

Fig. 5 – Digital radio station

- laptop with the navigation system;

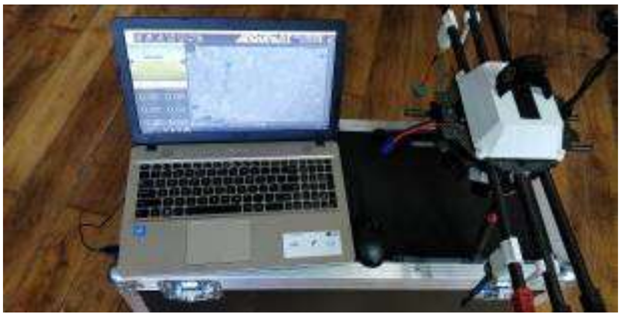

Fig. 6 - Laptop with the navigation software

- telemetry system on the computer of the flight parameters and of the location on the map;

Fig. 7 – Telemetry antenna

- software licence for the picture processing software;
- battery charger Li-Po with cell balancing 1000W and charging time 1 h;

Fig. 8 – Battery charger

- battery;

Fig. 9 - Li-Po battery

- Live portable telemetry soil broadcast system

Fig. 10 – Live portable telemetry soil broadcast system

- Transportation box

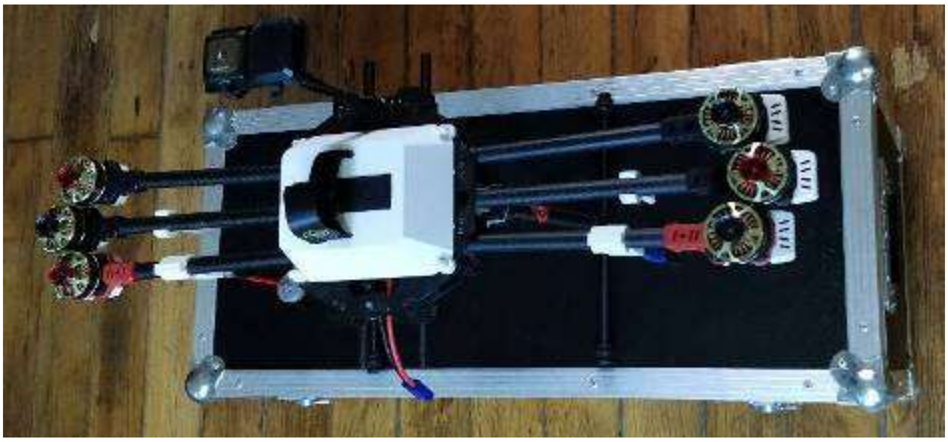

Fig. 11 – Transportation box

RESULTS

The role of using the multispectral sensor in precision agriculture is to produce multiple images of the light spectrum at the same time. When used in agriculture, multispectral detection areas target areas of light spectrum that belong to plant biology. Depending on factors such as stage of growth, stress level or impact of disease, plants reflect light differently. Multispectral sensors measure this difference.

Based on the updated maps obtained, the following can be determined:

- Areas with high and low productivity from each parcel;
- Different evolution of varieties from a certain crop;
- Insufficient or excessive fertilization;
- Poor quality agrotechnical operations;
- Excessive weed growth;
- Plant diseases or damages caused by insects;
- Hydric stress – lack of water of flooded areas;
- Damages caused by wild animals;
- Assessment of damages caused by hail.

CONCLUSIONS

Multispectral data obtained using the agricultural drone type spectral monitoring aerial system can lead to the identification of a seemingly healthy field of stress, disease outbreak or nutrient deficiency. Detection of such problematic areas and appropriate treatment determines the efficiency, yield and profit of the monitored culture. The health state of the crop is performed from the ground, but it is limited to what the human eye can see. Innovative technology using multispectral imaging complements researches on the field.

Benefits of using aerial mapping systems:

- High data accuracy degree on vast surfaces;
- Monitoring the crop growth dynamic in real time;
- Crop surveillance from sowing to harvest;
- Real crop mapping directory;
- Automated production /ha estimation;
- Measuring the necessary level of fertilizer – nitrogen in the soil;
- The area where the pesticides and fertilizers are applied excessively;
- Transmitting alerts to the moment of the intervention of external or internal weather-climatic – human nature;
- Transmitting alerts at the moment of modifying crops growth parameters;
- Modular program, easy and modern reporting system;
- Storing the history of the crop development history;
- Possibility to access de databases;
- Rational fertilization;
- Reducing personnel costs;
- Reducing costs for updating the exploited areas;
- Reducing fuel costs;
- Reducing costs for measuring nitrogen levels in the soil.

Accurate, timely information is provided to improve agricultural management. Analysing farmers' needs to provide the best solutions for optimizing allocated resources, reducing costs / ha and increasing agricultural productivity.

With the multispectral and multi-angle imagery provided by the satellites, the system processes, interprets and monitors the parameters of farmland, the state and evolution of vegetation, allowing farmers to make the best decisions and take actions in the knowledge, by giving quick access to the most comprehensive, applicative and fair digital agricultural solutions.

ACKNOWLEDGEMENT

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SOIL MAPPING USING MODERN METHODS ACCORDING TO THE CONCEPT OF PRECISION AGRICULTURE
/
CARTAREA SOLULUI PRIN METODE MODERNRNE CONFORM CONCEPTULUI DE AGRICULTURA DE PRECIZIE

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Keywords: *soil mapping, precision agriculture, drone, aerial maps*

ABSTRACT
Currently, precision agriculture offers a consistent support for the management of modern farms in the purpose of optimizing inputs in agricultural production (seeds, pesticides, fertilizers, etc) maximizing profits and achieving a very big resource saving. The paper presents a method for achieving a flight over a crop, through the means of an aerial mapping system, in the view of obtaining multispectral maps based on which vegetation indices of the monitored crop can be obtained.

REZUMAT
În prezent, agricultura de precizie oferă un suport consistent în managementul fermelor moderne cu scopul de a optimiza intrările din producția agricolă (semințe, pesticide, îngrășăminte, etc.) maximizând profiturile și realizând o economie cât mai mare de resurse. In lucrare este prezentată o metodă de realizare a zborului asupra unei culturi, prin intermediul unui sistem aerian de cartare, în vederea obținerii hărților multispectrale pe baza cărora pot fi obținuți indicii de vegetație ai culturii monitorizate.

INTRODUCTION
Currently, the more and more frequent use of drones in precision agriculture has the objectives to obtain high and good quality yields, to optimize economic profits, to have an integrated environment protection (*Hassanalian et al, 2014*). Drones have a variety of day to day applications, being estimated that, depending on their type, drones will have more than two hundred applications (*Sui et al, 2005; Watts et al, 2009*). By using drones in agriculture, farmers can benefit from maps that contain information on the vegetation indices (*Haboudanea et al, 2004*). Through the means of these maps, farmers would be able to pulverize the fertilizers where the soil is lacking nutrients, could irrigate only the dry areas and could only treat the plants that need to be protected from pests (*Rouse et al, 1974 Ruiz-Garcia et al, 2009*). This way, considerable potential savings can be achieved, plants would be healthier and increased yields of the monitored crops would be obtained (*Lorente et al, 2012; Mahlein et al, 2012*). This is a situation model of situation where everyone wins; a manner of practicing agriculture using technology (*Cavoukian A., 2012)*. It is a very economical and cost-effective manner, contributing to the protection of the environment and ensuring food for the entire planet. (*Sankaran et al.2010*).

MATERIAL AND METHOD
Infrared spectre vegetation assessment flights are applied in the agricultural and forestry field in the purpose of early highlighting the changes in the health status of plants, before they become evident in the visible spectrum.

Fig. 1 – Agricultural drone type aerial spectral monitoring system

The working method for achieving the spectral through the means of an *agricultural drone type aerial spectral monitoring system* comprises the following stages:

- The flight planification program is opened (ex: Mission Planner);
- The communication with the agricultural drone crop monitoring system is achieved.

Fig. 2 – Achieving the communication of the flight planification program with the drone

- “FLIGHT DATA” submenu is accessed. On the monitor will appear 3 screens:
  a) Live flight monitoring:
     - Flight altitude;
     - Virtual horizon;
     - Telemetry signal power;
  b) Configurable parameters;
  c) Drone localization.

Fig. 3 – Opening the Mission Planner program
1- live flight monitoring; 2-configurable parameters; 3-localizations

- “FLIGHT PLAN” submenu is accessed. “Home” button is clicked to get to the point where the drone is situated.

Fig. 4 – Setting the “Home” for the drone

- Polygon icon is clicked to establish the drone’s flight trajectory.

- Intermediate flight points are established.

Fig. 5 – Setting the intermediate flight points

- Measuring the surface that will be monitored.

Fig. 6 – Displaying the size of the surface to be monitored

- AutoWp - Survey (Grid) is clicked to generate the flight trajectory.

Fig. 7 – Generating the drone's flight path

- The multispectral camera type – Survey 3N is set; the flight speed and the multispectral camera orientation are set (always directed downwards); "Takeoff" and "RTL" (return to launch) boxes are ticked.

- After generating the trajectory, the program shows the number of photos that the multispectral camera will take and will estimate the time in which the drone will conduct the monitoring flight.

Fig. 8 – Display the number of pictures that the multi-spectral camera will take, as well as drone flying time

- In “Grid Options” menu, the longitudinal coverage, as well as the lateral coverage are set;
- From submenu “Simple – Internals” are verified the points where the multispectral camera will take crop monitoring pictures and the “Accept” button is clicked.

Fig. 9 – Displaying the points where the multispectral camera will take crop monitoring pictures

- The final drone monitoring trajectory is generated.

Fig. 10 – Displaying the monitoring route, including the take-off point

- “Write Wps” buttons are clicked to write the intermediate points in the droe and “Save Wps” to save the mission.
- The drone will start the flight in the “LOITER” mode.

- After the drone will take-off, its flight will pass in the “AUTO” mode.
- The drone will head towards the intermediate points.
- The actual beginning of the researched crop monitoring mission.

Fig. 11 – The actual start of the monitoring mission for the researched crop
1 – altitude set for the flight

- Finalizing the monitoring mission and returning the drone to the take-off/landing place “HOME”

Fig. 12 – Finishing the monitoring mission

RESULTS

The multispectral data obtained from the flight of the agricultural drone type aerial spectral monitoring system can lead to identifying on a an apparent healthy field of stress areas, diseases emergence of nutrient deficits.

The detection of such problematic areas and the adequate treatment determines the increase of efficiency, yield and profit of monitored crops.

After the flight over the monitored crop, the pictures obtained though the means of the multispectral camera for agriculture with incorporated GPS need to be processed using a pictures processing software (ex: Agisoft Photoscan, Pix4Dmapper, etc).

CONCLUSIONS

In order to truly evaluate plant health and not only their vigour, the chlorophyll content should be considered. In order to measure the chlorophyll content, certain bands of light must be used. Such a band is the Edge Red band, an extremely narrow and precise light band between Red and Near-Infrared. When used together with other bands and properly analysed, bands like Red Edge provide a more accurate measuring of the plant health.

Transforming multispectral images in maps showing the health of crops that a farmer can use is an extremely complex process. Therefore, obtaining and analysing the data concerning the vegetation indices help farmers specially to increase the yield of their crops.

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NUTRITIONAL QUALITY OF GLUTEN-FREE CEREALS: A REVIEW
/
CALITATEA NUTRIȚIONALĂ A CEREALELOR AGLUTENICE: REVIEW

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ABSTRACT

Consumers are more interested in maintaining a healthy diet and lifestyle. One of the increasing interests of consumers is gluten free diets thus the nutritional improvements in this frame is needed. This paper reviews recent studies dealing with the nutritional properties of gluten-free cereals and pseudocereals, like: rice, maize, oat, sorghum, millet, teff, soryz, buckwheat, amaranth and quinoa. The main focus is on proteins, dietary fiber, carbohydrates, fat, vitamins, minerals and some bioactive compounds. Besides being recommended for celiac people, some gluten-free cereals (i.e. sorghum, millet, pseudocereals) can represent an alternative source of health-promoting compounds for different other diets.

REZUMAT

Consumatorii sunt tot mai interesați în menținerea unei diete și a unui stil de viață sănătos. Unul din interesele crescânde ale consumatorilor este dieta fără gluten, astfel îmbunătățirea nutrițională în acest cadru este necesară. Acestă lucrare analizează studii recente privind proprietățile nutriționale ale cerealelor și pseudocerealelor fără gluten, cum ar fi: orez, porumb, ovăz, sorg, mei, teff, soriz, hrișcă, amarant și quinoa. Cercetarea s-a concentrat pe conținutul în proteine, fibre dietetice, carbohidrați, grăsime, vitamine, minerale și anumiți compuși bioactivi. Pe lângă faptul că sunt recomandate pentru persoanele care suferă de boală celiacă, unele cereale fără gluten (printre care, sorg, mei sau pseudocereale) pot reprezenta o sursă alternativă de compuși care promovează sănătatea pentru diferite alte diete.

INTRODUCTION

Celiac disease is a chronic enteropathy which affects approximately 1% of the global population. Currently, the only treatment for celiac disease is strict lifelong adherence to a gluten-free diet (*Vici et al., 2016*). Besides people with celiac disease, more and more healthy subjects are becoming interested in gluten-free products. Over the years, cereals, grains, seeds, legumes and nuts (like rice, maize, buckwheat, amaranth, quinoa, millet, sorghum, teff, flax and chickpeas, among others) became popular among patients with celiac disease. Soryz (*Sorghum oryzoidum*) is a relatively new gluten-free cereal of hybrid origin (from Republic of Moldova) with great potential for use in human nutrition. It is a rich source of starch, mineral substances and other nutrients and biologically active substances.

In general, the nutritive and quality value of the gluten-free products – with a reduced content in dietary fiber, vitamins, iron and folate – is lower than the corresponding conventional products (*Arendt and Dal Ballo, 2008*). Thus, inclusion of alternative grains cereals or legumes contribute to the improvement of the quality of gluten-free products.

Pseudocereals (quinoa, amaranth and buckwheat) are underutilized crops and are receiving considerable attention as interesting alternatives for the formulation of gluten-free products due to their higher nutritional value (i.e. larger amount of bioavailable proteins and unsaturated fats) than common cereals (*Rocchetti et al., 2017*). For example, teff and quinoa are characterised by high fiber content, high in minerals (calcium, magnesium and iron) as well as high in protein content showing a favourable fatty acid composition (*Hager et al., 2012*). Besides many essential nutrients, pseudocereals also contain saponins which have many agro pharmacological and industrial applications (*Valcárcel-Yamani and da Silva Lannes, 2012*).

This paper reviews recent studies dealing with the nutritional properties of gluten-free cereals and pseudocereals.

MATERIAL AND METHOD

Web of Science database was electronically searched for articles published in the last 10 years. The literature search included as document type: research article and review, the topic: „gluten-free" and the article title containing the name of the different gluten-free cereals. The search resulted in the following number of articles: 203 (rice), 99 (buckwheat), 87 (oat), 67 (corn), 75 (quinoa), 71 (sorghum), 47 (amaranth), 33 (maize), 30 (millet) and 24 (teff).

RESULTS

Proteins

Proteins, amino acids and peptides are important food constituents. In addition to their nutritional significance, they contribute to the flavor and texture of the food.

Compared to wheat flour, teff, buckwheat and quinoa flours have higher protein content (Table 1). Quinoa flour has the highest protein content and it is considered as one of the best leaf protein concentrate. The quantity and quality of the protein in pseudocereals is higher than cereals. In particular, lysine – the limiting amino acid in cereals, is found in high amounts. The high content of arginine and histidine both essential for infants and children are in higher amounts in amaranth and quinoa than in cereals (*Mir et al., 2018*). Sorghum, corn and oat have a lower protein content. Protein value is also relatively low for rice (Table 1). High variations in protein content are not only due to genetic factors, but also to the effects of environmental conditions.

Table 1

Protein content in different cereals and pseudocereals

Source	Protein, %	References
Wheat	11.3	*Rosell et al. (2014)*
	11.5	*Hager et al. (2012)*
Rice	7.3	*Hager et al. (2012)*
	7.9	*Rosell et al. (2014)* Sakač et al. (2015)
Maize	5.5	*Hager et al.(2012)*
	9.4	*Rosell et al. (2014)*
Oat	6.9	*Hager et al.(2012)*
Sorghum	4.7	*Hager et al.(2012)*
	11.3	*Rosell et al. (2014)*
Buckwheat	8.7	Sakač et al. (2015)
	12.2	*Hager et al.(2012)*
	12.5	*Drzewiecki et al. (2018)*
	13.1	*Mir et al. (2018)*
	13.2	*Rosell et al. (2014)*
Amaranth	11.0	*Mir et al. (2018)*
	12.5	*Drzewiecki et al. (2018)*
	13.6	*Rosell et al. (2014)*
Quinoa	11.3	*Mir et al. (2018)*
	13.5	*Hager et al.(2012)*
	14.1	*Rosell et al. (2014)*
	14.5	*Drzewiecki et al. (2018)*
Teff	12.8	*Hager et al.(2012)*
	13.3	*Rosell et al. (2014)*

The importance of proteins in gluten-free cereals is based on their quality and their composition in amino acids. Amino acids in pseudocereals give a significantly advantageous nutritional profile due to the high content of essential amino acids. In particular, methionine, lysine, arginine, tryptophan and some sulphur-containing amino acids are found at higher concentrations than some gluten-free cereals. Because of the high proportion of lysine in globulins, pseudocereals provide approximately twice as much of this amino acid than that provided by wheat or maize.

Fiber

Compared to cereals, the flours are significantly poorer in fiber because of the grinding process which to some extent removes bran and germ. Due to the differences in the chemical composition of the grains and the milling procedures applied, the fiber content in the flour varies greatly, some examples are shown in table 2 (*Hager et al., 2012*). Studies have shown that the pseudocereals amaranth, quinoa and buckwheat represent good sources of dietary fiber. Dietary fiber content is significantly higher in buckwheat seeds in comparison with amaranth and quinoa, which have fiber levels comparable to those found in common cereals (*Alvarez-Jubete et al., 2009*).

Table 2

The fiber content from different flours

Source	Wheat	Whole wheat	Rice	Oat	Quinoa	Buckwheat	Sorghum	Maize	Teff
Fiber, %	3.4	11.4	0.4	4.1	7.1	2.2	4.5	2.6	4.5

Carbohydrates

Cereals usually contain about 50–80% carbohydrates, relative to dry matter. Starch is the principal polysaccharide in cereals and is the major reserve carbohydrate in food, being the main source of physiological energy in the human diet, and is therefore generally classified as available carbohydrate.

Table 3 shows the starch content of some cereals and pseudocereals (*Hager et al., 2012*). Sorghum presented the highest starch content. Compared to quinoa and amarant, buckwheat had a much higher starch content. Starch content from amaranth accounts for up to 65% to 75%. *De Fructos et al. (2018)* underlined that amaranth starch has interesting advantages due to the very small granules (0.75–3 μm) that exhibit very high water-absorption capacity providing unique functional properties to food.

Table 3

Starch content in different flours

Source	Wheat	Rice	Oat	Quinoa	Buckwheat	Sorghum	Maize	Teff
Starch, %	68.1	77.5	69.4	48.9	61.4	73.2	71.5	57.8

Alvarez-Jubete et al. (2010) showed that buckwheat seeds contain a type of soluble carbohydrate called fagopyritols with ranges from 269.4 to 464.7 mg/100 g of dry matter. Fagopyritols are a source of D-chioro-inositol, a compound that has shown beneficial effects in patients with non-insulin dependent diabetes mellitus.

Fat

Although fat represents only about 1.5 – 7.0% of the cereal grain mass, it presents nutritional and physiological importance because of its role of supplying energy and being a source of essential fatty acids. *Hager et al. (2012)* found that oat, teff, buckwheat and sorghum flours were relatively high in fat (6.7%, 4.4%, 4.2% and 3.5%) compared to wheat flour. Fat content in amaranth and quinoa is between 2 and 3 times higher than in buckwheat and common cereals such as wheat (*Alvarez-Jubete et al., 2009*). The fat from amaranth, quinoa and buckwheat is characterized by a high degree of unsaturation. Linoleic acid is the most abundant fatty acid (50% of the total fatty acids in amaranth and quinoa, and approximately 35% in buckwheat) followed by oleic acid (25% in amaranth and quinoa and 35% in buckwheat) and palmitic acid (*Alvarez-Jubete et al., 2009*). Quinoa is the pseudocereal with the highest amount of fat and it is characterized by a high content of unsaturated fatty acids with increased nutritional value.

Vitamins

Vitamins play an important role in most physiological functions of the body. Amaranth is a good source of riboflavin, quinoa of riboflavin, thiamine and folic acid, while buckwheat of thiamine, riboflavin and pyridoxine. These flours are also good sources of vitamin E. The total vitamin E content in amaranth, quinoa and buckwheat seeds was reported to be 5.7; 8.7 and 5.5 mg/100 g (relative to dry matter), respectively (*Alvarez-Jubete et al., 2010*). Folic acid was found in quinoa at 78.1 µg/100 g and 102 µg/100 g in amaranth, thus 2.5 times higher than wheat (*Mir et al., 2018*). Rice and maize have a lower folate content than pseudocereals (*de Frutos et al., 2018*).

Minerals

Minerals are important for different physiological functions in the human body. The gluten-free diets are deficient in minerals. The pseudocereals amaranth, quinoa and buckwheat are generally a good source of calcium, magnesium and iron and other important minerals (*Alvarez-Jubete et al., 2009*). *Hager et al. (2012)* showed that buckwheat, quinoa or tefff has higher iron content (2.9 mg/100 g, 5.4 mg/100 g and 8.5 mg/100 g, respectively) than other gluten-free flours. Buckwheat is a richer mineral source (except for calcium) than many cereals such as rice, sorghum and corn, with a higher content of magnesium (173.6 mg/100 g), zinc (1.88 mg/100 g), potassium (402.3 mg/100 g) and copper (0.51 mg/100 g). *Nascimento et al.*

(2014) have been reported that the phosphorus and magnesium content in quinoa may contribute up to 55% of the daily recommended intake.

Phenolic compounds

The identification and characterization of bioactive compounds, such as polyphenols, are of great importance regarding the quality of gluten-free food products, generally associated with some nutritional deficiencies.

Polyphenols are a wide and complex family of phytochemicals present in almost all plant foods, usually grouped into a number of subclasses depending on their carbon backbone and ring saturation. Phenolic compounds represent much interest due to their related health properties, partially attributed to their antioxidant capacity, the most reknown being cholesterol-lowering potential, the prevention of atherogenesis and type II diabetes, anti-inflammatory and estrogenic activities, reduction of oxidative damage to lipids (*Rocchetti et al., 2019*). Other important health-promoting properties were atributed to the gluten-free grains such as: reduction and/or prevention and of oxidative stress, anti-cancer, anti-diabetic, anti-inflammatory, cardiovascular disease prevention and anti-hypertensive (*Taylor et al., 2014*).

Besides their direct antioxidant activity, phenolic compounds can be linked to the indigestible component of foods (for example, fiber fractions), without being absorbed in the small intestine of healthy individuals and reaching the colon intact, where they become available by bacterial microflora (*Rocchetti et al., 2017*).

Quantification of total polyphenol content is usually performed through spectrophotometric using the Folin-Ciocalteu reagent and gallic acid as standard, the results being expresses as gallic acid equivalents (GAE). Different types of solvents are used to prepare extracts for phenolic analysis. *Drzewiecki et. al (2018)* stated that water extracts of pseudo-cereals showed higher phenolic content than their corresponding methanol extracts, mainly because of the result of non-specific reactions of the Folin-Ciocalteu reagent with other components of the water extract which could overestimate the phenolic content. To identify the type and the quantity of polyphenolic compound, liquid chromatography analysis coupled with diode array detector is used.

According to *Hager et al. (2012)*, the total polyphenol content (expressed as mg GAE/100g) in different gluten-free flours decreased in the order: buckwheat (465.5) > teff (175.6) > sorghum (103.3) > maize (97.8) > quinoa (78.2), while oat and rice flours were with significantly lower values (22.2 and 14.2, respectively). This observation was also confirmed by another study (*Sakač et al., 2015*).
The total polyphenol content (expressed as mg GAE/g dry weight) of water extracts of pseudo-cereal seeds were higher in buckwheat (4.21), followed by quinoa (3.58) and different amaranth cultivars (2.21-2.87) (*Drzewiecki et al., 2018*). *Alvarez-Jubete et al. (2010)* found similar values in methanolic extracts of pseudo-cereals. Thus, the total polyphenol content (expressed as mg GAE/100 g dry weight) of the seed extracts decreased in the following order: buckwheat (323) > quinoa (71.7) > amaranth (21.2).

In a recent study (*Rocchetti et al. 2019*), the total polyphenol content vary in different gluten-free flours: 500.4 mg GAE/100 g (violet rice flour), 130 mg GAE/100 g (red and black quinoa), 71.9 mg GAE/100 g (red lentil), 52.3 mg GAE/100 g (white sorghum flour).

Rocchetti et al. (2017) found the highest polyphenol content (expressed as mg GAE/100g) in black rice (147.9), followed by quinoa extracts (87.2). Also, the antioxidant capacity was highest in black rice and quinoa flours. The authors found a high correlation between polyphenol content and antioxidant capacity with Pearson's coefficient of 0.90.

Phenolic compounds can be considered the major contributors of antioxidant activity in the gluten-free samples analyzed (*Drzewiecki et al., 2018*; *Rocchetti et al., 2017*).

In gluten-free flours, different phenolics compounds were identified by metabolomic approach; these compounds belonged to the following classes: flavonoids (anthocyanins, flavanols, flavanones, flavones, flavonols, dihydrochalcones, dihydroflavones and isoflavonoids), phenolic acids (hydroxycinnamic acids, hydroxybenzoic acids and hydroxyphenylacetic acids) and other phenolics (tyrosol derivatives, lignans and stilbenes) (*Rocchetti et al., 2019*; *Rocchetti et al., 2017*).

The main phenolic acids identified in gluten-free flours are presented in table 4. Amaranth contains phenolic acids as protocatechuic, *p*-hydroxybenzoic, syringic, gallic, *p*-coumaric and vanillic. Quinoa is also a good source of bioactive compounds such as phenolic acids (acid caffeic, ferulic, *p*-coumaric, *p*-

hydroxybenzoic, vanillic, gallic, cinnamic and protocatechuic), phytosterols, flavonoids (myricetin, quercetin, kaempferol, isorhamnetin, rutin, orientin, vitexin, morin, hesperidin, neohesperidin) and tocopherols.

Among different gluten-free flours, the phenolic profile is diverse, but it represent a valuable source of health-promoting compounds, mainly belonging to phenolic acids and flavonoids.

Table 4

Phenolic acids in gluten-free flours

Source (Reference)	Phenolic acid	Source (Reference)	Phenolic acid
Amaranth (*Mir et al., 2018*)	*p*-hydroxybenzoic	Sorghum (*Taylor et al., 2014*)	gallic
	syringic		*p*-hydroxybenzoic
	gallic		vanillic
	p-coumaric		caffeic
	vanillic		*p*-coumaric
Buckwheat (*Mir et al., 2018*; *Taylor et al., 2014*)	ferulic	Quinoa (*Mir et al., 2018*; *Taylor et al., 2014*)	caffeic
	caffeic		ferulic
	gallic		*p*-coumaric
	p-coumaric		*p*-hydroxybenzoic
	p-hydroxybenzoic		vanillic
	o-coumaric		gallic
	sinapic		cinnamic
	vanillic		
Millet (*Kotášková et al., 2016*)	*p*-coumaric	Rice (*Kotášková et al., 2016*)	gallic
	ferulic		*p*-hydroxybenzoic
	cinnamic		

CONCLUSIONS

The evaluation of the nutritional, bioactive profile and composition of gluten-free flours has an important role in the formulation of gluten-free products with the aim of increasing the nutritional quality. A much more attention should be paid to the nutritional quality of gluten-free diets, particularly with regard to the intake of iron, calcium, fiber and vitamin B. It can be considered that pseudocereals are good candidates for nutritional improving of gluten-free products.

Briefly, the different sources of gluten-free from the point of view of the nutritional composition can be characterized as follows:

- rice and corn have a low protein, fiber and folate content;
- teff, quinoa, amaranth and buckwheat have a favorable composition of fatty acids and high protein content;
- amaranth and teff are rich in calcium, magnesium and iron, the content largely depending on the region of cultivation;
- teff has an excellent amino acid composition (including all 8 essential amino acids for humans).

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MODULAR MANUAL SEED DRILLS FOR SMALL SEEDS IN ALVEOLI / *SEMĂNĂTOARE MANUALĂ MODULARĂ PENTRU SEMINȚE MICI ÎN ALVEOLE*

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ABSTRACT

The paper presents the theoretical studies regarding the realization of a modular manual sowing machine for the sowing of small seeds in the alveoli, highlighting the advantages of this type of seeders by the superior parameters obtained for the studied seeds.

REZUMAT

În lucrare se prezintă studiile teoretice privind realizarea unuei semănători manuale modulare pentru semănatul seminţelor mici în alveole, evidenţiind avantajele acestui tip de semănătoare prin parametrii superiori obţinuţi pentru semințele luate în studiu.

INTRODUCTION

Utilization the equipment proposed for sowing small seeds in seedbeds decreases the volume of manual force required to do the work, decreases the amount of seed per surface unit, eliminates the execution of works thus reducing costs for obtaining seedlings (*Mărdărescu R., 1968; Oprean A., 1982*).

It is also ensured the sowing depth and emerging uniformity of plants. To achieve the equipment plastic products or existing components of some installations and equipment that can be reused, are used.

Studies and experimental tests relating to the production index, consumption standard, the emerging degree and the plants percentage obtained will be continued. Based on the rules relating to the influencing factors for achieving optimal density can be established by species, the crop nature, the crop schemes implicitly expressing the productivity (*Cristache Avram et. al., 1968; Hulea A.,1962*).

MATERIAL AND METHOD

Studies aim to achieve an equipment that can be used to set up small specific seed crops respectively forestry, flower, vegetable species and develop in the mechanization laboratories of the Faculty of Horticulture and Agriculture from Craiova (*Saracin et. al., 2010; Saracin and Pandia., 2010)*. Therefore, some of the methods used for sowing manually or mechanized the small seeds, existing in the country and abroad, were (*Sărăcin I., 2002 -2004)*. Also have been studied some characteristics of the seeds belonging to forestry, flower and vegetable species (*Hulea A.,1962*).

Documentation and studies consideration was given to the following:

- Direct sowing in cups;
- Consecutive sowing in several cups at the same time;
- Possibilities for sowing depth adjustment (*Sărăcin et. al., 2009)*;
- Automation possibilities for sowing small seeds in cups.

Based on the rules relating to the influencing factors for achieving optimal density, the production indexes, expressing the final productivity may be established on species, the crops nature on culture scheme.

Research and testing relating to the production indices at the consumption norms, will continue (*Scripnic V., Babiciu P., 1979; Toma D., 1975)*.

Following the results obtained recently through research, the consumption norms of the seeds sown in seedbeds should be set in relation to the average index of soil emergence, determined by laboratory germination, with plants maintenance index and the percentage of capable plants obtained. Sowing rate can be calculated as it follows:

a) Sowing rate in number of seeds per linear meter of the ditch channel, with the relation (1):

$$n = i * \frac{100}{R} * \frac{100}{M} * \frac{100}{A} = I * \frac{1.000.000}{R*M*A} \text{ seeds/meter}$$

or:

$$n = \frac{I}{L} * \frac{1.000.000}{R*M*A} \quad \text{[seeds/m]}, \qquad (1)$$

where:
n = consumption rate (sowing rate) in seeds number and seeds number to be sown per meter [pcs/m];
i = index of production per ditch meter [pcs/m];
R = index (percentage) of emerging;
G = technical germination or potency germination indicated in the analysis report [%];
M = index (percentage) of plant maintenance;
A = percentage of plants capable for planting.
b) Sowing rate in grams of seed per meter, with the relation (2):

$$q = n * \frac{G1000}{1000} * \frac{100}{P} = n * \frac{G1000}{10*P} \text{ [g/m]}$$

or

$$q = \frac{I}{L} * \frac{1.000.000}{R*M*A} * \frac{G1000}{10*P} = I * \frac{1.000.000*G1000}{R*M*A*P} \text{ [g/m]} \qquad (2)$$

where:
q = consumption rate (sowing rate), in grams of seeds or quantity of seeds in grams to be sown at linear meter;
G1000 = weight of 1000 seeds, indicated in the analysis report, stating the average number of seeds per kilogram - NK;
P = seeds purity [%], indicated in analysis reports.

ABOUT THE CONSTRUCTION AND FUNCTIONING OF THE MACHINE

The small, cylindrical shape drill (50 length, 30 cylinder diameter) transmits the motion from the wheels directly to the cylinder, the position of which is adjusted according to the vertical sowing depth on the tread, shown in the figures below:

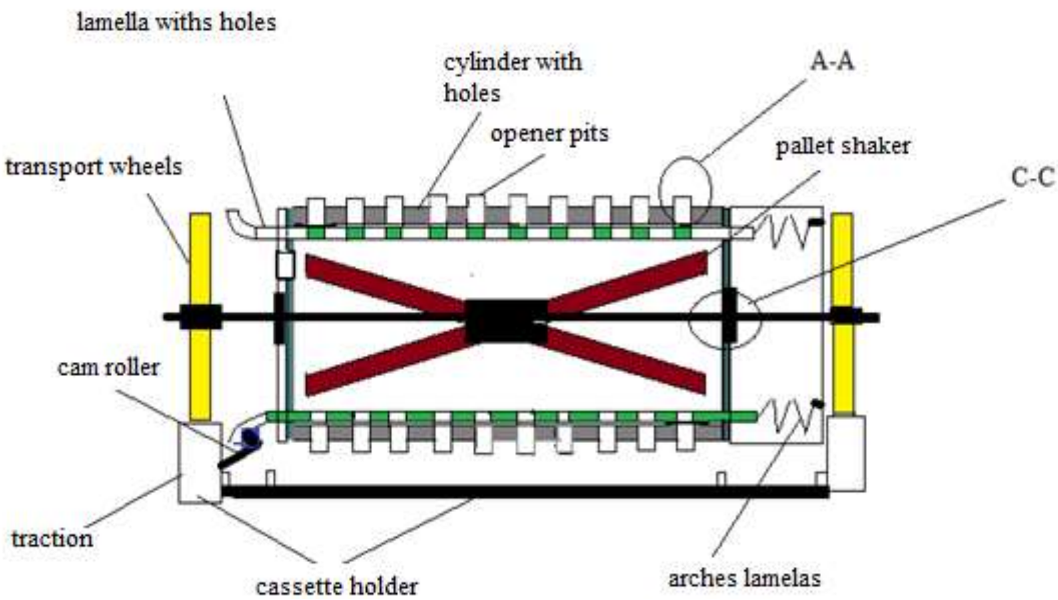

Fig. 1 - Components of modular seed drill small hand

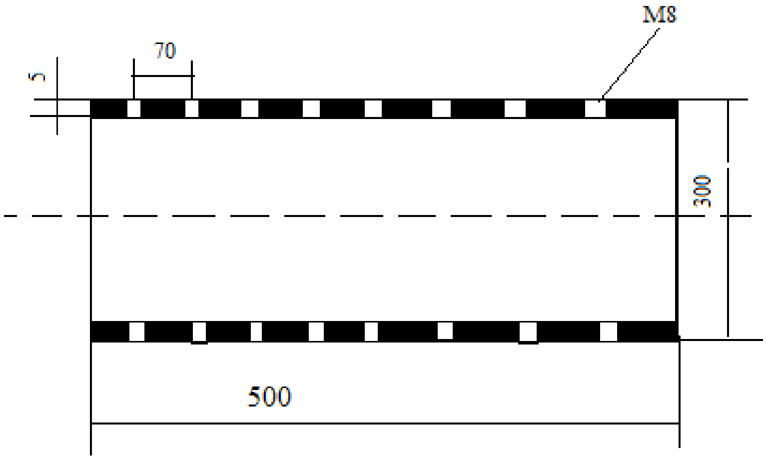

Fig. 2 - Cylinder with holes for mounting the dispensing heads and forming the recesses

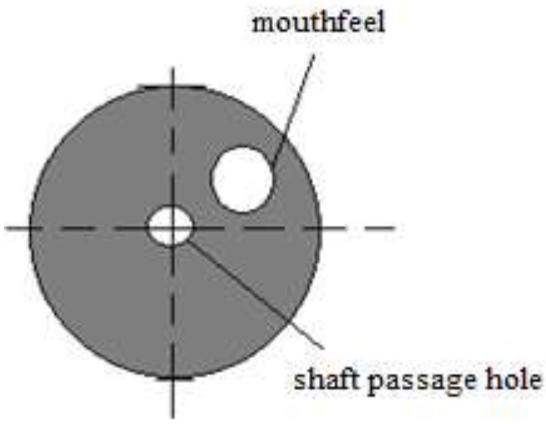

Fig. 3 - Left handle with the feed and emptying of the cylinder

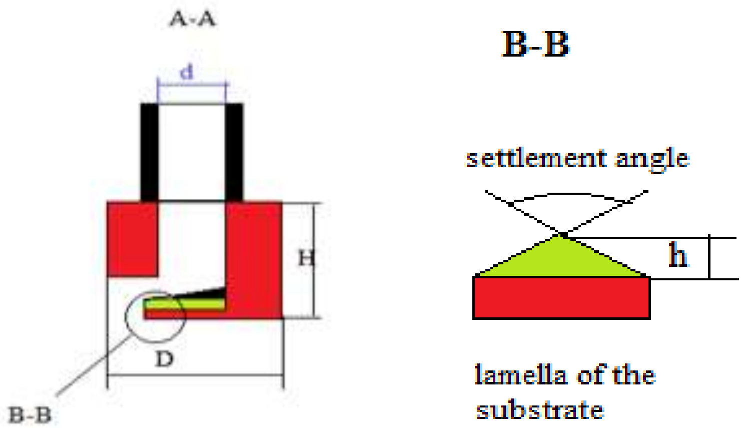

Fig. 4 - Distributor opener recess

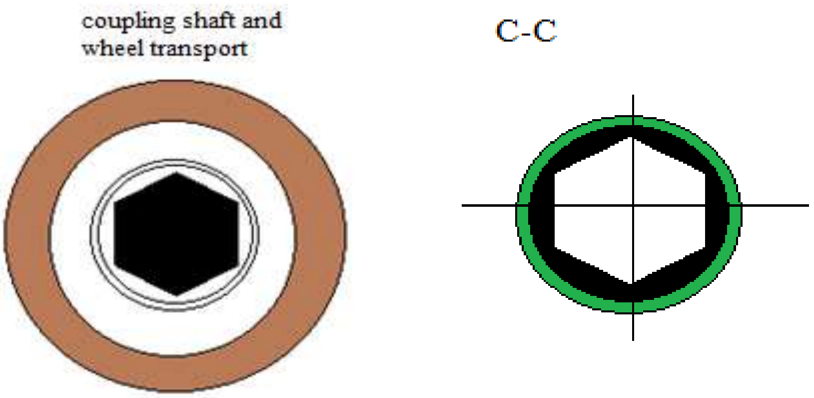

Fig. 5 - Module coupling shaft and rotation of the cylinder

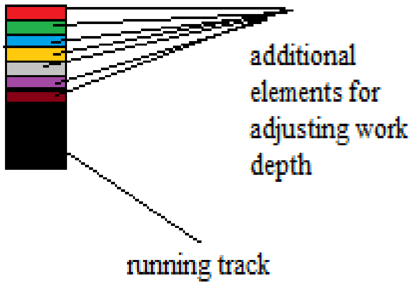

Fig.6 - Cylinder runway with additional elements for adjusting the depth of sowing

For the calculation of the distance between the seeds and the respect of the center of the surface between the two alveoli adjacent to the same row, the relation was used:

$$D = 2 * r \sin \alpha / 2 \qquad (3)$$

where:
R is the radius of the cylinder;
a - the center angle after which the rows of alveoli are drawn on the cylinder;
$\alpha = 60^o$.

RESULTS

The results obtainedin laboratory regarding the uniformity of distribution of turnip, eggplant and tabacco seedsare shown in Figures 1, 2 and 3:

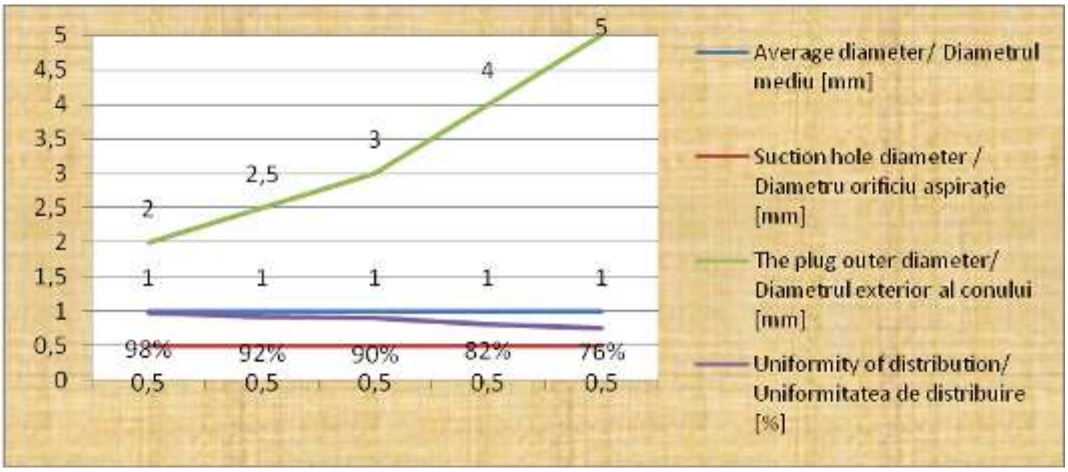

Fig. 1 - Uniformity of distribution for turnip small grain saver age diameter of 1 mm and suction hole diameter of 0.5 mm

From the graph it can be observed that the uniformity of seed distribution decreases with the outer diameter of the cone. This happens probably because the surface between the hole and the exterior of the cone allows setting more seeds on it during the aspiration.

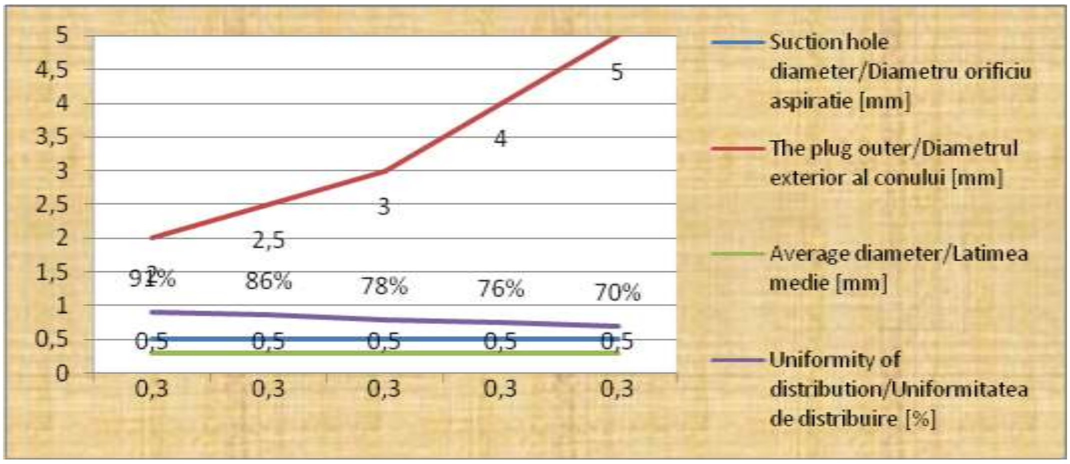

Fig. 2 - Uniformity of distribution for small seeds of eggplants with average diameter of 1 mm and suction hole diameter of 0.5 mm

From the graph it can be observed that the uniformity of seed distribution decreases with the outer diameter of the cone. This happens probably because the surface between the hole and the exterior of the cone allows setting more seeds conditioned by width during the aspiration.

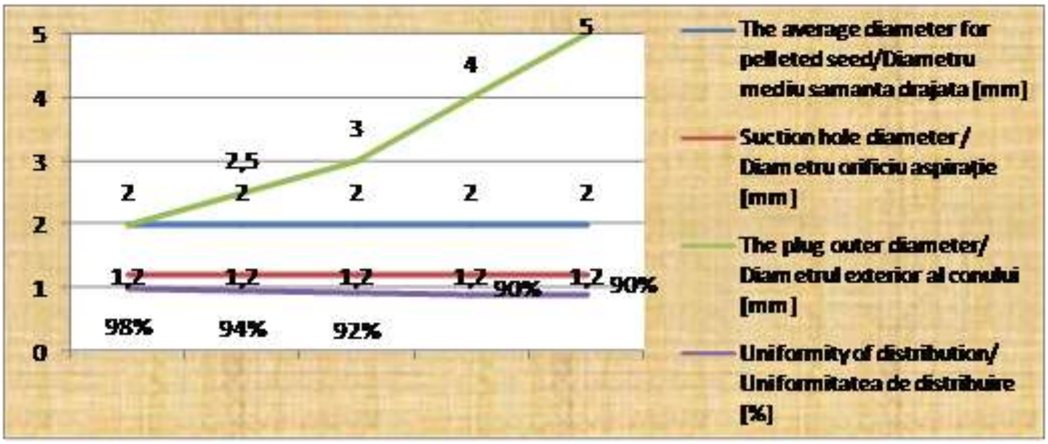

Fig. 3 - Uniformity of distribution for small seeds of polluted tobacco with average diameter of 1 mm end suction whole diameter of 0.5 mm

From the graph it can be observed that the uniformity of seed distribution decreases with the outer diameter of the cone. This happens probably because the seeds outer diameter grows by polluting and the surface between the cone and the hole does not allow setting more seeds during the aspiration.

CONCLUSIONS

For performing the production indexes the following technical indications related to compulsory minmum works to perform are imposed, such as:

When preparing the seeds: verification of seeds quality, establishing the sowing norms, setting the sowing method, preparation of seeds according to each variety;

When sowing the seeds: soil temperature, at the moment of sowing should be between +9ºC and +15ºC;

When covering the seeds: seeds covering with the humus-sand mixture prepared, slightly compressing the humus after soil covering;

Equipment can be used in narrower spaces, being easily to handle and use;

The dispensing heads must be 1.4 -1.5 of the smallest seed size;

The dispensing heads do not allow multiple seeds to be placed at the same time on the dispensing hole;

Using the manual drill modulation increases productivity, decreases the space for the establishment of the nursery box, seed decreases and sepot time like several kinds of seeds at the same time;

Ensuring the germination, emergence and growth of plants;

The seed drill can also be equipped with a box of seed covering material after sowing and surface leveling and leveling.

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PERFORMANT EQUIPMENTS DESIGNED FOR GRAPE MARC SEEDS SEPARATION AND CALIBRATION FOR SUPPERIOR CAPITALIZATION IN FOOD AND PHYTOPHARMACEUTICAL INDUSTRY
/
ECHIPAMENTE PERFORMANTE PENTRU CURĂŢAREA ŞI SORTAREA SEMINŢELOR DE STRUGURI DIN TESCOVINĂ ÎN SCOPUL VALORIFICĂRII SUPERIOARE ÎN INDUSTRIA ALIMENTARĂ ŞI FITOFARMACEUTICĂ

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Keywords: *grape seeds, sieves, seed separation, calibration.*

ABSTRACT:
One of the most important process operations from wining byproducts capitalization, it is the grape seed recovery from grape marc. In this paper are presented a serias of processes and performant equipments which are integrated in whell known seed separation and calibration technological flows, that can be succesfuly used in the grape seed selection line. Due to their working principle, these equipmens lead to high quality seeds material, which can guarantee the food and phytopharmaceuticals production to meet the most demanding requirements of the interested consumers.

REZUMAT
Una din operaţiile importante din cadrul activităţilor de valorificare a produselor secundare rezultate din procesele de vinificaţie, îl constituie recuperarea seminţelor de struguri din tescovină. În aceasta lucrare sunt prezentate o serie de procedee si echipamente performante din componenţa fluxurilor tehnologice de curăţare şi sortare a seminţelor de culturi agricole ce se pot utiliza cu succes şi în cazul seminţelor de struguri. Datorita principiului de lucru, aceste echipamente conduc la obţinerea în final a unor seminţe de calitate superioară, ce pot garanta fabricarea de produse alimentare şi fitofarmaceutice care să satisfacă cele mai exigente cerinţe ale consumatorilor interesaţi.

INTRODUCTION
The cleaing and selection operations of cereals and other crop seesds, have a purpose to grow the agricultural products qualitative indices according to their destination and physicomechanical properties. Usualy the seeds and cereals that are ment to get through the processing lines, firstly must be eliminated the impurities (mineral formations, weeds and vegetal parts) and calibrated. Thouse operations usually are designe in accordance with the type of seeding material and cereals, the mechano-pneumatic separation system that is provide with smaleser and smaller mesh sivels, but also by the number of passings. This combination usually can be found on all perfomant equipments which operating on the gravitational and aerodynamic principle, the material that passes throu the sieve mesh is known as sifted (fine sort) and the other refusal (roughly sort). The mechanic screening equipments are provided with several sieves whereby the elimination of impurities and seeds calibration in several dimensions. In scientific and technical documentation thouse equipments are classified as:

- Shape and dimension calibration equipments;
- Aerodynamic properties calibration equipments;
- Combined separation equipments (dimension and aerodynamic criteria);
- Volumic mass separation equipments (known also as specific mass);
- Color separation echipaments.

The right seed separation process is applied taking in to consideration the initial product purity, the tipe and the nature of the impurities, copared to the basic seed properties, as well as the destination of the final product (short- or long-term storage, consumption, industrialization, marketing, sowing material, etc.). In technical literature thouse equiments are devided in two categories taking in to consideration the sieve form:

- Equipments with plane sieves;
- Equipments with cylindrical sieves.

Due a proper technologic analise of the cleaning and calibrationg equipments designed for seeds and cereals, was concluded that those equipments can be used also in winery by-produscts, respectively fresh grape marc processing, appling small changes regarding the cinematic conditions and some technologic adaptations in order to obtaine greape seeds *(Voicu et al., 1995; Costin I., 1988).*

Taking in to consideration the percentage of by-products (marc, yeast and stone of wine) obtained from wine making process, that in some cases is evaluate at 18 ÷20 %, and the estimations that the rate grape seeds in the marc is 18 ÷ 25 % (the rest is liquid remains and 55÷65 % peels), this process is profitable, only if significant quantities are collected from major wine manufacturers. In the world, grape marc processing is made entirely, mainely grape seeds - to obtain oil and peels for the food industry and natural dyes. The marc separation process is very important because every component hase a specific composition and post processing technology.

As exemple, the greape seed postrocesing technology imply drying in order to rich at a certaine humidity that assure good storage on optimal consitions for a certaine period of time (maimum 3 mounths). Some times the dryng methods are naturaly (sun exposure or attics) or enclosures with controlled environment – dring instalations. In some cases, the oil extraction from greape seeds (that have an oil content of 8-12 %) can be made by pressing (mechanical processiong) or by solvent (chemichal processiong). Acording to scientific studies made by known research centers in the food and phytopharmaceutical industry, stated that grape seed oil meets all the qualities of a food oil (light yellow color, pleasant taste, a greate content of E vitamine and low concentration of bad cholesterol). In order to obtaine good greape seed oil [11], must be respected the below technologic requiremants:

a) seed separation must be made from fresh marc (swite marc);
b) seed drying can be made for a temeperature of maximum 110 ^{0}C;
c) seed mass humidity during the storage must be 11÷12 %.

In Figure 1 is presented the diagram of an innovative technology to process fresh marc made from INMA Bucharest and incorporets three maine phases: phase I - components coarse separation of the non-homogeneous mixture; phase II - dry mass obtaine; phase III - components fine or final separation from non-homogeneous mixture. All these phases can be interconnected by transport interphasic operations that will be monitored through a Command and Controll Unit – UCC.

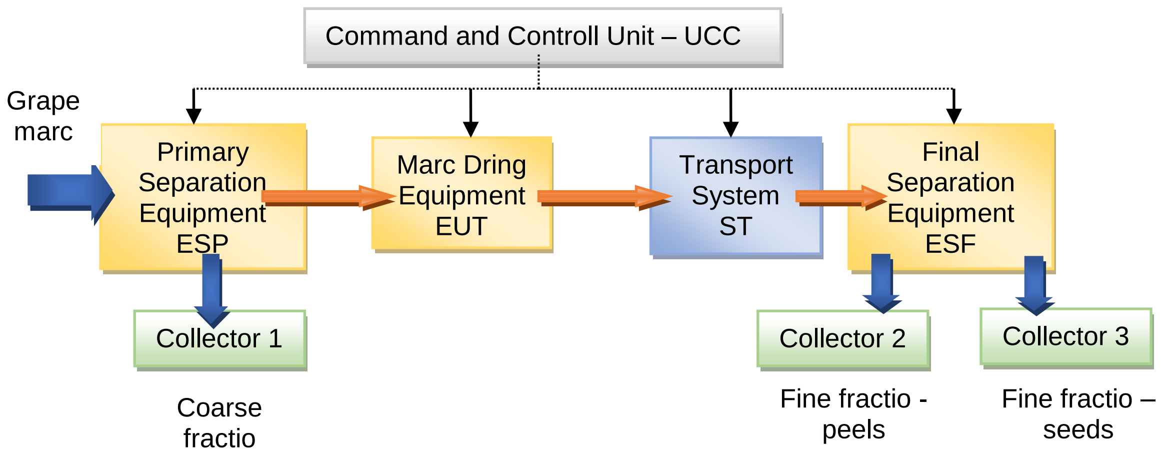


Fig. 1 - Diagram of an innovative technology to process fresh marc *(Milea D., 2018)*

The greape seed cleaning and calibration equipments can be implemented in 1th and 3th phase, usually in current practical applications, in phase 1th are used cilindrical sieve cleaning equipments and in 3th phase, when the material hase a lower humidity, are used plane or circular sieves. The UCC hase the role to control and commands the marc tehnologic processing in accordance with grape variety, tipo-dimensions of greape seeds and material destination (food or phytopharaceutic industry).

MATERIAL AND METHOD

In this part will pe presented most representative equipments used in the greape seed processing used in marc capitalization by the most representative companies.

I. Seed separation and calibration with cilindrical sieve equipments.

In technical applications these equipments have specific design and can made several operations, as:

- seed separation, this operation the equipment is provided with different kind of sieves and meshes, placed on different configuration relative to the rotation center axis. From this point of view, here will be presendet the next models:

a) the sieve with different mesh sectors, that is used in multiple operations as: first se to eliminate the small impurities, the next sectors to separate the sived material in categories and the last mesh for large impurity elimination (Fig. 2);

b) the coaxial sieves diametral dispuse sives, this equipments are designe to separate and calibrate the seeds and its gauge to be smaller (Fig. 3);

- coares processing, this operation is achived in the case in which the roatry sieves have the same mash in order to eliminiate the coarse impurities from the marc composition, directim them to the collector opning and the sieving mass is formed form small impuritiesm peels and seeds (Figures 4 and 5);

- seed calibration (seed separation).

In Figure 2 is presented the technologic scheme of a seed separation and calibrating equipment that uses an multi mesch cylindric sieve and the material flow, which can be adjusted by sieve axis inclination compared to horizontal position (this angle usually is 3 ÷ 5^0). Also, in this figure are presented its main components and the fractions that can be obtained during its operation. The raw material is supplied from inlet funnel *1*, reaches the rotary sieve work area *8*, which is provided with meshes *9*.

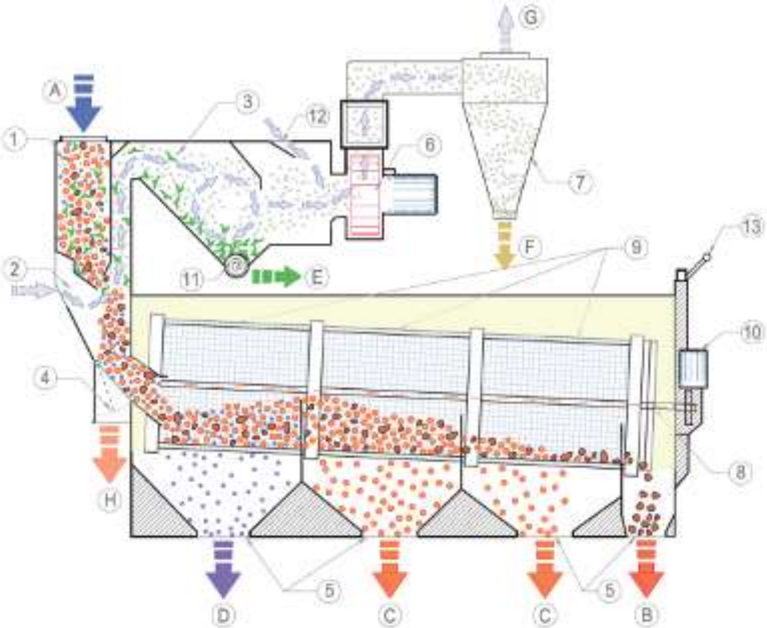


Fig. 2 - Technologic scheme of a seed separation and calibrating equipment with cilindrical sieve [7]

1-supply funnel; 2–air inlet opening; 3–aspiration chamber; 4-by-pass falp;5 – outlet opening; 6 – fan; 7–separation cyclon; 8-rotary sieve; 9-metalic meshes; 10-sieve power engine; 11-light impurities outnet conveyor; 12–air flow flap;13-sieve inclination; A–raw material; B–large impurities; C–seed calibration; D–small impurities; E-light impurities; F-dust and small particles; G-air evacuation; H-seeds pre-cleaned by aspiration.

The separation process is made using sieves made from perforated sheets with round or rectangular holes. Cylindrical separators are less widespread than plane separators, due to their lower working capacity. Compared to site planes, the cylindrical separators have a quiet operation mode because, they do not have balancing masses and the construction of the hollowing system is simpler.

In Figure 3 is presented a performant ceral/seed selector model Kongskilde KDC 4000 designed for grate capacity plants, beging from 14 to 40 t/h.

The coares processing equipments have usually simpler structure (Fig. 5), and are embaded in large industrial technologies and some times in small scale for small scale processing – small producers (Fig. 4).

Fig. 3 - Kongskilde KDC 4000m selector, Danemark [8]

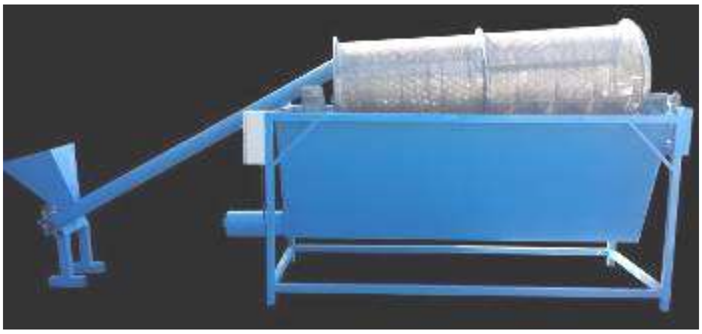


Fig. 4 - Plant for separating grape seed with sieve [19]

The model presented in Figure 6, is specialy designed for greape sweet marc, respectively for high humidity seeds, desiged with rotary sieve on which are placed helical inner groovers and axial pallets with the purpose to provide product advance and rummage it during the working process.

Fig. 5 - Onmak Makina grape seed separator, Turchi [21]

1 – Metalic frame; 2 – Rotary cylindrical sieve; 3 –exterior rotary brush; 4 – rubber belt conveyor

To avoid the cylindrical sieve perforations clogging must be used a cleaning system that usually is provided with rollers or brushes, so that the wet seed separation process to be efficient and uninterrupted, (Fig. 6.a and b). The sieved material can be transported to the next machine in the stream, by a rubber belt or helical conveyor (Fig. 4, 5 and 7).

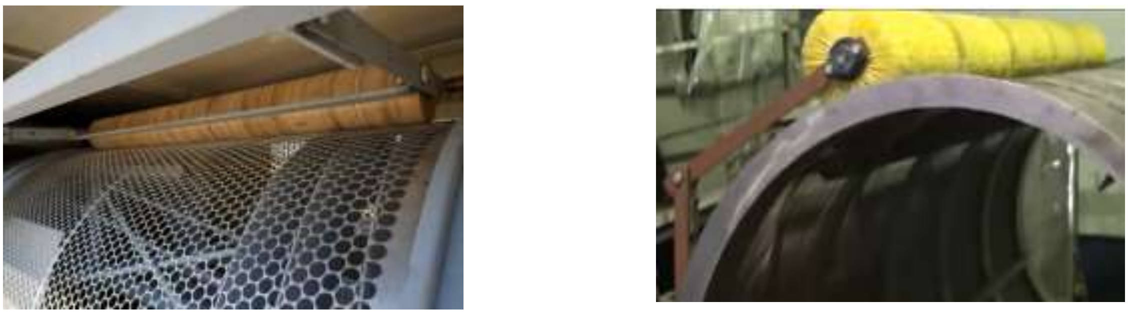


Fig. 6 - Rotary circular sievs and their cleaning systems

a – rollers cleaning system, b – circular brushing system

Another modular constructive solution from this type of equipments is presented in Figure 7, in which the circular sieve is supplied from a belt conveyor that is positioned under an upper supply funnel, and the seeds are collected from another two belt conveiors positioned to transport the processed material to sillage packing bags.

Fig. 7 - OPTION rotary seieve installation for separating grape seed from marc, Italy [9]

II. Seed separation and calibration with plan sieve equipments

A plane sieve equipment is working as is represented in fig.8, which works according a combined working principle, separation by seed size and aerodynamic characterisitics. The maine components of this equipment are: an aspiration chamber with two air suppling ducts (provieder with air flow control mechanisms and with light impurities evacuation); two frames with hanging plane sieves of the machine frame through elastic blades; a stedy plaine sieve; an eccentric mechanism for the frames action; a series of gutters and funnels for evacuating the products resulting from the working process. Cleaning the plane mashes in this case is done with linear brushes.

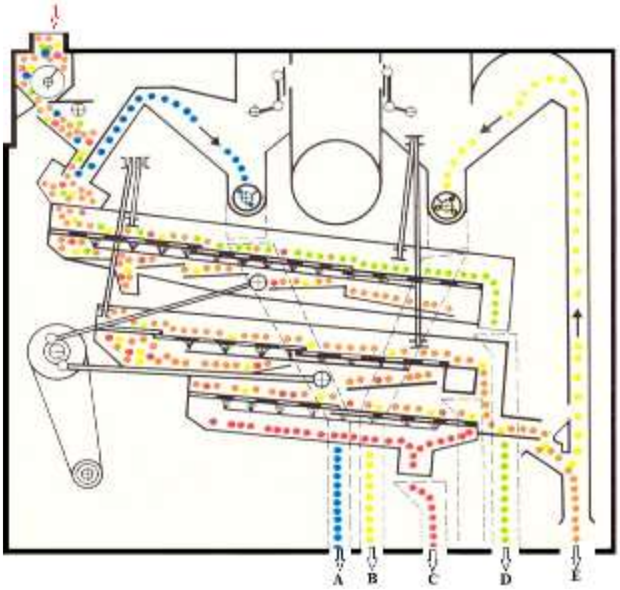


Fig. 8 - Technologic scheme of a seed separation and calibrating equipment with plane sieves [17]
A–preliminary aspirator&discharge; B–final aspirator & discharge; C–lower sieve & discharge; D–upper sieve & discharge; E–processed product.

In Figure 9 is presented a smaller gauge seed separator/calibrating equipment which the mobile plane sieves are powerd by two motovibrating electric engines placed on each lateral sieve side. Also the equipment is provaided with light impurity aspiration chanel. The sieve frame is positioned on four shock elastic elements (helicaly springs or ribber buffers).

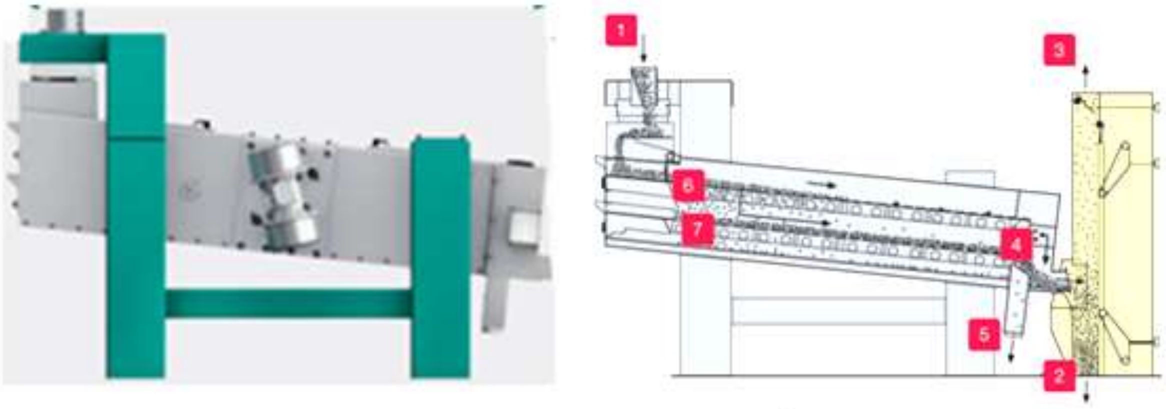


Fig. 9 - MTRC 100/200 separator made by Bühler [10]

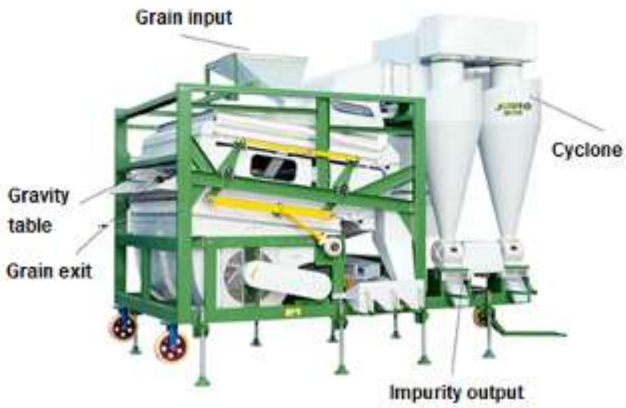
1-row material feed; 2-product discharge; 3-light impurities outlet; 4–side material discharge (large grain, cords straw, etc.); 5– fine waste descharge (broken seeds, sand, etc.); 6–coarse sieve; 7–sand sieve.

The active separation surfaces discharge is made by a ruber ball special configurating system placed under it. The equipment constructive simplicity results from: the sites action mode; lack of lubrication points and through the rapid sieves change. In this way provides, easy accessibility and easy adjustments that ultimately lead to reduced maintenance and exploitation costs.

In order to support the small producers of cereal seeds, technical plants and other types of agricultural crops, the equipment and machinery for seed cleaning and calibration, have developed advanced mobile equipments (Fig.10 and 11), which performs simultaneous processing operations that combine several clening and calibrationg processes such as: in air currents - after aerodynamic qualities; with sieves – after seeds shape and size and special surfaces – after their specific weight, *(Bracacescu et all, 2017).*

Layer	Four
Sieve Surface Area (mm)	1250 x 2400
Capacity (T/H)	7.5
Power (kw)	8.5
Weight (T)	1.86
Overall Size L x W x H (mm)	5100 x 2050 x 3430

Fig. 10 - Air Screen Cleaner 5XFS-7.5C Julite Machinery, China [15]



Sieve Surface Area (mm)	1700 x 2000
Capacity (T/H)	40
Power (kw)	20.55
Weight (T)	3.3
Overall Size L x W x H (mm)	4500 x 2560x3550

Fig. 11 - DOUBLE Gravity Table Cleaner 5XFZ-40Z, Julite Machinery, China [16]

III. The seed cleaning and calibration using gravitational equipments

Usualy this equipments are working with different components density from seed mass, this method is used both for cleaning and for calibration in different fractions, that are different not only by some physical properties but also by certain physiological and productivity characteristics. In practice, segregation after specific mass is done today with gravitometric sortators called densimetric or gravitational tables.

The gravitational separator is mainly made from: support frame; one or sevelat fans (to generate upper air flow lines) placed on an aspiration chanber; a special calibrationg table that allows to pass the air lines and to be orientate on two perpendicular directions and an excentricaly driving mechanism that generates an osilation motion at a certaine frecevency from a pre-eshatablish working field, according to operational technologic requirements imposed by the finit produsct quality, *(Bucurescu et al., 1992).*

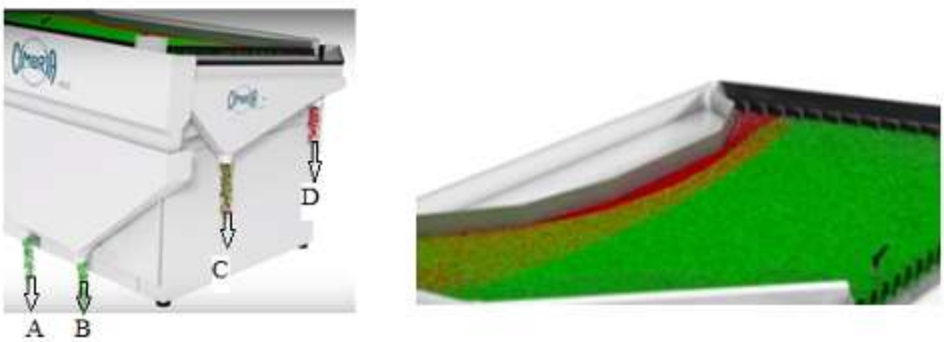


Fig. 12 - Working principle of gravitational separators [14]
a – Evacuare produse sortate; b – Separarea fractiilor pe masa de sortare;
A and B – habey fractions; C – mixt fractions; D – light fractions

The gravitational equipment working principle is presented in Figure 12, the seed/cereal mass is in continuous gravitational and vibrating movement, fact that arrange them in a thin layer on upper table surface. The upward currents, generated by the fans, order their disposal in accordance with their mass, so the havey elements are on the buttom and the lighter ones on the exterior, this effect is increased also by the table vibratory motion that decrease the friction coefficient. Iin ccordance with table inclination the lighter particles are collected in the lower part and the havey ones in the upper part. In Figures 12 and 13 can be seen two models of gravitational separators with different supply systems and configuration.

Fig. 13 - Cimbria Heid gravity separator GA-210, Austria [12]

Fig. 14 - Julite Machinery gravity separator – 5XZ-8, China [20]

Although the gravitational equipments can select a wide range of impurities, can not replace the aspiration equipments known in the technical literature as "tarar" or triora, and usualy are placed normaly at the end of the technologic line to absorb the finest impurities.

To have the proper results in separation and calibration operations using gravitational equipment, must be fulfil two main conditions: the raw material must be previously secected afer granulation (a short dimensional field) and the working parameters must be adjusted accordance with that critetia (as: even material flow; constant air pressure on all active survace, the table working frecvency and the inclination angles.

IV. Seed separation and calibration on vibratory round sieves

The vibratory round sieves are the most popular separation equipments from agriculture and food processing industry. Such equipments and its working principle is shown in Figures 15 and 16.

The raw material is supply on the upper inlet, which is oriented toward sives outside part to outlet ducts *7*, *8* and *9*. Due to sieve rotation, the sieved material hase an helical motion and rising up on sieve due to vibratory and centrifugal forces. The modular frame *11* is placed on the mounting stand *1* via compression springs *15*. Under the oscillations generated by the power engine *2*, the sieves have an oscilatory motion and a rotatory regime set in accordance with raw material weight.

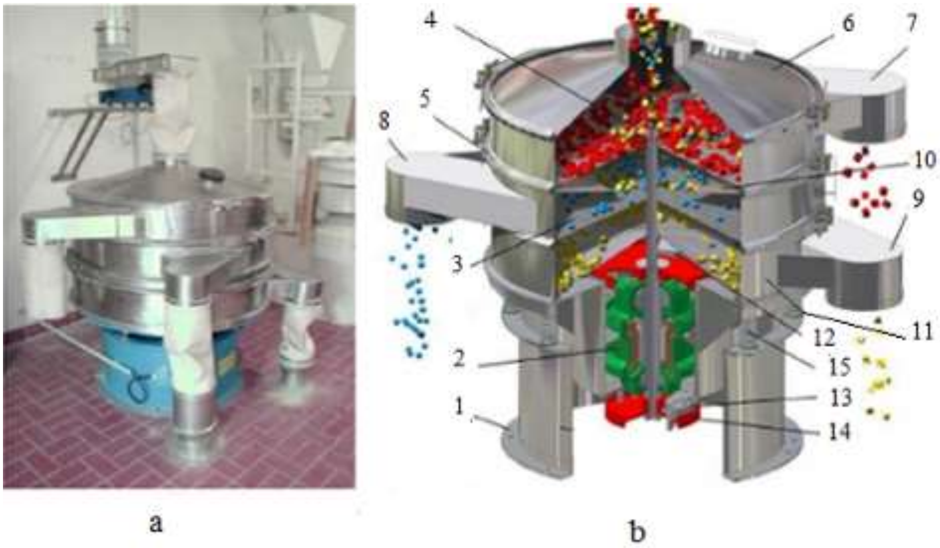


Fig. 15 - Sweco equipment with vibratory round sieves LS-18 [18]

a.-general view; b.-working principle diagram, 1- mounting stand; 2.-electric power engine; 3.-round sievewith small mesh; 4.-round sieve with large mesh; 5.-rapid coupling frame; 6.-Upper coverage; 7, 8, 9 – fraction seed outlet ducts; 10.-discharge coverage; 11.-modular frame; 12, 14.–conterweights (adjust vibration amplitude); 13.-sieve inclination angle (displacemtn speed); 15. Compression springs.

The eccentric counterweights position of the lower and upper shaft of driving motor can generate four working regimes (Fig.16).

Fig. 16 - The vibratory- round sives working parameters [18]

The upper counterweight rotation *12* generate vibrations in horizontal plane, fact that influence the seeds are guided to sieve extremity. The weight from bottom *14* generate vertical vibrations and due to inclination mechanism *13* is obtained also a trasversal motion. The material speed and trajectory can be adjusted by the operator in order to rich the maximum separation efficiency for any type of granular material (dray or wet, light or havy, coarse or fine).

V. **Equipments to separate the seeds by the color**

Industrial photoseparators are designe to separate the seeds/cerals form other weed seeds, minerals or stains seeds. This separation method uses fotoelectric cels that directs each seed in an analise chamber, sow to be seperd from the unwanted ones. In the moment that a seed si out of the acceptabele field an air current is generated and detache it from the good ones to another trajectory. This working principle is presented in Figure 17. Thouse equipments have high efficiency and productivity to separate large and heavy seeds/cereals (as: vegetabele seeds, cereals, etc.) and also increase the biologic quality and their germination. Thouse equipments are implemented at the end of seed/cereal processing lines and usualy are very expensive.

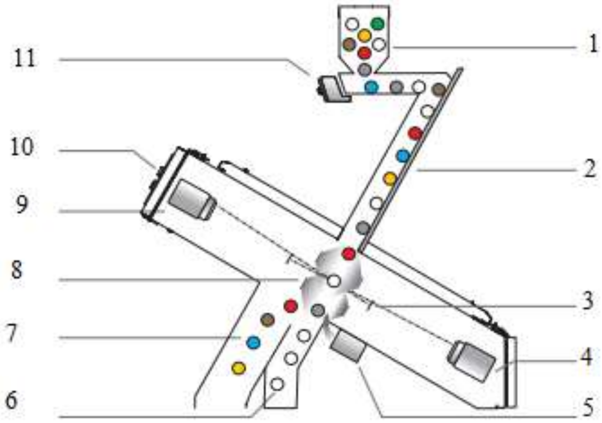


Fig. 17 - Seed color separation working principle [13]

1.-feed hopper; 2.-sloping ducte; 3.-background plate; 4.-full-color RGB CCD cameras; 5.-air ejectors; 6. -dischargid hopper for sorted product; 7.-reject products discharged hopper; 8. -front LED Backlighting; 9. -front CCD camera; 10. -power supply switch; 11.-vibratory feeders

In Figure 18 are presented two models of such of equipments manufactured by Cimbria Company from Austria. The SEA-Chromex separator (Fig.18.a) hase RGB sensory module and a LED illumination system, this system hase the performance to detect a wide variety of colors and nuances also, at this moment, hase the greatest production capacity on the market.

a **b**

Fig. 18 - Cimbria color selector equipments, Austria [13]

a –SEA CHROMEX 5model; b –SEA NEXT 4model.

Those equipments integrate the most modern and smart method to process food and no-food industry products, on which the optical systems must detect and eliminate the anproper pices with the same color but with diferent nuances (the color degradation can reflect low quality). Thouse systems can be easly adjusted due to the calibration systems and programing software, and some are provided with internet conection module to have a long-distance control.

CONCLUSIONS

To capitalise the byproducts from wining industry hase a greate importance because, in addition to obtain valuable food and pharmaceuticals products, contributes directly to mitigate environmental pollution.
Grape seed oil is one of the most powerful antioxidant oils, helping to maintain blood vessel elasticity and lowering cholesterol levels. Also, it hase the role of: protecting the circulatory system, increases the immune system's activity being rich in mineral substances such as copper, selenium, zinc); contains E and F vitamins; antianidins (which have an anti-aging effect 50 times stronger than that of the famous vitamin E) and also is in beauty and cosmetic industry providing a tonic and refreshing effect on skin, ensuring its hydration and elasticity.

The quality of the products obtained form greape seeds depends directly of seed separation process performnces.

ACKNOWLEDGEMENT

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A SURVEY REGARDING THE PERFORMING DRYERS USED IN MARC CAPITALIZATION TECHNOLOGIES
/
STUDIU PRIVIND USCĂTOARELE PERFORMANTE UTILIZATE IN TEHNOLOGIA DE VALORIFICAREA TESCOVINEI

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ABSTRACT

In the current context of the waste capitalization technologies development designed for wine industry focus on the aspect of integration in industrial flows that respect the concept of circular economy and thus the economic process sustainability is justified on medium and long term. A representative part of the process waste of wine is grape marc (skins and seeds). The grape seeds have a particular importance because they are used to obtain nutritionally valuable oils, and the drying process can damage the final raw product quality. For this reason, in this paper are presented some advanced equipment.

REZUMAT

În contextul actual de dezvoltare a tehnologiilor de capitalizare a deșeurilor din industria vinurilor, se pune accent și pe aspectul de integrabilitate în fluxurile industriale ce respectă conceptul de economie circulară, iar astfel este justificată sustenabilitatea procesului economic pe termen mediu și lung. O parte reprezentativă din deșeurile procesului de vinificație este tescovina (pielițe și sâmburi). Sâmburii reprezintă o importanță deosebită, deoarece aceștia sunt utilizati la obținerea de uleiuri valoaroase din punct de vedere nutrițional, iar procesul de uscare poate deteriora calitatea produsului brut. Din aceste considerente, în această lucrare se prezintă câteva echipamente performante.

INTRODUCTION

The marc capitalization technology used by the wine producers are mainly used to obtain bio-fuels but due to latest research in Phyto-pharmaceutic field revealed that the fresh mark can be used also as an important source of oxidants and valuable compounds for the human health, and in many other related fields (animal and fish feeding, soil bio-nutrients, etc.). Taking in to consideration that wine industry is present on all continents, the technical and environmental potential and impact has a great impact, for this reason the regenerative systems “is a must”, because the resource input are the wine waste, emission, and energy leakage are minimized by slowing, closing, and narrowing energy and material loops.

The means to achieve circular economy, respectively “long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, recycling, and upcycling” (*Geissdoerfer et al., 2017*), is in contrast to linear economy which has a production model like 'take, make, dispose'. (*Ellen MacArthur Foundation, 2012*).

In favor of the circular economy approach is mentioned the next arguments: to achieve a sustainable world does not involve to change product quality and consumers purchasing power; doesn’t require loss of revenues or extra costs for manufacturers and other economic agents. But the circular economy focuses on areas such as design thinking, systems thinking, product life extension, and recycling, in order to achieve models that are economically and environmentally sustainable, idea supported by most researchers and experts in the field of economy.

Based on the circular economy principles, the study of feedback-rich (non-linear) systems are similar to particularly living systems (*Ellen MacArthur Foundation, 2012*) and its practical applications to economic systems evolved incorporating different features and contributions from a variety of concepts sharing the idea of closed loops. Some of the relevant theoretical influences are cradle to cradle, laws of ecology, looped and performance economy, regenerative design, industrial ecology, biomimicry and blue economy. (*Geissdoerfer et all, 2017*)

In 2017 in order to provide guidance to organizations that implement circular economy strategies, the British Standards Institution (BSI) developed and launched the first circular economy standard "BS 8001:2017 Framework for implementing the principles of the circular economy in organizations. Guide". BS 8001:2017 standard, intend to align the far-reaching ambitions of the CE with established business routines at the organizational level. It contains a comprehensive list of CE terms and definitions, describes the core CE principles, and presents a flexible management framework for implementing CE strategies in organizations. Circular economy monitoring and assessment is given, but it missing the consensus yet on a set of central circular economy performance indicators applicable to organizations and individual products.

This fact is generated maybe, because there are not yet implemented this system and the environmental polices strong enough to stimulate and reward the participants, or because the sanctions and fines have no impact on the phenomenon generators enough to stop and mitigate the contaminated sites.

Wine trade between the EU and third countries excels, with exports reaching the level of 6.7 billion euro, in 2010, almost a quarter of European exporters of agricultural products. Economically speaking, European production plays a strategic role, having in to consideration the fact that in 2016, the wine market turnover reached 377 million euro and it is estimated that in 2017 to be 385 million euro, reaching the highest level in recent years. The Romanian market place in the big wine producers in the world is placed on 13th position, next to Portugal (6.6 mhl), Hungary (2.9 mhl) and Austria (2.4 mhl), and is among the few European countries that have registered an increase compared to 2016. According to KeysFin analyses, after more than 10 years of changes and reorganization, wine sector business has come close to maturity *(Chiriță C., 2018).*

In Romania from approximatively 1 million tons of grapes used to processes wine, are obtained 120,000 tons of marc without bunch and 400,000 hectoliters of yeast. Usually from 1 tone of grapes it is made 1.2 kg of tartaric acid, 180 kg of marc and 4.5 kg of yeast, and by processing the marc and yeast is resulted 8.8 liters alcohol, approximative 22 liters of yeast brandy of 40 % vol. *(Pomohaci N., 2002).*

If we apply the concept of circular economy in Romania, the innovative technology to capitalize marc is perfect integrable and can create a valuable chain reaction (Fig. 1), and in the main beneficiary is the human being for the food product (wine, grape seed flour and oil) and phytopharmaceutical.

Fig. 1 - An example of wine technological process combined with marc capitalization technology respecting the principle of circular economy *(Milea et al., 2018)*

In some cases, the direct beneficiaries are the farm animals (bio concentrates with high nutritional intake in the form of pellets – as it is implemented in Nebraska Screw Press company) and the farmers because in the soil management process can be integrated the bio-fertilize technologies, namely bio-compost (fertilizers, if using the earth worm technology - one of the newest applications in the field) *(Domínguez et al., 2016).*

MATERIAL AND METHOD

Taking in to consideration the technological aspect of agroecosystem sustainability and ecological aspects of waste recycling, the INMA presents an innovative technology to recover the vineyard by-products, in accordance of newest trends in this field of activity (Fig. 2).

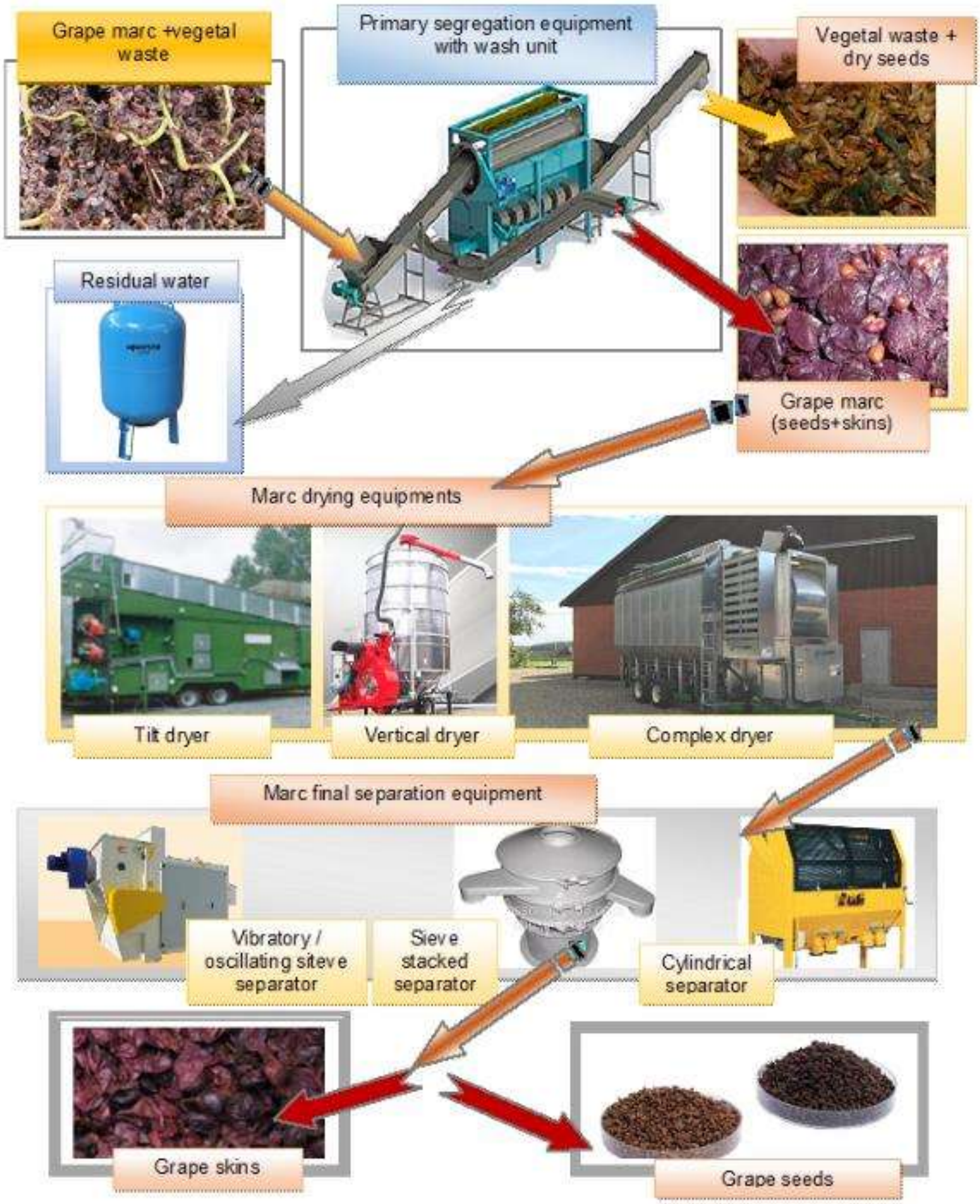

Fig. 2 - Innovative technology to capitalize preclean grape marc (*Milea, et all, 2018*)

This technology is working upon a logical order to ensure the technological grape seed separation from skins, in accordance with specific processes of secondary material, which can be later capitalized in multiple ways and new products.

As it can be noticed, in this technology it is presented a primary segregation equipment that has a washing unit, this unit it is optionally, but it is necessary in case fresh marc separation followed by obtaining high quality grape seeds used for grape oil extraction.

Furthermore, within the marc/grape seed technological flow is used drying equipment's, this operation is important because it influence the purity and quantity of grape seeds *(Pomohaci N., 2002)* and is stipulated that the maximum temperature to be 110ºC, in order to assure a humidity of 11÷12% during the conservation/deposition period and to provide sterile conditions to inhibit the growth of acetic bark and mildew lead to the degradation of extractives.

Usually in industrial technologies are used convective driers, typically the wet grape seeds come into contact with the drying agent, hot air or combustion gases, from which it receives by convective process the heat required by drying process; in most cases the drying agent is air.

In the drying technique, outside of this type of dryer are also used: the intermediate heating dryer, the recirculation dryer, the recirculation and the intermediate heating dryer, and also the closed-circuit dryer. This large verity is influenced by the technologic flow placement, material low (in charge or in continuous flow), and the heating agent flow or with energy saving circuit. In the next paragraph will be presented several types of commercial driers.

RESULTS

Various stages of the technological process to capitalize the grape marc, are used for drying of, either whole material or its components, shells and seeds. In the following, some constructive variants will be briefly presented.

Intermediate heating dryer. From this category, on the market is the Alvan Blanch continuous double flow drier, is manufactured by UK and it is promoted also by Rusland company from Russian, because has in its construction a transport chain which takes the material on two ding levels: the upper level for hot-air drying and the lower level for cold air treatment to prevent hot spots when stored.

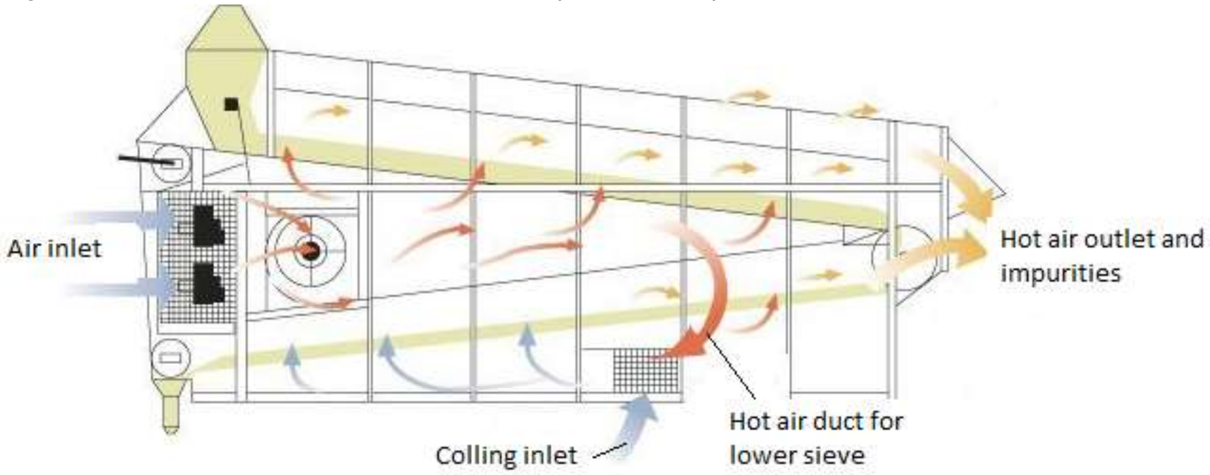

Fig. 3 - The working principle of the continuous flow dryer [10]

Also, this equipment is used on USA seed processing technologies to decrease from 25 % to 9 %, the temperatures that can be achieved are from 70 to 110 ^{0}C. An advantage is to remove particles of dust and chaff from the processing material, the light part is discharged through the upper air vents into the collector box, and the heavier part is deposited at the base thereof. This system is necessary to reduce the risk of fire. The automatic control system ensures the flow control and the sensors placed on the power supply signal if there is no material, and there are also sensors for detecting possible blockages, overheating of the grain, overcharging of the motors and burner failure, as well as stopping the equipment in case of failure.

Another constructive solution for chare flow dryer is the model presented in Figure 4, manufactured by PEDROTTI company from Italy, this model also can be found manufactured by the ex-communist states (Russia, Hungary, etc.). According to its spreading, it is noticed that this system is the favorite of seed/cereal processors and its technical advantages appreciated and used at large scale. This drying system is in line with technological developments and can be easily adapted to the processors needs.

The Mecmar Company has the FSN model (Fig. 5), to dray cereals, sorghum, grape seeds, etc., in a closed loop circuit. This equipment was designed to make 5 operations: supplying, draying, cooling, impurities selection and evacuation, and this working capacity can vary.

Fig. 4 - PEDROTTI trailed vertical dryer [11]

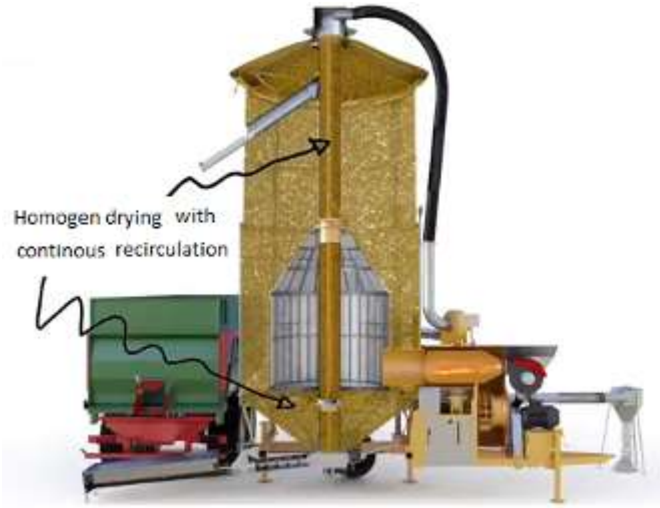

Fig. 5 - Grain vertical dryer – FSN [12]

Recirculation dryers can be with different structures and gauges, apart from the model shown in Figure 3 can be presented also the high humidity dryer manufactured by Stronga company. In Figure 6 is presented the working principle and the main components. The working draying principle is mainly the hot air diffusion in all processing material due to the belt transportation conveyor that generates also a waving motion.

a) *b)*

Fig. 6 - High humidity cereal and granular materials dryer [13]

1-supplay bunker; 2-programable control station; 3-pulsing draying belt;4 – go forth scraper transport system; 5- outlet opening; 6 - thermic isolation; 7 – transversal conveyor for small particles; A- diffusion hot air flow; B- hot air inlet provided by HEATEX.

SUKUP dryer, manufactured by DANCORN, has an interesting design and the drying process is fully automated and controlled (Fig. 7). Thus, model has a complex structure with modular construction and patented heating circuits with recirculation system in order to recover energy and optimize drying operation, constructing a closed-circuit dryer equipment. This model also is provided with innovative elements to assure maintenance and easy replacement of the moving parts.

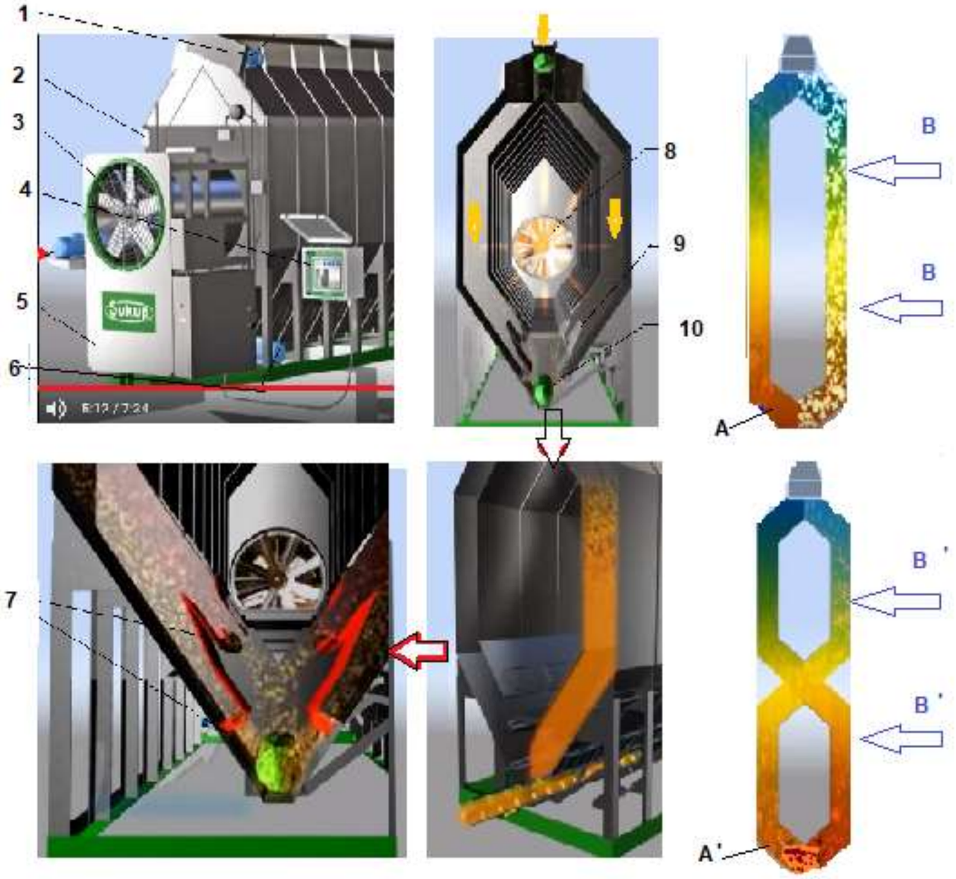

Fig. 7 - FSN cereal/seed dryer working principle and patent drying solutions [14]
1-engine to supply conveyor; 2-process lighting boll; 3-ventilation system; 4- control and command panel; 5--heat generator; 6-seed outlet conveyor engine; 7-seed flow distributor 8-heating source; 9-distribution and weighting system; 10- outlet system with sensors; A and A'- drayed cereals; B and B'-cold air flow-wind.

Recirculation and the intermediate heating dryers, are used at large scale, such systems are rotative dryers, as develops the WESTPRO company (Fig. 8).

Fig. 8 - Tubular rotative dryer [15]

These solutions are used mainly to industrial scale and have low maintenance, because: low cost of spare parts; low labour; are self-centring and do not have gears or chains which can easily be swallowed. Usually their dimension is external diameter of 0.6÷2.7 m and length of 0.4÷1.65 m. Depending on the processed material humidity, the rotary drum is provided with various ravaging systems, such as longitudinal and radial vanes (Fig. 9), wings (Fig. 9 b-f), helical profiles (Gig. 9.g and j), dedicated profiles for different types of materials and their combinations (Fig. 9. k, m and n).

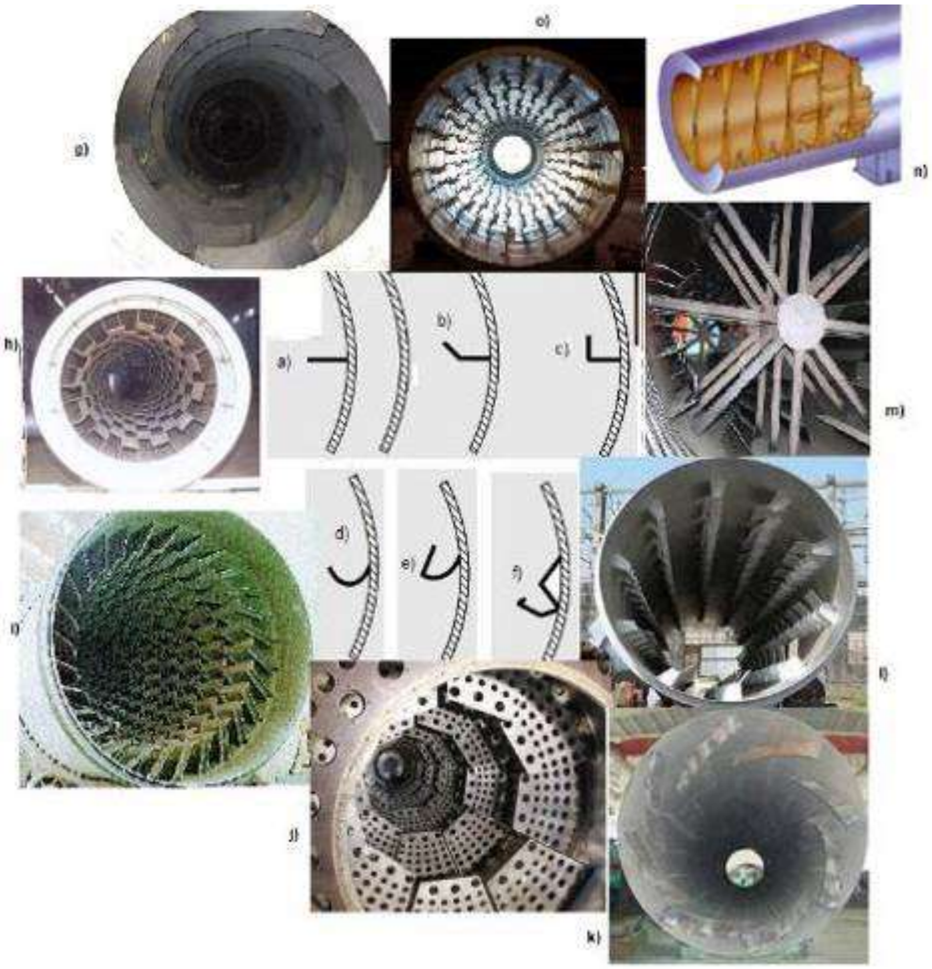

Fig. 9 - Rotary drum is provided with various ravaging systems

In USA the company Economy Industrial have manufactured combined drying systems and separations of the solid granular materials with high humidity. The constructive solution is presented in Figure 9 and presents four sectors: fan induction system; a rotary dryer; a rotating screen for separating the material and a heating system. For the maintenance of the separation element (sieve/sieves), a brush system parallel to the sieve axis is also provided to detach the wet material from the orifices of the rotary sites.

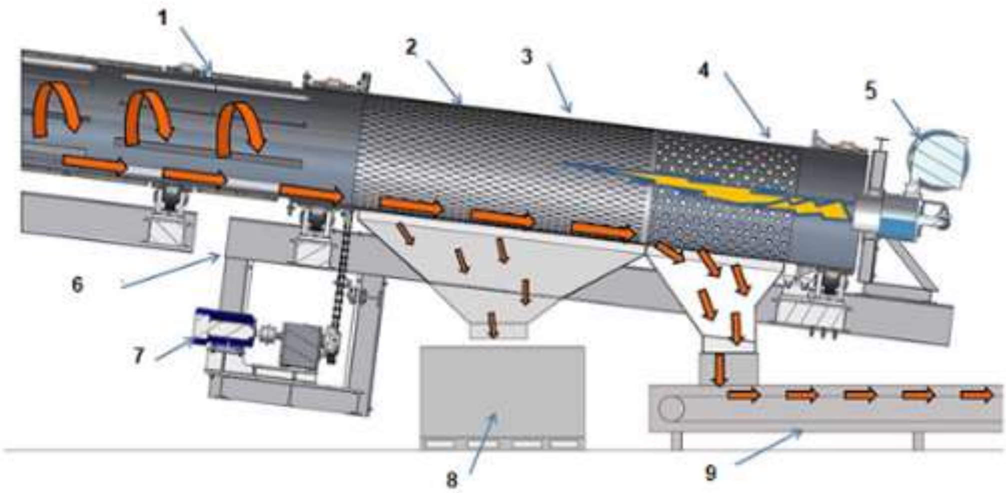

Fig. 9 - Combined drying equipment to process granular material at industrial scale [16]

1-rotary dryer; 2-separation sieve (2 mm mesh); 3-rotary screen; 4-separation sieve (2-40 mm mesh); 5—heating chamber; 6-rotary screen support; 7-power engine of the rotary screen; 8- collector chamber; 9-Transport conveyor toward the packing and storage.

CONCLUSIONS

This survey has the purpose to present the technical state of seed dryers, that manly have the same working principle of the cereals ones, and their place in the marc capitalization technologies, a very appreciated by product in food and phytopharma industry due to their low harmful cholesterol, high content of mineral and antioxidants.

Here in presented technology has a modular structure and can integrate a large variety of performant equipment's, which can be harmonized and suited in an flexible technical processing flow that can be adjusted in accordance with seed (granular material) mechanical and physiologic characteristics, and also of mark state (humidity, seed concentration, marc components, etc.) that in many cases is processed in fresh state, right after it was exhausted from the grape pressing lines.

Another technical fact that can be observed, is the fact that drying equipment's have many constructive features that can be used in almost all processing conditions: on site, outdoors or on platforms, but also in the industrial halls. In almost all the cases presented on internet the marc processing lines are placed on open halls, especially when is processed fresh marc, because the large marc quantity that the fermentation process is not finished and du this fact the working environment must be well ventilated.

ACKNOWLEDGEMENT

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MODERN SYSTEM FOR LOCAL SOIL COMPACTION MAPPING / *SISTEM MODERN DE ELABORARE A HĂRȚILOR DE COMPACTARE LOCALĂ A SOLULUI*

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Keywords: compaction maps, compression, soil productivity

ABSTRACT

Compaction of agricultural land is a form of soil degradation, an unwanted phenomenon that occurs during the execution of agricultural works, the phenomenon being impossible to avoid but which can be kept under control by appropriate management; for this, it is necessary to monitor the causes of land compaction.

To assess the physical condition of the soil at a given moment, to determine the correlation between the soil compactness state with the resistance opposed to the performance of agricultural works or to the development of the roots of agricultural crop plants or to determine the bearing capacity of the land, the technical mean measuring soil resistance to penetration with a standard metal body is used. One of the most commonly used methods is based on the concomitant measurement of the force to be applied to a standard conical body at forced penetration into the soil undergoing analysis and the depth of penetration. Compacted land detection can be accomplished by mechanical methods, using static, dynamic or analog penetrometers, or by direct observations on crop plant development based on the effects generated by soil compaction.

The main purpose of this paper is to research and study a modern system for local soil compaction mapping intended for agricultural holdings using methods and techniques specific to precision farming (large culture and horticulture). The system will help improve farm management by providing information on compacted areas and depth of soil compaction as a result of the repeated passage of soil cultivation machines to apply recovery measures only in those areas.

REZUMAT

Compactarea terenurilor agricole este o formă de degradare a solului, un fenomen nedorit care apare în timpul executării lucrărilor agricole, fenomenul fiind imposibil de evitat, dar care poate fi ținut sub control de către un management adecvat; pentru aceasta, este necesar să se monitorizeze cauzele compactării terenurilor.

Pentru a evalua starea fizică a solului la un moment dat, pentru a determina corelația dintre starea compactă a solului și rezistența opusă performanței lucrărilor agricole sau la dezvoltarea rădăcinilor plantelor de cultură agricolă sau pentru a determina capacitatea portantă a terenul, se utilizează media tehnică de măsurare a rezistenței solului la penetrare cu un corp metalic standard. Una dintre metodele cele mai frecvent utilizate se bazează pe măsurarea concomitentă a forței care trebuie aplicată unui corp conic standard la penetrarea forțată în solul supus analizei și adâncimea de penetrare. Detectarea compactată a terenului poate fi realizată prin metode mecanice, utilizând penetrometre statice, dinamice sau analogice sau prin observații directe asupra dezvoltării plantelor de cultură, pe baza efectelor generate de compactarea solului.

Scopul principal al acestei lucrări este cercetarea și studiul unui sistem modern pentru cartografierea locală a compactării solului, destinat exploatațiilor agricole, folosind metode și tehnici specifice pentru agricultura de precizie (culturi mari și horticultură). Sistemul va contribui la îmbunătățirea gestionării fermelor prin furnizarea de informații privind zonele compacte și adâncimea compactării solului ca urmare a trecerii repetate a mașinilor de cultivare a solului pentru a aplica măsuri de recuperare numai în acele zone.

INTRODUCTION

The process of agricultural production is directly linked to the soil, land productivity and the profitability of production activity largely depending on its general state, which can be characterized by the following parameters: moisture, porosity and compactness.

Compaction of agricultural land is a form of soil degradation, an unwanted phenomenon that occurs during the execution of agricultural works, the phenomenon being impossible to avoid but which can be kept under control by appropriate management; for this, it is necessary to monitor the causes of land compaction.

If a relatively long period of time is necessary to naturally form a structured soil, the degradation of soil quality, as a result of human activity, is very rapid.

Soil compaction effect is different, depending on a number of soil physical properties such as texture, structure, moisture, organic matter content, etc. Soil compaction is defined as an increase in soil apparent density with concomitant reduction of porosity.

This phenomenon is manifested by the reduction of non-capillary spaces volume, resulting in the modification of the aeration porosity. The volume of the capillary spaces does not change significantly. The biological activity in the case of compacted soil reaches the minimum levels, which is evidenced by the very slow decomposition of the vegetal debris incorporated into the soil.

Soil compaction can be prevented on the basis of measures regarding the construction of agricultural technical equipment, the execution of agricultural works and the periods of their execution respectively. These aspects refer to:

- the execution of agricultural works when soil has optimal moisture;
- reducing the number of passages on land surface by using complex agricultural aggregates;
- reducing the pressure exerted on the surface of the soil by using radial tires, low pressure tires with the largest size of the balloon, twinned wheels or elastic tracks *(Abu-Hamdeh N.H., Al-Widyan M.I., 2000);*
- reducing the loads on the axles of tractors, agricultural machinery and equipment by increasing the number of axles *(Molnar and Roş, 2009).*

Among the measures currently adopted to achieve these objectives are the efforts of the tire companies which are mainly directed towards increasing the size of the tire balloon and reducing the internal pressure, the pressure being the parameter that influences the most the compression phenomenon, respectively soil compaction phenomenon.

In this respect, equipment has been developed to automatically adjust, during movement, the air pressure in the tires of tractors and agricultural machines with which they work in aggregate *(Dinu L., 2010).* The pressure is monitored and adjusted according to the prescribed level. An alarm system comes into operation when the pressure in a tire falls below the prescribed value.

The control block, located on the tractor, can be programmed to individually track the pressure in each wheel, the load on each axle or the total load on the tractor or agricultural machine.

A number of authors have also produced maps on soil penetration resistance using geostatistical data and comparative data on compaction *(Adamchuk et al., 2010).*

The detection of compacted lands can be done by mechanical methods using static, dynamic or analog penetrometers *(Rus and Csatlos, 2009).* or by direct observations on the development of crop plants based on the effects generated by soil compaction.

Resistance to penetration is influenced by soil moisture, penetration resistance values being lower in soils with higher moisture.

The main purpose of this paper is to research and study a modern system for local soil compaction mapping intended for agricultural holdings using methods and techniques specific to precision farming (large culture and horticulture).

MATERIAL AND METHOD

Location of experiments

Experiments to monitor local soil compaction and moisture status of the soil were carried out on a plot of land located at the National Institute of Research - Development for Machines and Installations Designed to Agriculture and Food Industry Bucharest, with the following data.

a) Name of the agricultural lot: L2 – Experimental lot;

b) Lot location: National Institute of Research - Development for Machines and Installations Designed to Agriculture and Food Industry Bucharest;

c) Lot surface: 8100 m^2;

d) Lot preparation: plowed and shredded by discing after harvesting previous crop.

Equipment used

In the experimental procedure were used a Delta-T Weather Stations-WS-STD1 professional weather station and an Eijkelkamp Penetrologger electronic penetrometer with digital display, having an Eijkelkamp Thetaprobe moisture sensor connected to the penetrometer electronic module, the characteristics of which are presented in Table 1.

The Delta-T Weather Stations-WS-STD1 professional weather station has the following components:

- Standard anemometer;
- Wind direction sensor;
- Compact rain gauge for flat plate;
- Solar energy sensor;
- Soil thermometer probe;
- Thermo/hygro sensor;
- Barometer;
- Data logger for general use DL2E;
- Chargeable battery 12V/10Ah;
- Battery charger;
- System of charging from photovoltaic module;
- GSM modem with accessories.

It measures and records:

- air temperature: -30...70±0.3ºC
- relative moisture: 5...95±2 RH
- barometric pressure: 15…115 kPa with precision <±1.5%
- rainfall: tilting container
- solar radiation: 0...1.1 kW.m^2, 300...1100±5%nm
- wind direction: ±4º
- wind speed: 0...75±0.1 m/s

Table 1

Features of the Eijkelkamp Penetrologger electronic penetrometer

Operating temperature	50°C
Memory 1 500 measurements	1.500 measurements
Maximum penetration force	1.000 N
Total measuring length of the probe	97 cm (except for the cone)
Depth of recording	80 cm
GPS precision	<2.5 m CEP (Circular Error Probable)

Working method

Conducting field experimental research requires compliance with the following procedural rules:

- identifying the location of agricultural land through the following elements:
- localization in GPS coordinates;
- determining the size of the agricultural land surface;
- identifying the type of soil;
- traceability of crops (previous crop history),
- marking/setting out the points of interest;
- location of the weather station provided with a data logger for automatic data recording at various time intervals in an area that meets certain specific conditions (easy access, communication favourable spatial features, etc.);
- making a mapping plan;
- identifying points of interest or points where measurement of various parameters is desired;
- establishing coordinates (rows, columns, density of sampling points),
- inserting mapping plan data into the electronic penetrometer memory;
- measuring and mapping the compaction state and soil local moisture on the monitored plot.

The data collection focused on the sampling, analysis and recording of soil samples by manual methods.

Contact pressure and local moisture in the monitored plot soil were recorded by slow penetration with the Eijkelkamp Penetrologger penetrometer fitted with the Eijkelkamp Thetaprobe moisture sensor. With integrated GPS, the measuring point has been accurately recorded.

For each measuring point (total 12 points), a series of 12 records representing contact pressure and soil moisture values were performed. Resistance to penetration F was calculated with the relation:

$$F = p \times S, [N]$$

where: - p is the contact pressure in MPa measured with penetrometer Eijkelkamp Penetrologger;
- S – penetration cone surface in mm^2.

With the help of the data obtained after the calculations using Excel, two-dimensional graphs were plotted for each location of resistance to compaction for 30 cm depth using the MATCHAD program. The map of the soil moisture distribution, in percent, was plotted for the depth of 6 cm.

The processing of experimental data and the creation of spatial distribution maps of agricultural land parameters were carried out by moving from the geographical sexagesimal coordinate system to decimal coordinates with the help of the on-line coordinate converter. Aspects during testing are shown in Figure 1.

Fig. 1 - Aspects during the experiments

A modern system for local soil compaction mapping, specific to precision farming, has three major main functions, namely monitoring, data collection and mapping.

a) Monitoring

The operation of this system involves the physical **storage** of data from sensors by means of a device known as the generic name of "*data loggers*", which is equipped with non-volatile memory, the **transmission** being carried out by traditional methods using data cable (en. *wired*). The next step is the **processing** of data by the final recipient, the central processing unit (en. *CPU – Central Processing Unit*). Data acquisition is an operation that allows the use of a whole range of methods to build the geographic database found inside any GIS software (in digital form). Spatial positions resulting from the use of the *Global Navigation Satellite System (GNSS)* integrated in the Eijkelkamp Penetrologger penetrometer, the GPS, are directly integrated into a GIS.

b) Mapping - As a result of using the GPS system and the achievement of a higher degree of precision with regard to the location of certain soil characteristics at certain spatial points (contact pressure and local moisture), all information to which GPS coordinates are assigned is managed.

c) Data collection - Classical manual sampling is done with the help of the human operator through the slow penetration operation and the introduction of the moisture sensor in different areas of the specific plot.

The **modern system for local soil compaction and moisture mapping** can be conceptually divided into three main stages: a) establishing the input and output elements relevant to the system's operation, b) establishing the system requirements, and c) implementing the concept and experimenting with the system.

The diagram of the system is shown in Figure 2.

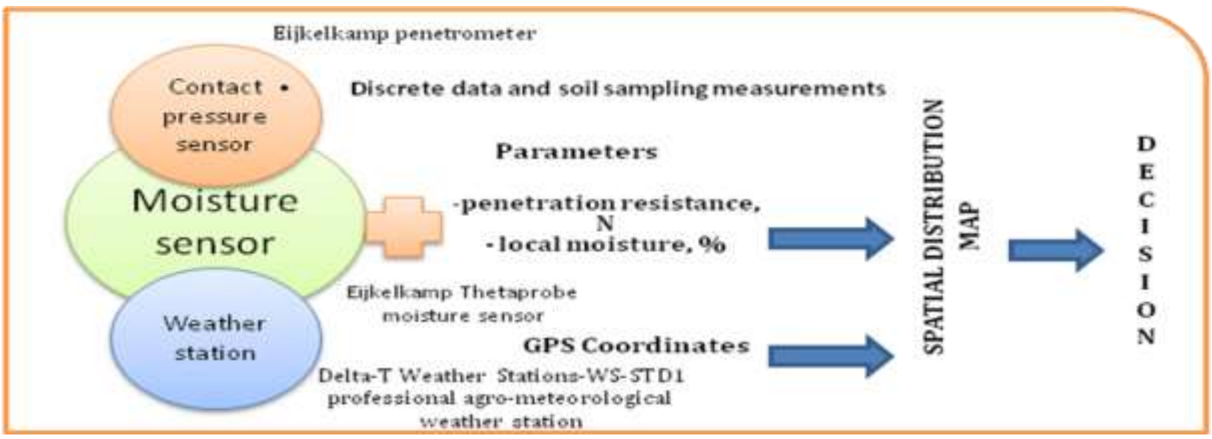


Fig. 2 - Schematic representation of the modern system for spatial distribution mapping

The Global Positioning System of the penetrometer is a satellite-based localization system. As a structure, the GPS system can be divided into 3 segments: the space segment - satellites, the control segment - the United States Department of Defence, and the third segment - the user segment is composed of all those using the GPS system for positioning and time determination.

The soil penetration resistance, in N, is given by the penetration force per unit area, in [MPa], multiplied by the area of penetration cone, in mm^2. Soil or superficial subsoil penetration resistance, measured by penetrologger, is a compaction measure or land bearing capacity (0 - 200 N uncompacted land; 200 - 300 N land undergoing compaction; over 300 N compacted land).

The ThetaProbe sensor measures volumetric soil water content, θv, by the well-established method of responding to changes in the apparent dielectric constant. These changes are transformed into a DC voltage practically proportional to the water content of the soil over a wide range of work. The volumetric soil water content is the ratio between the volume of water present and the total volume of the sample. This is a non-dimensional parameter, expressed either as a percentage (% vol.) or a ratio ($m^3.m^{-3}$). Thus, 0.0 $m^3.m^{-3}$ corresponds to a completely dry soil and pure water of 1.0 $m^3.m^{-3}$.

The following activities were carried out in order to achieve the modern system for local soil compaction mapping:

1. Converting geographical sexagesimal coordinates into decimal coordinates by direct calculation or using available utility software;

2. Formation of an ASCII file containing on columns the data obtained by measurements and calculations for latitude, longitude, penetration resistance and local soil moisture. The columns were marked by the TAB marker;

3. Choosing mathematical computing software, for example MATHCAD;

4. Importing the ASCII file made in MATCAD using the command: Insert->DATA->FILEINPUT ->filename.txt;

5. Marking as data vector each column in the ASCII file;

6. Statistical processing of imported data: average, standard deviation, kurtosis, skewness;

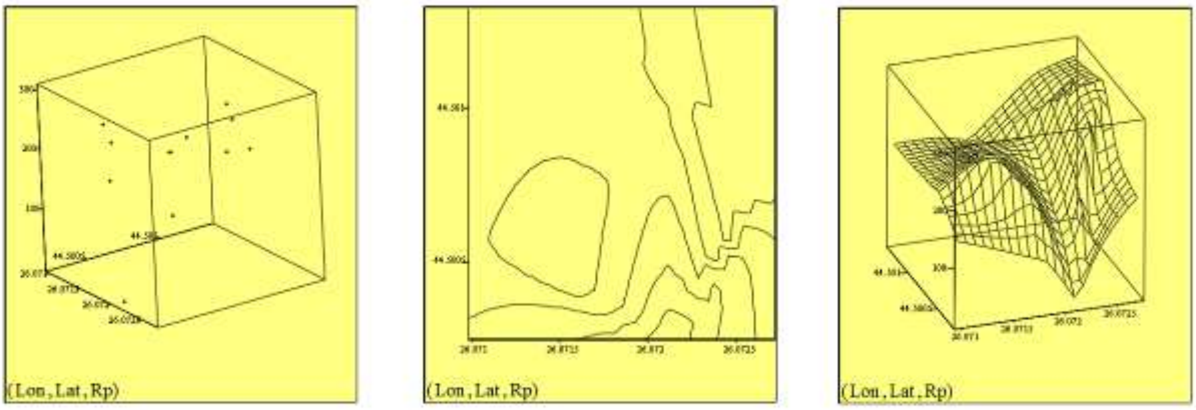
7. Obtaining 3-coordinate charts with Surfaceplot or ContourPlot functions;

8. Inserting in the chart, the columns that generated the graphs;

9. Importing the graphs image into the raster map obtained from the Google Earth archive.

RESULTS

The graphical representations of penetration resistance according to the geographical decimal coordinates (longitude and latitude) are shown in Figure 3.



a. points graph **b. plane graph** **c. surface graph**

Fig. 3 - Graphical representations of penetration resistance according to the geographical decimal coordinates (longitude and latitude)

In Figure 4 is shown the map of the penetration resistance distribution obtained with the MATCAD program.

The overlay of the penetration distribution map over the aerial image, taken from the Google Earth image archive, of the experimental lot is shown in Figure 5.

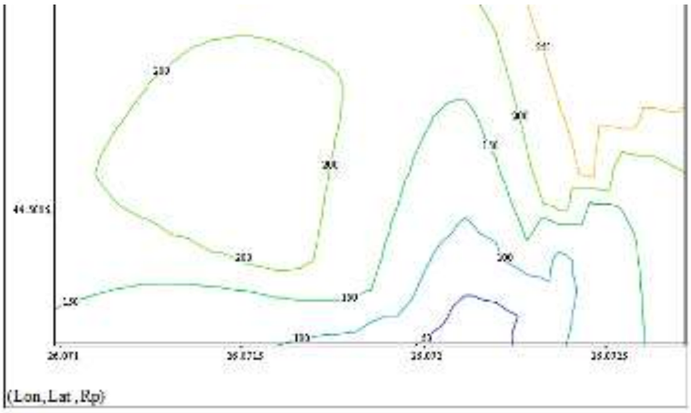


Fig. 4 - Distribution map of penetration resistance

Fig. 5 - Overlay of penetration resistance distribution map over aerial image

CONCLUSIONS

Compaction of agricultural land is a form of soil degradation, an unwanted phenomenon that occurs during the execution of agricultural works, the phenomenon being impossible to avoid but which can be kept under control by appropriate management; for this, it is necessary to monitor the causes of land compaction.

Accentuated state of compaction also leads to the difficult circulation of substances in the soil, the destruction of organic matter, a sharp decrease in porosity (which in fact generates a big part of the other problems).

Soil penetration resistance values are important in land classification, and the soil penetration resistance profile along with the depth is required to quantify soil compaction degree. It also contributes to the provision of a common soil characterization system from which it may be possible to determine the number of passes of agricultural machinery in order to predict traction performance.

The novelty of the research lies in the fact that, compared to the classical use of digital models and the production of maps, the introduction of an accompanying map with overlapping aerial photographic image, in the background, facilitates the rapid identification of areas requiring repairs, both in terms of compactness and local soil moisture.

Information and compactness and local soil moisture mapping can be synthesized, providing users with the information they need.

The modern system for spatial distribution mapping developed in accordance to the case study carried out, to identify compacted lands, provide a complex and comprehensive tool set of spatial analysis necessary in the future for its complete computerization.

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STAND FOR DETERMINATION OF OPERATING PARAMETERS FOR VERTICALLY ROTOR MILLING CUTTERS ACCORDING TO THE CYCLOID DESCRIBED BY KNIVES /

STAND PENTRU DETERMINAREA PARAMETRILOR DE EXPLOATARE LA FREZELE CU ROTOR VERTICAL ÎN FUNCȚIE DE CICLOIDA DESCRISĂ DE CUȚITE

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KEYWORDS: *stand, rotor, knife, cycloid*

ABSTRACT

The paper presents the realization of an experimental stand for vertical rotor grapples. The number of knives on the rotor of the vertical grapple was increased from two to three when the stand was made, mounting them on different diameters. By actions on the number of knives, the rotor speed and the speed of rotor movement, it is intended to establish the parameters working and functional. Operating parameters are represented by the number of rotor blades, rotor speed, and the travel speed of the trolley. The clicloids representing the trajectories of the blades in the ground during the work can be drawn, conclusions will be drawn and proposals will be made on other solutions technical improvement.

REZUMAT

În lucrare se prezinta realizarea unui stand experimental pentru grapele cu rotor vertical. La realizarea standului a fost crescut numarului de cutite de pe rotorul grapei verticale de la doua la trei,montarea acestora facându-se pe diametre diferite.Prin acțiuni asupra numarului de cuțite,turației rotorului și vitezei de deplasare a rotorului,se urmareste stabilirea parametrilor de lucru și funcționali. Parametrii de exploatare sunt reprezentați prin numărul de cuțite de pe rotor,turația rotorului,și viteza de deplasare a căruciorului.Se pot trasa clicloidele care reprezintă traiectoriile cuțitelor în sol în timpul lucrului,se vor trage concluzii și se vor face propuneri privind și alte soluții de îmbunătățire tehnică.

INTRODUCTION

In this work paper we aim to determine the working parameters for the vertical rotor cutters, for the determination of these parameters we made a test stand (*Glodeanu, 2015*). The stand was designed to increase the number of knives on the rotor, positioning them on different axes, and the knives were of different lengths. The variation in the carriage speed, in turn, requires correlation with the number of knives on the rotor and with the rotor speed to obtain superior working quality indices. Along with increasing the working capacity and productivity of the aggregate, while reducing the consumption of Fuel. They will trace cycloids on the sivor table draw conclusions on other technical improvement solutions (*Sărăcin et al., 2008*).

MATERIAL AND METHOD

The method used is according to the literature (*Saracin et. al., 1982*). Stand shown in Figure 3, consisting of: transport carriage, electric motor, vertical rotor , chain transmission with possibilities of varying the transmission ratio between the electric motor and the transport carriage and between the electric motor and the rotor of the vertical grater, knives, chalk mounted knives for cycloid drawing, sheet for drawing of cycloid (*Bratucu, 2010*).

During work, an M point on the knife describes a cycloid (*Makange, 2015*). On the AB part of the cycloid, the ground chip is cut on the depth a, and on the BC portion the blade acts additionally on the soil layer (the splinters previously decompose), increasing the degree of soil demolding. It can be noticed that the soil chips are not overturned nor discarded, so the soil is dislodged and shredded (*Ssăracin, 2013*). From Figure 4 we find that a ground blade is cut several times by the same knife and by the neighboring knives on the same rotor and on the neighboring rotors. It is noted that at high peripheral speeds and low speeds of displacement, the degree of ground shrinkage will increase spectacularly (*Boruz, 2015*).

During the working process, a point on the knives carries a motion composed of the rotation around the axis of the rotor with the angular velocity ω = πn / 30 and the translation with the speed Variable to the movement of the machine (*Rus, 2005*). Considering that after the time t the machine passes the distance OO1iar the knife rotates with the angle φ, the cycloid equations in the XOY axis system have the form: $x_m = v_d t + R\sin\omega t$.

$$Y_m = R\cos\omega t$$

where R is the radius of the cutter rotor. (*Libin, 2010*).

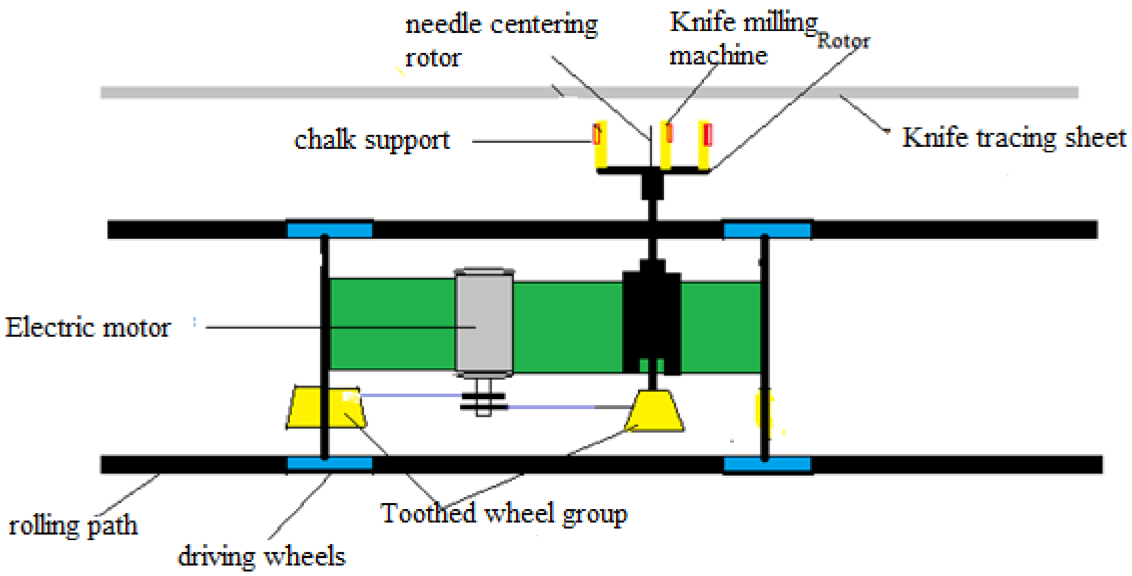

Fig. 1 - Sketch of the showcase, top view

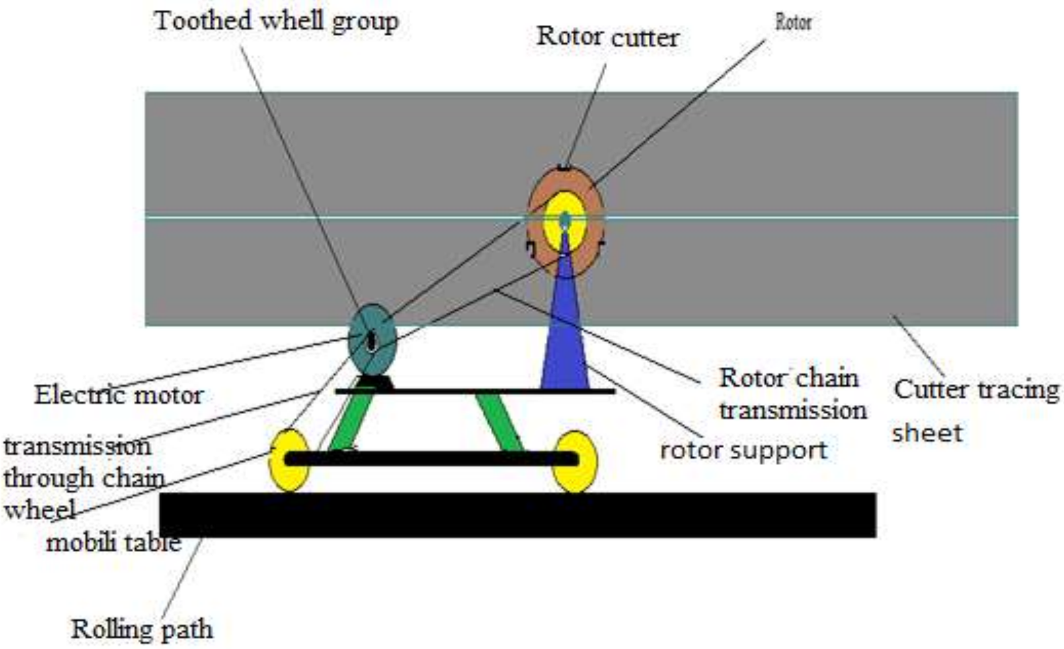

Fig. 2 - Sketch of the showcase, front view

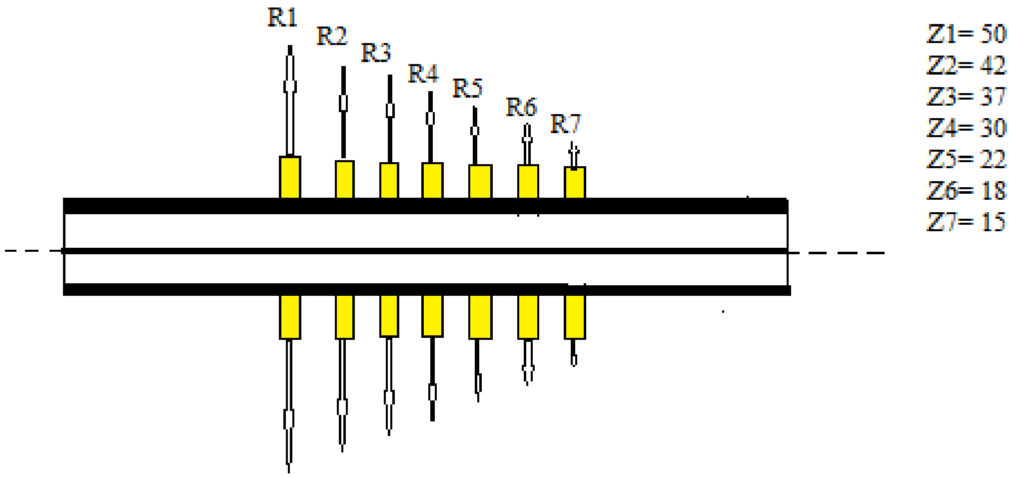

Fig. 3 - Block of pinions

RESULTS

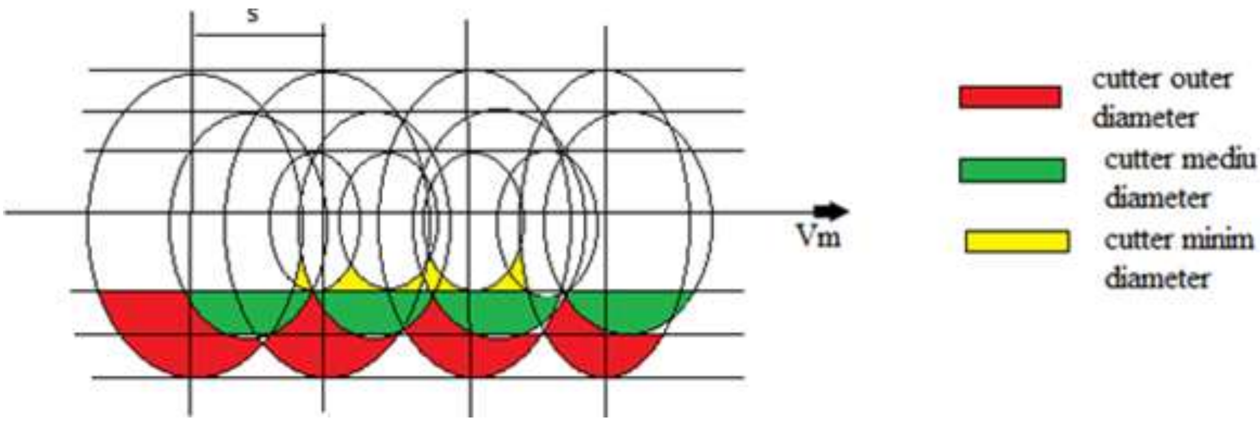

Fig. 4 - Cycloid traced by the knives on the rotor

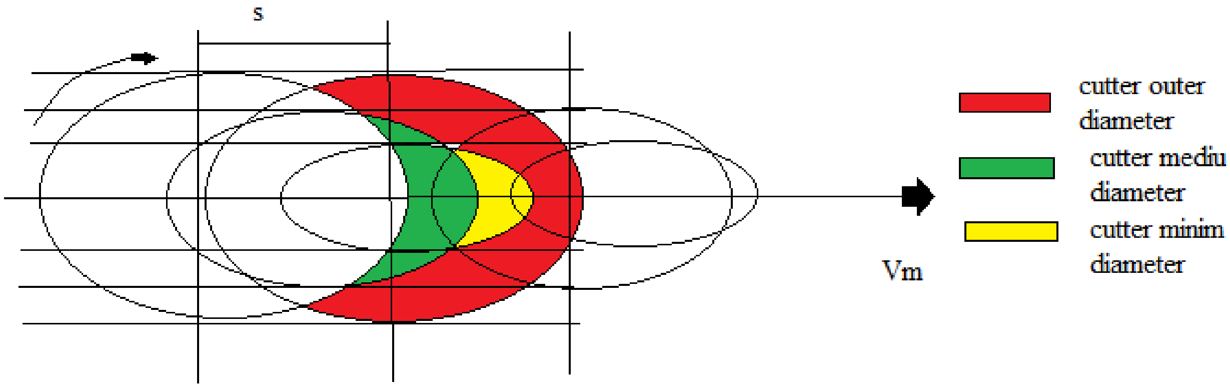

Fig. 5 - Sliced soil slices and cuttings result as a result the intersection of the knife trajectories on the adjacent discs

The trajectories obtained on the standboard will analyze the shape and dimensions of the soil slopes according to the rotor speed and the trolley travel speed, as well as the energy consumption for each rotor speed and for each speed of the carriage in depending on the depth of work controlled by the force of the trajectory indicators on the board.

CONCLUSIONS

From the researches conducted in this paper, the following conclusions can be given:

- increasing the degree of ground shredding;
- We note that soil chips are not overturned and virtually dislocated and shredded;
- energy consumption due to increased number of knives on the rotor;

- Increasing travel speed;
-- Decreasing soil thickness.

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MONITORING SYSTEM OF LOCAL SOIL MOISTURE USING ITS DISTRIBUTION MAPS
/
SISTEM DE MONITORIZARE A UMIDITĂȚII LOCALE A SOLULUI, UTILIZÂND HĂRȚILE DE DISTRIBUȚIE A ACESTEIA

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Key words: soil parameters monitoring, moisture distribution map

ABSTRACT

Soil is the main means of production in agriculture, the action of the agricultural machinery working parts on it having the final aim of obtaining material goods. Soil, as a biological environment where complex processes and transformations occur, acts and influences directly plant development.

For high moisture soils, due to the high adhesion coefficient, a layer of soil adheres to the surface of the working part through the intermediary of the water layer, the friction occurring between the adherent soil layer and the soil layer which moves in relation to the work part surface during the working process is characterized by the internal friction coefficient which has values higher than the external friction coefficient (the coefficient of friction between the work part surface and the soil mass). The optimum soil moisture corresponds to the interval that is characteristic of the friable consistency. In this interval the cohesion and the adhesion of the soil are minimal, the soil does not exhibit plasticity, it can be easily ground, the resistance to mechanical processing is minimal, and the quality of the works is good.

The main purpose of this paper is to research and study a modern system for local soil compaction mapping intended for agricultural holdings using methods and techniques specific to precision farming (large culture and horticulture). The research carried out led to the substantiation of a new method of real-time determination of the soil sample properties, together with the acquisition of the geospatial coordinates of each sample taken correlated with time (GMT) via the GPS satellite network and their storage, in order to draw up maps on local moisture.

REZUMAT

Solul este principalul mijloc de producție în agricultură, acțiunea pieselor de lucru ale mașinilor agricole care au ca scop final obținerea bunurilor materiale. Solul, ca mediu biologic în care se produc procese complexe și transformări, acționează și influențează în mod direct dezvoltarea plantelor.

Pentru solurile cu umiditate ridicată, datorită coeficientului mare de aderență, un strat de sol aderă la suprafața piesei de lucru prin intermediul stratului de apă, fricțiunea care apare între stratul de sol aderent și stratul de sol care se mișcă în raport cu suprafața piesei de lucru în timpul procesului de lucru este caracterizată de coeficientul de frecare intern care are valori mai mari decât coeficientul de frecare extern (coeficientul de frecare dintre suprafața piesei de lucru și masa solului). Umiditatea optimă a solului corespunde intervalului care este caracteristic consistenței friabile. În acest interval, coeziunea și aderența solului sunt minime, solul nu prezintă plasticitate, poate fi ușor măcinat, rezistența la prelucrarea mecanică este minimă, iar calitatea lucrărilor este bună.

Scopul principal al acestei lucrări este cercetarea și studiul unui sistem modern pentru cartografierea locală a compactării solului, destinat exploatațiilor agricole, folosind metode și tehnici specifice pentru agricultura de precizie (culturi mari și horticultură). Cercetarea efectuată a condus la fundamentarea unei noi metode de determinare în timp real a proprietăților eșantioanelor de sol împreună cu achiziționarea coordonatelor geospațiale ale fiecărei probe prelevate în corelație cu timpul (GMT) prin rețeaua de satelit GPS și stocarea acestora, pentru a elabora hărți privind umiditatea locală.

INTRODUCTION

Soil production capacity depends on its fertility, which characterizes the soil capacity to provide plants continuously and in sufficient quantities with water, air and nutrients. At the same time, the soil must be a favourable environment for plant root development and support for the root system so that they are well fixed without the danger of uprooting as a result of the violent action of some meteorological factors.

Air presence, soil water retention capacity and soil workability are closely related to texture, structure and soil porosity. During agricultural campaigns, the soils structure and porosity are the properties that are directly influenced by the action of the working and rolling parts of agricultural machinery.

Agricultural practice in the last 30-40 years, characterized by the execution of agricultural works in conditions of increased soil moisture, the execution of multiple and high intensity soil operations, in order to obtain increased vegetal crops, the change of perennial crops share in favour of annual crops, the use of large-scale equipment has created situations where the natural regeneration of the soil does not cope with the maintenance of soil health, which ultimately leads to the degradation of the soil structure.

Moisture is a soil attribute that influences the specific activities of agricultural production, conditioning the following *(Molnar and Roş, 2009)*

- how soil works are performed;
- choosing the moment of execution (optimum time);
- soil suitability for processing;
- agricultural machines used;
- working norms and fuel consumption norms;
- use of air pressure in the tires adapted to soil conditions *(Dinu L., 2010)* etc.

For high moisture soils, due to the high adhesion coefficient, a layer of soil adheres to the surface of the working part through the intermediary of the water layer, the friction occurring between the adherent soil layer and the soil layer which moves in relation to the work part surface during the working process is characterized by the internal friction coefficient which has values higher than the external friction coefficient (the coefficient of friction between the work part surface and the soil mass).

The optimum soil moisture corresponds to the interval that is characteristic of the friable consistency. In this interval the cohesion and the adhesion of the soil are minimal, the soil does not exhibit plasticity, it can be easily ground, the resistance to mechanical processing is minimal, and the quality of the works is good.

Water puddling on the surface of the soil due to the occurrence of the compacting phenomenon occurs as a result of soil permeability reduction, which has as consequence the decrease of the infiltration velocity of the water in the soil mass. The rate of water infiltration in the soil depends on the depth at which the soil horizon is analyzed and the degree of compaction.

In soils with moderate moisture, as the load on the wheel increases, the depth at which the soil compaction effect is transmitted increases. Experimental research has highlighted the fact that, for the same pressure exerted on the soil, larger balloon tires loaded with a higher load cause more compaction than lesser-size tires that are loaded with a lower load. It is therefore desirable for agricultural works to be carried out when the soil has proper moisture at the working depth. There are cases, in which the soils are dry and hard at the surface, and there are no traces left on the passing of vehicles, but they are moist and likely to be compacted in depth.

To determine moisture, the most commonly used methods are currently:

- radioactive methods of measurement using neutron probes that are directly buried in the soil;
- conductometric methods whose electrodes are introduced into the soil, the electrical conductivity being influenced by humidity *(Yang and Xiang, 2008).*
- also, a number of authors have produced maps on soil penetration resistance using geostatistical data and comparative data on compaction *(Adamchuk and Jonjak, 2010).*

The main purpose of this paper is to research and study a modern system for local soil compaction mapping intended for agricultural holdings using methods and techniques specific to precision farming (large culture and horticulture.

MATERIAL AND METHOD

Objectives

The research carried out led to the substantiation of a new method of real-time determination of the soil sample properties, together with the acquisition of the geospatial coordinates of each sample taken correlated with time (GMT) via the GPS satellite network and their storage, in order to draw up maps on local moisture.

Location of experiments

Experiments to monitor local soil compaction and moisture status of the soil were carried out on a plot of land located at the National Institute of Research - Development for Machines and Installations Designed to Agriculture and Food Industry Bucharest, with the following data.

a) Name of the agricultural lot: L2 – Experimental lot;

b) Lot location: National Institute of Research - Development for Machines and Installations Designed to Agriculture and Food Industry Bucharest;

c) Lot surface: 8100 m^2

d) Lot preparation: plowed and shredded by discing after harvesting previous crop.

The location of the experimental area in relation to the localities of Bucharest and Otopeni is shown on the map in (Figure 1).

Fig. 1 – Location of the experimental area in relation to the localities of Bucharest and Otopeni – inside the blue ellipse

Equipment used

In the experimental procedure were used a Delta-T Weather Stations-WS-STD1 professional weather station and an Eijkelkamp Penetrologger electronic penetrometer with digital display, having an Eijkelkamp Thetaprobe moisture sensor connected to the penetrometer electronic module, the characteristics of which are presented in Table 1.

The Delta-T Weather Stations-WS-STD1 professional weather station has the following components:

- Standard anemometer;
- Wind direction sensor;
- Compact rain gauge for flat plate;
- Solar energy sensor;
- Soil thermometer probe;
- Thermo/hygro sensor;
- Barometer;
- Data logger for general use DL2E;
- Chargeable battery 12V/10Ah;
- Battery charger;
- System of charging from photovoltaic module;
- GSM modem with accessories.

It measures and records:

- air temperature: -30…70±0.3ºC
- relative moisture: 5…95±2 RH
- barometric pressure: 15…115 kPa with precision <±1.5%
- rainfall: tilting container
- solar radiation: 0…1.1 kW.m^2, 300…1100±5%nm
- wind direction: ±4º
- wind speed: 0…75±0.1 m/s

Tabel 1

Features of the Eijkelkamp Penetrologger electronic penetrometer

Operating temperature	50°C
Memory 1 500 measurements	1.500 measurements
Maximum penetration force	1.000 N
Total measuring length of the probe	97 cm (except for the cone)
Depth of recording	80 cm
GPS precision	<2,5 m CEP (Circular Error Probable)

Working method

Conducting field experimental research requires compliance with the following procedural rules:

- identifying the location of agricultural land through the following elements:
- localization in GPS coordinates;
- determining the size of the agricultural land surface;
- identifying the type of soil;
- traceability of crops (previous crop history),
- marking/setting out the points of interest;
- the location of the weather station provided with a data logger for automatic data recording at various time intervals in an area that meets certain specific conditions (easy access, spatial features favourable to communication, etc.);
- making a mapping plan:
- identifying points of interest or points where measurement of various parameters is desired;
- establishing coordinates (rows, columns, density of sampling points),
- inserting mapping plan data into the electronic penetrometer memory;
- measuring and mapping the compaction state and soil local moisture on the monitored plot.

The data collection focused on the sampling, analysis and recording of soil samples by manual methods, local moisture in the monitored plot soil being recorded by slow penetration with the Eijkelkamp Penetrologger penetrometer fitted with the Eijkelkamp Thetaprobe moisture sensor. With integrated GPS, the measuring point has been accurately recorded.

For each measuring point (total 12 points), a series of 12 records representing soil moisture values were performed. With the help of the data obtained after the calculations using Excel, two-dimensional graphs were plotted for each location. The map of the soil moisture distribution, in percent, was plotted for the depth of 6 cm using the MATCHAD program.

The processing of experimental data and the creation of spatial distribution maps of agricultural land parameters were carried out by moving from the geographical sexagesimal coordinate system to decimal coordinates with the help of the on-line coordinate converter.

Aspects during the experiments are shown in (Figure 1).

Fig. 1 - Aspects during the experiments

A modern system for local soil moisture mapping, specific to precision farming, has three major main functions, namely monitoring, data collection and mapping.

a) Monitoring

The operation of this system involves the physical **storage** of data from sensors by means of a device known as the generic name of "*data loggers*", which is equipped with non-volatile memory, the **transmission** being carried out by traditional methods using data cable (en. *wired*). The next step is the **processing** of data by the final recipient, the central processing unit (en. *CPU – Central Processing Unit*). Data acquisition is an operation that allows the use of a whole range of methods to build the geographic database found inside any GIS software (in digital form). Spatial positions resulting from the use of the *Global Navigation Satellite System (GNSS)* integrated in the Eijkelkamp Penetrologger penetrometer, the GPS, are directly integrated into a GIS.

b) Mapping - As a result of using the GPS system and the achievement of a higher degree of precision with regard to the location of certain soil characteristics at certain spatial points (contact pressure and local moisture), all information to which GPS coordinates are assigned is managed.

c) Data collection - Classical manual sampling is done with the help of the human operator through the slow penetration operation and the introduction of the moisture sensor in different areas of the specific plot.

The **modern system for local soil moisture mapping** can be conceptually divided into three main stages: a) establishing the input and output elements relevant to the system's operation, b) establishing the system requirements, and c) implementing the concept and experimenting with the system.

The following activities were carried out in order to achieve the modern system for local soil moisture mapping:

1. Converting geographical sexagesimal coordinates into decimal coordinates by direct calculation or using available utility software;
2. Formation of an ASCII file containing on columns the data obtained by measurements and calculations for latitude, longitude, penetration resistance and local soil moisture. The columns were marked by the TAB marker;
3. Choosing mathematical computing software, for example MATHCAD;
4. Importing the ASCII file made in MATCAD using the command: Insert->DATA->FILEINPUT ->filename.txt;
5. Marking as data vector each column in the ASCII file;
6. Statistical processing of imported data: average, standard deviation, kurtosis, skewness;
7. Obtaining 3-coordinate charts with Surfaceplot or ContourPlot functions;
8. Inserting in the chart, the columns that generated the graphs;
9. Importing the graphs image into the raster map obtained from the Google Earth archive.

RESULTS

Parameters recorded by the Delta-T Weather Stations-WS-STD1 professional weather station during measurements in the monitored plot soil are: air temperature and humidity, barometric pressure, wind speed and direction and rain.

Figure 2 represents the rain recorded during the measurements in the monitored plot soil.

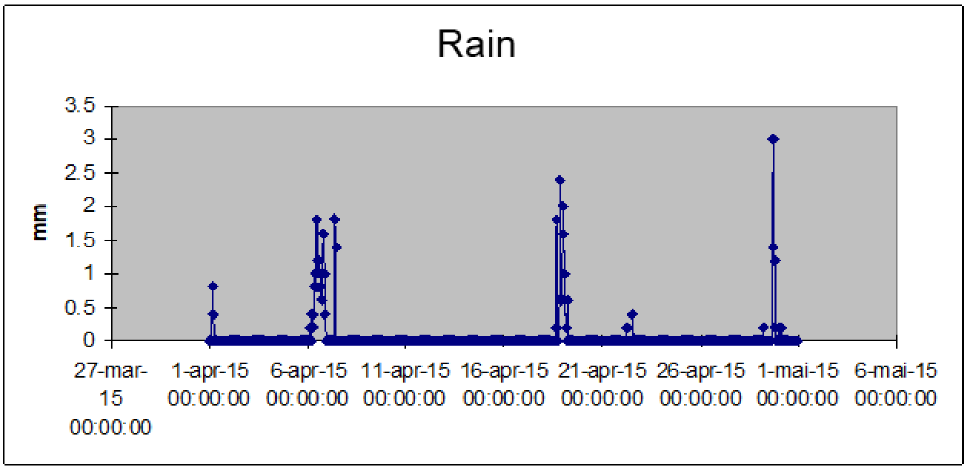


Fig. 2 - Graphical representation of rain

Table 2

The coordinates of the measurement points

Measurement point	Date	Latitude	Longitude	Ground level, m
1	17-APR-11 10:55:40	44°30'0.89"N	26° 4'19.70"E	93
2	17- APR -11 10:58:58	44°30'1.81"N	26° 4'20.66"E	93
3	17- APR -11 11:04:04	44°30'2.91"N	26° 4'21.79"E	93
4	17- APR -11 11:06:59	44°30'3.29"N	26° 4'20.54"E	93
5	17- APR -11 11:09:56	44°30'3.60"N	26° 4'19.64"E	93
6	17- APR -11 11:13:31	44°30'4.77"N	26° 4'18.08"E	93
7	17- APR -11 11:21:42	44°30'3.64"N	26° 4'16.76"E	93
8	17- APR -11 11:23:28	44°30'2.44"N	26° 4'15.54"E	93
9	17- APR -11 11:23:57	44°30'1.62"N	26° 4'17.17"E	93
10	17- APR -11 11:28:42	44°30'1.23"N	26° 4'18.39"E	93
11	17- APR -11 11:31:21	44°30'2.21"N	26° 4'19.62"E	93
12	17- APR -11 11:33:39	44°30'2.69"N	26° 4'18.43"E	93

The soil moisture values, in%, at the measurement points are shown in Table 3.

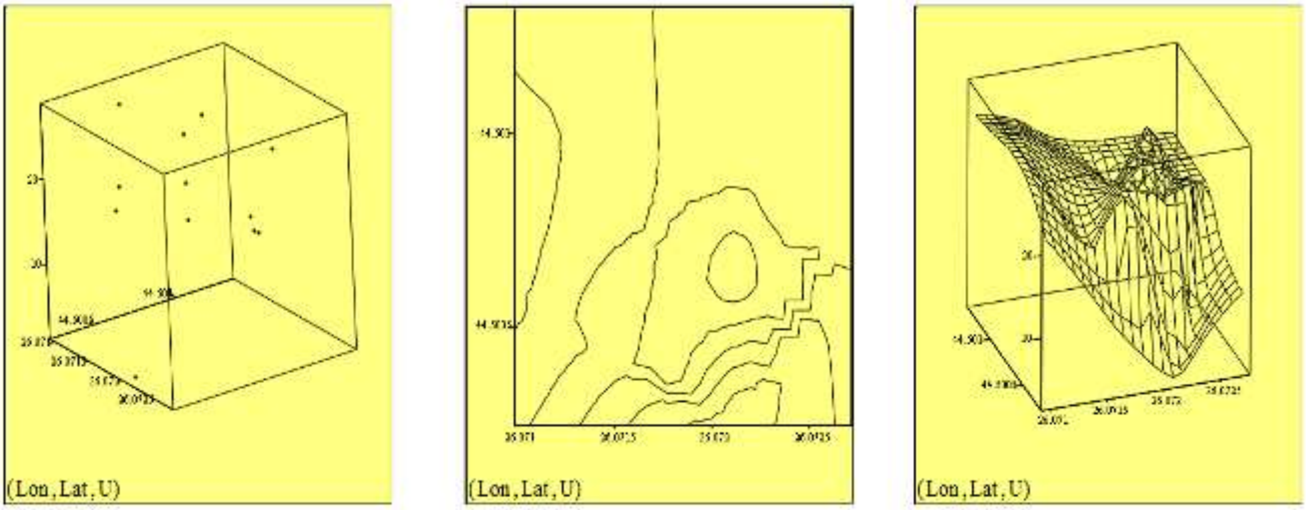
Table 3

Measured soil moisture values

Measurement point	Measurement depth, cm	Soil moisture, %
1	6	20
2	6	18
3	6	16
4	6	16
5	6	20
6	6	24
7	6	26
8	6	26
9	6	17
10	6	22
11	6	28
12	6	20

The average local moisture is 21.08%, resulting in an experimental lot with sufficient moisture.

The graphical representations of local moisture according to the geographical decimal coordinates (longitude and latitude) are shown in Figure 3 (**a**- points graph, **b**- plane graph and **c**- surface graph).



a. b. c.

Fig. 3 - Graphical representations of local moisture according to the geographical decimal coordinates (longitude and latitude)

In Figure 4 is shown the map of local moisture distribution obtained with the MATCAD program.

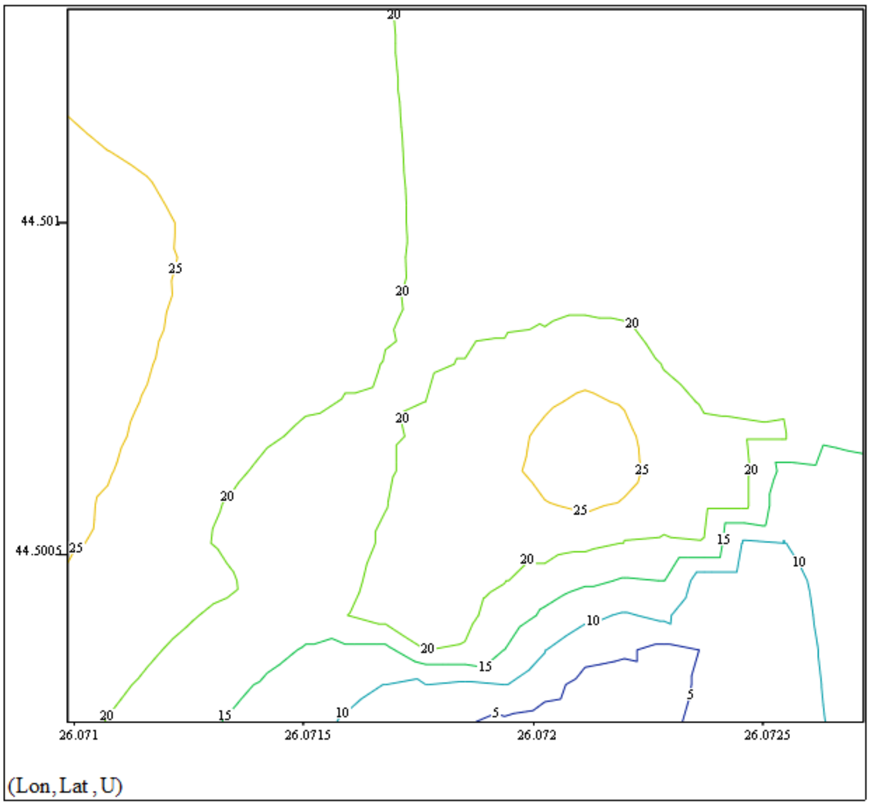


Fig. 4 - Local moisture distribution map

The overlay of the local moisture distribution map over the aerial image, taken from the Google Earth image archive, of the experimental lot is shown in Figure 5.

Fig. 5 - Overlay of the local moisture distribution map over the aerial image of the experimental lot

CONCLUSIONS

During the execution of agricultural works, knowing the soil moisture is very important, as it can lead to the adoption of a management by the agricultural producers.

Soil moisture values are important in land classification and contribute to providing a common soil characterization system from which it may be possible to determine the number of passes of agricultural machinery in order to predict traction performance.

The novelty of the research lies in the fact that, compared to the classical use of digital models and the production of maps, the introduction of an accompanying map with overlapping aerial photographic image, in the background, facilitates the rapid identification of areas requiring repairs, in terms of local soil moisture.

Information and local soil moisture mapping can be synthesized, providing users with the information they need.

The modern system for spatial distribution mapping developed in accordance to the case study carried out, to identify excessive moisture lands, provide a complex and comprehensive tool set of spatial analysis necessary in the future for its complete computerization.

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STUDY ON INFLUENCE OF FRUIT SOIL CONTAMINATION - A REVIEW
/
STUDIUL INFLUENȚEI CONTAMINĂRII SOLULUI ASUPRA FRUCTELOR – A REVIEW

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Keywords: *heavy metal, soil contamination, fruits*

ABSTRACT

This paper presents considerations regarding the accumulation of heavy metals from soil and road dust in fruits and the assessment of the impact of contamination produced by their consumption on human health. There are sites from different countries, such as: Nigeria, Serbia, China, Brasil, Romania, Turkey, Iran, etc, contaminated with heavy metals (iron, copper, nickel, cadmium, manganese, chromium, lead, zinc etc.), the bioaccumulation of metals in fruit grown in the vicinity of the sites.

REZUMAT

Lucrarea prezintă considerații cu privire la acumularea metalelor grele din sol și din praf în fructe și evaluarea impactului contaminării produs de consumul acestora asupra sănătății omului. Se prezintă situri din diferite țări, cum ar fi: Nigeria, Serbia, China, Brazilia, Romania, Turcia, Iran, etc. contaminate cu metale grele (fier, cupru, nichel, cadmiu, mangan, crom, plumb, zinc, etc), bioacumularea metalelor în fructe cultivate în vecinătatea siturilor.

INTRODUCTION

In soils, heavy metals mainly originate from the resulting from human activities, such as industrial activities, the application of agricultural chemicals and the improper disposal of waste. Heavy metals are natural weathering of soil parent material and from external inputs (*Jitin and Jain, 2016*).

Roadside soils are the "recipients" of large amounts of heavy metals from a variety of sources, including vehicle emissions, coal burning waste and other activities. Automobile traffic pollutes roadside environments with a range of contaminants. Heavy metals are found in fuels, in the walls of fuel tanks, in engines and other vehicle components and in catalytic converters, tires and brake pads, as well as in road surface materials (*Jitin and Jain, 2016*).

Heavy metals such as Cd, Cu, Pb, Cr and Hg are important environmental pollutants, particularly in areas with high anthropogenic pressure. Their presence in the atmosphere, soil, water, even in traces, can cause serious problems to all organisms. It is well known that an excess or deficiency of trace metals present in the human body can cause harmful effects. For example an excess of Cu in the body cause Willson's disease while a deficiency of Zn is responsible for retarded body growth (*Kooner et. al., 2014*).

Health risk assessment for heavy metals of the population is a very good technique because such assessment would be useful to give information about any threat regarding heavy metals contamination in vegetables. Ingestion of heavy metals through food can cause accumulation in organisms, producing serious health hazards such as injury to the kidney, symptoms of chronic toxicity, renal failure and liver damage (*Kooner et. al., 2014*).

Heavy metals are defined as a metallic element with a density between 4-5 g/cm. Commonly found toxic heavy metals include lead (Pb), chromium (Cr), arsenic (As), zinc (Zn), cadmium (Cd), copper (Cu). In toxic concentrations heavy metals can cause damage to the ecology, environmental, nutritional and evolutionary characteristics of the polluted areas (*Jitin and Manish, 2016*).

Soils are heavy metals sinks, heavy metals originate from the earth's crustal rock and are released through weathering processes through its anthropogenic sources such as, fertilizers, mine tailings, pesticides, sewage sludge and smelting, causing unnaturally high contamination. Concentration of heavy metals persists as they are not degraded by microbial activity or chemicals, like the organic compounds, reducing soil quality. Prolonged contamination of soils severely reduces the soil quality, however, changes to chemical form are possible.

Heavy metals and plants have complex relationships. Heavy metals are essential nutrients in trace concentrations for healthy growth as plants require the nutrients for essential physiological functions. Deficient or toxic concentrations can cause disruptions to essential functions leading to poor health or death. The degree of toxicity or deficiency the plant has to tolerate, survival is affected by the metal form and concentration, bioavailability and species. High and low concentrations of heavy metal in soil can negatively affect crop growth, as these metals interfere with metabolic functions in plants, including inhibition of photosynthesis and respiration and degeneration of main cell organelles, even leading to death of plants (*Jitin and Manish, 2016*).

Zinc: Zn is an essential micro-nutrient for physiological functions. Zn is a building block for enzymes, in addition, many enzymatic reactions are activated by zinc. Zinc exerts a great influence on many plant life processes, such as, nitrogen metabolism and uptake of nitrogen and protein quality; photosynthesis and chlorophyll synthesis, carbon anhydrase activity; resistance to abiotic and biotic stresses and protection against oxidative damage. Zn deficiency is commonly reported in crop growth. Zn deficient plants suffer from physiological stress caused by enzyme dysfunction and other metabolic function disruptions. Symptoms of deficiency include stunted growth, inter-venial chlorosis in younger leaves, necrotic tips and photosynthetic problems.

Zinc toxicity leads plants to suffer from physiological stress caused by enzyme dysfunction and other metabolic function disruptions. Zn excess can cause ATP synthesis, other symptoms include chlorosis, smaller leaves and necrotic leaf tips (Fig.1) (*Jitin and Manish, 2016*).

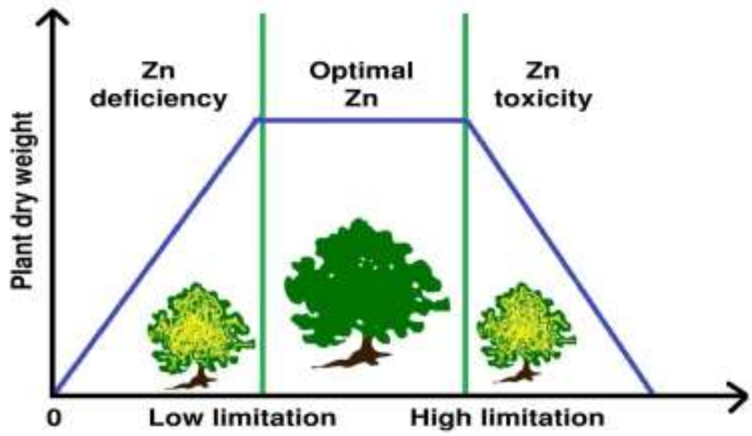

Fig. 1 - Zinc concentration and its effect on the likelihood of the symptoms deficiency and toxicity being present (*Jitin and Manish, 2016*)

Cadmium: Cadmium is a relatively rare heavy metal, which occurs naturally in combination with other metals. Cadmium has been observed in road dust due to its presence in automobile fuel and in soil. Therefore, inhalation exposure to Cd can occur from road dust. After inhalation, the absorption of Cd compounds may vary greatly depending upon the particle sizes and their solubility. Cadmium is a metal, which can cause severe toxicity in humans. Prolonged exposure to Cd can affect a variety of organs with the kidney being the principal target (*Jitin and Manish, 2016*).

Lead (Pb) exists in many forms in the natural sources throughout the world and is now one of the most widely and evenly distributed trace metals. Soil and plants can be contaminated by lead from car exhaust, dust, and gases from various industrial sources. Pb was found to be acute toxic to human beings when present in high amounts. Since Pb^{2+} is not biodegradable, once soil has become contaminated, it remains as a long-term source of Pb^{2+} exposure. Metal pollution has a harmful effect on biological systems and does not undergo biodegradation (*Jitin and Manish, 2016*).

Nickel: Nickel combined with other elements occur naturally in the earth's crust. It is found in all soils. In the environment, it is primarily found combined with oxygen or sulphur as oxides or sulphides. Nickel is also released into the atmosphere by oil and coal burning power plants, and trash incinerators. Health hazards associated with exposure to Ni in the occupational environment, have resulted primarily from inhalation (*Jitin and Manish, 2016*).

Chromium is present in human tissues in variable concentrations and its deficiency is characterized by disturbance in glucose, lipid and protein metabolism. It is an element occurring in food products of both plant and animal origins. It is regarded as an essential trace element in humans and animals, taking part in various metabolic processes. As an element, it has been reported that it is usually present in food in the trivalent form; the hexavalent form of it however, is toxic and not normally found in food. It has been reported to cause skin rashes, stomach ulcer, kidney, liver damages, lungs cancer and ultimate death (*Garba et. al., 2018*).

The study aim was to investigate the concentrations of potentially toxic elements (Pb, Cd, Cu, Ni, Cr, Mn, Zn, etc.) in soil and fruits (fruit juice extracts, leaves, branches, vegetative branches, fruit branches and fruit) grown on polluted soils in many countries and road dust to assess the health risk associated with exposure to these elements.

MATERIAL AND METHOD

***Heavy Metals*:** Heavy Metals are defined as a metallic element with a density between 4-5g/cm^3. Commonly found heavy metals include Lead (Pb), chromium (Cr), arsenic (As), zinc (Zn), cadmium (Cd), copper (Cu). In toxic concentrations heavy metals can cause damage to the ecology, environmental, nutritional and evolutionary characteristics of the polluted area.

Soils are heavy metals sinks heavy metals originate from the earth's crustal rock and are released through weathering processes although its anthropogenic sources such as; fertilisers, mine tailings, pesticides, sewage sludge and smelting have caused unnaturally high contamination. Concentration, of heavy metals persists as they are not degraded from microbial or chemicals like organics, reducing soil quality. Prolonged contamination of soils severely reduces the soil quality. However, changes to chemical form are possible (*Jitin and Jain, 2016*).

***Heavy Metals and Plants*:** Heavy metals and plants have complex relationships. Heavy metals are essential nutrients in trace concentrations for healthy growth as Plants require the nutrients for essential physiological functions. Deficient or toxic concentrations can cause disruptions to essential functions leading to poor health or death. The degree of toxicity or deficiency the plant has to tolerate surviving is affected by Metal Form and concentration, bioavailability and species. High and low concentrations of heavy metal in soil can negatively affect crop growth, as these metals interfere with metabolic functions in plants, including inhibition of photosynthesis and respiration and degeneration of main cell organelles, even leading to death of plants (*Jitin and Jain, 2016*).

Analyses of plant tissue heavy metal levels Plant tissues weighed about 0.5 g for fruit and 0.5 g for leaf samples, digested with concentrated HNO_3 – H_2O_2 acid mixture (2:3 v/v) in three step (first step; 145ºC, 75% radio-frequency power (RF), 5 min; second step; 180ºC, 90%RF, 10 min and third step; 100ºC, 40%RF, 10 min) in microwave (Bergof Speedwave Microwave Digestion Equipment MWS-2). Contents of P, K, Ca, Mg, Fe, Cu, Mn, Zn, Cd, Pb, Ni and Cr in plant tissue were determined by using an Inductively Couple Plasma, Optical Emission Spectrophotometer (Perkin-Elmer, Optima 2100DV, ICP/OES, Shelton, CT 06484-4794, USA) (*Pehluvan et. al., 2012*).

RESULTS

In many papers, heavy metal concentrations varied among different fruit species due to their different absorption capacity and the regional soil and atmospheric degree of pollution. The concentration of heavy metals in fruit samples were determined on the basis of dry weight and are summarized in Table 1 (*Pehluvan et. al., 2015*).

Table 1

Heavy metal levels of fruit species in leaves and edible part (mg/kg dry weight) (*Pehluvan et. al., 2015*).

Sample name	Cd	Pb	Ni	Cr	Cd	Pb	Ni
	Leaf	Fruit	Leaf	Fruit	Leaf	Fruit	Leaf
Sweet cherry	12.07	3.41	8.74	1.75	4.56	1.27	0.18
White mulberry	4.15	2.34	4.15	2.15	3.85	1.36	0.18
Black mulberry	5.46	2.10	3.48	1.62	4.11	1.03	0.14
Apricot	9.32	3.40	6.55	2.20	3.11	1.24	0.10
Apple	6.75	1.12	5.13	2.06	2.34	0.70	0.21
Peach	12.76	5.11	7.69	3.15	5.10	1.15	0.21
Hawthorn	8.59	1.78	8.67	3.10	4.11	0.85	0.12
Rosehip	11.25	1.32	10.36	2.85	5.45	0.91	0.08
Plum	15.41	5.87	12.09	3.41	4.43	0.86	0.20

Generally, stone fruit species and mulberries were found to be more contaminated with trace elements and heavy metals than other fruits. There are many explanations for heavy metal accumulation in fruits and one of them are motor vehicles. Increase of Pb and Cd levels in fruits might be attributed to motor vehicles in the study area which lead to the accumulation of Pb and Cd emitted from trailer trucks and cars exhaustion. Second may be soil which was polluted by coal combustion. It is an important source and has high heavy metal contents (*Pehluvan et. al., 2015*). In Table 2 shows a synthesis on the concentration of heavy metals in the fruits from different parts of the world.

Table 2

Concentration ranges of heavy metals in the fruits (mg/kg dry weight)

Fruits	Concentration of heavy metals in some fruits [mg/kg]										Study area	Cittion
	Fe	Cu	Cd	Pb	Zn	Cr	Ni	Mn	S	Co		
Watermelon	-	0.004	0.004	0.108	-	-	-	-	-	-	Lagos (Nigeria)	[15]
Pineapple	-	0.015	0.005	0.128	-	-	-	-	-	-		
Orange	-	0.002	0.005	0.106	-	-	-	-	-	-		
Tangerine	-	0.003	0.005	0.097	-	-	-	-	-	-		
Grape	-	0.003	0.005	0.092	-	-	-	-	-	-		
Banana	-	0.009	0.005	0.118	-	-	-	-	-	-		
Pawpaw	-	0.003	0.003	0.072	-	-	-	-	-	-		
Apple	-	0.003	0.004	0.112	-	-	-	-	-	-		
Mulberry	-	2.12-3.14	0.01-0.02	0.28-0.47	5.97-8.74	0.09-0.23	0.3-0.75	74.1-127.2	-	0.08-0.26	Upper Coruh Valley (Turkey)	[12]
Pindo palm	16.12	11.47	0.06	-	38.88	1.15	4.99	30.51	-	0.06	South of Brazil	[13]
Guabiroba	18.3	6.16	0.02	0.08	17.39	1.80	3.25	10.87	-	0.62		
Uvaia	21.27	5.03	0.02	-	60.48	1.56	4.54	26.37	-	0.18		
Araticum-do-mato	8.42	80.38	0.04	0.10	9.24	1.19	3.36	29.06	-	0.10		
Yellow guava	14.91	6.20	0.03	-	19.62	1.35	3.40	7.43	-	0.31		
Red guava	11.03	5.54	0.01	-	4.76	0.41	3.16	29.86	-	3.17		
Orange	-	0.004	0.005	0.106	0.045	-	0.120	-	-	-	Urmia (Iran)	[3]
Grape	-	0.015	0.004	0.088	0.063	-	0.115	-	-	-		
Banana	-	0.008	0.005	0.128	0.046	-	0.132	-	-	-		
Watermelon	-	0.003	0.002	0.118	0.051	-	0.142	-	-	-		
Pineapple	-	0.004	0.005	0.132	0.040	-	0.124	-	-	-		
Apple	-	0.005	0.004	0.112	0.065	-	0.136	-	-	-		
Pears	-	0.006	0.006	0.101	0.058	-	0.152	-	-	-		
Pomegranate	-	0.004	0.004	0.126	0.046	-	0.098	-	-	-		
Mango green	-	-	0.016	0.05	-	0.1	-	-	-	-	Iran	[14]
Mango Ripe	-	-	0.004	0.009	-	0.07	-	-	-	-		
Apple	-	-	0.0006	0.0184	-	0.0192	0.0623	-	-	-	Liaoning, Hebei, Xinjiang, Jiangsu, Henan, Anhui areas (China)	[10]
Pear	-	-	0.0009	0.0051	-	0.0143	0.0696	-	-	-		
Peach	-	-	0.0029	0.0190	-	0.0321	0.0739	-	-	-		
Grape	-	-	0.0005	0.0050	-	0.0112	0.0170	-	-	-		
Jujube	-	-	0.0013	0.0159	-	0.0207	0.0985	-	-	-		
White mulberry	23.06	0.86	2.46	0.09	2.23	-	0.36	-	-	-	South East Serbia	[9]
Red mulberry	57.38	1.51	1.84	0.20	5.04	-	0.37	-	-	-		
Black mulberry	42.13	1.07	1.77	0.14	3.40	-	0.27	0.81	-	-		

Apple	-	163.13	-	-	43.29	-	4.39	4.49	450.83	-	Central part of Eastern Serbia on the Balkan Peninsul	[7]
Pear	-	94.06	-	-	31.11	-	4.14	2.99	271.19	-		
Peach	-	135.61	-	-	50.27	-	1.26	3.46	348.35	-		
Apricot	-	95.43	-	-	23.69	-	9.37	4.58	305.33	-		
Apple - *Ardelean*	3.21	4.02	-	-	1.23	-	-	1.69	-	-	Cluj (Romania)	[1]
Apple - *Auriu*	2.29	3.98	-	-	1.89	-	-	1.23	-	-		
Apple *Feleac*	2.01	3.26	-	-	1.23	-	-	1.23	-	-		
Apple *productiv*	3.56	2.56	-	-	2.28	-	-	1.01	-	-		
Apple *Red*	3.01	2.10	-	-	1.24	-	-	1.35	-	-		

The study of *Chata et. al. (2018)* sought to determine the concentration of heavy metals in four mango fruit varieties sold in Minna Modern Market, Niger State in order to determine their health statuses and implications where present Morphology of Mango is presented in Figure 2.

Cherry Mango *Kerosene Mango* *Julie Mango* *Binta Sugar Mango*

Fig. 2 - Morphology of Mango (*Chata et. al., 2018*)

The data in Table 3 show the comparison of heavy metals in four mango fruit varieties with that of (*WHO, 2011*) guideline and standard respectively. The heavy metals were obtained at part per million levels and reported as mg/L for all the mango fruit varieties.

Table 3

Comparative analysis of mango fruit juice extracts in Early April *(Chata et. al., 2018)*

Parameters, mg/L	Sherry Mango	Julie Mango	Binta Sugar Mango	Kerosene Mango	WHO/FAO Standard (mg/L)
Manganese (Mn)	0.40	0.30	1.30	0.37	2.03
Iron (Fe)	1.30	1.60	0.80	1.50	8.0
Copper (Cu)	0.13	0.09	0.20	0.20	3.5
Lead (Pb)	0.50	0.40	0.50	0.33	0.3

Values are expressed in mean ± Standard error for three replicates (n=3).

The results of this study confirmed that the four mango fruit varieties collected from Minna main Market of Niger State contained measured levels of non - essential toxic metal (Pb) and essential metals (Mn, Fe and Cu) which were below the recommended safety limits for the essential metals and slightly above the recommended limit for the non-essential toxic metal. Continuous biomonitoring of heavy metals in fleshy fruits is vital as these serve as sources of food for humans in many parts of the world *(Chata et. al., 2018).*

In study of *Stanica (2000),* the soil samples taken during autumn 1991 were analysed for heavy metal contents. As one can see in Table 4, the following elements were present: Pb, Cu, Zn, Ni, Cd, Mn. Related to the distance from the Bucuresti – Ploiesti, Romania, motorway axis, one can see a diminution of Pb from 65 ppm/10 meters to 35 pm/200 meters, the normal limit in our country being of 20 ppm Pb. The quantity of copper is 55 ppm at a distance of 10 m and only 40 ppm at 100 and 200 m, the values being within the limit values (Maximum admitted limit: MAL*=100 ppm Cu) (*Stanica, 2000).*

Table 4

The heavy metal contents (mg/kg) of brown reddish soil in Baneasa-Bucharest, Romania (*Stanica, 2000)*

No.	m*	Variety	Metals (mg/kg)					
			Pb	Cu	Zn	Ni	Cd	Mn^{2+}
1	10	Golden delicious	65	55	70	45	0.5	575
2	100	Idared	45	40	70	45	0.5	580
3	200	Akane	35	40	70	45	0.5	575

m*- meters to the highway

The samples of plants were taken at the same time as those of soil. The following plant parts were sampled: leaves, branches, vegetative branches, fruit branches and fruit. The elements that were examined were Pb, Cu, Zn, Ni, Fe^{2+}, Fe^{3+} and Mn^{2+} The content of different organs varied as follows in Table 5:

Table 5

The metal contents in apple tree (mg/kg dry matter) (*Stanica, 2000*)

No.	m*	Variety	Metals (mg/kg)						
			Pb	Cu	Zn	Ni	Fe^{2+}	Fe^{3+}	Mn^{2+}
leaves									
1	10	Golden delicious	306	5.85	48.7	9.21	40.5	547	108
2	100	Idared	11.7	12.8	43.3	5.97	96.0	326	10.2
3	200	Akane	-	16.2	45.3	9.38	66.7	322	130
vegetative branches									
1	10	Golden delicious	334	21.6	27.5	6.17	30.7	103	35.0
2	100	Idared	-	25.9	41.9	2.44	43.0	188	28.3
3	200	Akane	-	27.0	32.3	14.4	50.6	128	71.5
fruit branches									
1	10	Golden delicious	-	58.8	67.5	8.08	68.3	296	18.4
2	100	Idared	-	94.4	74.8	1.33	28.9	198	8.32
3	200	Akane	-	30.4	83.9	3.86	33.9	109	21.5
fruits									
1	10	Golden delicious	-	23.0	16.9	6.19	37.4	48.6	9.59
2	100	Idared	-	8.36	10.0	0.36	210	26.6	14.6

m*- meters to the highway

So, as a conclusion, the longer the distance from the pollution source, the least the risk of the presence of heavy metals on the surface of the plants. The danger of pollution being obvious especially on the part of the plain located less than 100 m from the main road axis (*Stanica, 2000).*

Regarding the presence of the other elements like Cu, Zn, Ni, Fe, Mn found in different organs of the 3 varieties of apple located at 10 m, 100 m and 200 m from the main road axis the observed variation of values may be depending on the variety and the organ as follows (*Stanica, 2000).*:

- the quantity of Cu found in the apple leaves varied between 5.85 ppm (Golden delicious) and 16.2 ppm for the Akane being situated within the limits of 5-20 ppm Cu quoted in the related literature.
- the quantity of Cu in fruit varied between 8.36 and 23.0 ppm being higher than the limits quoted by the specialists.

In apple leaves Zn exceeded the typical range of 15-20 ppm, quoted by the specialists, being as high as 43.3 and 48.7 ppm, respectively, while the quantity found in fruit varied according to the limits quoted by the specialists – 15 ppm Zn, i.e. 10.0 ppm/Idared variety and 16.9 ppm/Golden variety (*Stanica, 2000)*. Mn quantified in both leaves and fruit varied within ranges specified in literature.

CONCLUSIONS

The plants cultivated in the neighborhood of the heavy traffic highways are exposed to Pb pollution, which is more intense in the immediate neighborhood. As for the soil pollution, fixing protection curtains or boards adjacent to the high way diminishes the danger.

Road dust is an increasing problem for developed and developing countries and is a source of various diseases. Several studies on the pollution of soils along the highways indicated the presence of carcinogenic heavy metals and polycyclic aromatic hydrocarbons. The maximum concentration of both heavy metals and polycyclic aromatic hydrocarbons were found to be at 10–30 m distance from road/highways. Although the reports presented in present review article discloses the load of heavy metals and polycyclic aromatic hydrocarbons on soil ecosystems via vehicular emissions, yet, the literature is scanty from many parts of the world. Considering the harmful consequences of pollutants released from vehicular emissions, the strict guidelines should be laid and followed in order to reduce the pollution load.

There are many explanations for heavy metal accumulation in fruits and one of them are motor vehicles. Increase of Pb and Cd levels in fruits might be attributed to motor vehicles in the study area which lead to the accumulation of Pb and Cd emitted from trailer trucks and cars exhaustion. Second may be soil which was polluted by coal combustion. It is an important source and has high heavy metal contents. And third are agricultural practices. Pesticides are used intensively for protection fruit trees from insects and some pathogens. It might be result in accumulation of Cu and other metals in fruit samples.

In toxic concentrations heavy metals can cause damage to the ecology, environmental, nutritional and evolutionary characteristics of the polluted area.

Accumulation of these metals in fruits may therefore pose a direct or indirect threat to human health.

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REMEDIATION OF CONTAMINATED SOIL WITH HEAVY METALS BY NEW TECHNOLOGIES
/
REMEDIEREA SOLULUI CONTAMINAT CU METALE GRELE UTILIZAND NOI TEHNOLOGII

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ABSTRACT

Environment pollution with heavy metals, due to the intensification of industrial activities and technological processes, has become an important issue. Soil contamination due to natural or anthropogenic causes (such as mining, smelting, warfare and military training, electronic industries, fossil fuel consumption, waste disposal, agrochemical use and irrigation) is a major environmental hazard endangering not only flora and fauna but indirectly human life. This article presents innovative new methods for soil decontamination.

REZUMAT

Poluarea mediului cu metale grele, datorită intensificării activităților industriale si datorită proceselor tehnologice, a devenit o problemă importantă. Contaminarea solurilor datorită cauzelor naturale sau antropogenice (cum ar fi mineritul, topirea, pregătirea militară, industriile electronice, consumul de combustibili fosili, eliminarea deșeurilor, utilizarea agrochimică și irigarea), reprezintă un pericol major pentru mediul înconjurător punând în pericol nu numai flora și fauna, ci indirect și viața umană. Acest articol prezinta metode noi inovative pentru decontaminarea solului.

INTRODUCTION

Rapid industrialization and urbanization have contributed to the pollution of soil and groundwater with various heavy metals, such as: Cd, Pb, Cu, Hg, As, Se, Zn, Ni (*Gong et al., 2018, Khalid et al., 2017*). The anthropogenic causes (such as mining, smelting, warfare and military training, electronic industries, fossil fuel consumption, waste disposal, agrochemical use and irrigation) can contaminate the soil, for exemple: fossil fuels (coal) contain heavy metals such as Hg, Pb, Cd, Cr, Cu, Co, Zn and Ni in concentrations of 0.1 to 18 mg kg^{-1}; these heavy metals are released into the environment by vapors, flue gas particles, fly ash and ash from coal combustion (*Nalbandian, 2012, Liu et al., 2018*). Another possibility to pollute the soil with heavy metals is waste from construction materials and inappropriate soil storage in industrial mines. Field application of phosphorus (P) fertilizers, Cu-based pesticides, biosolids and animal manure and irrigation of wastewater and poorly treated industrial wastewaters are the main ways for heavy metals to enter into soils (*Bolan et al., 2014*). Globally there are >5 million sites covering 20 million ha of land in which the soils are contaminated by different heavy metal(loid)s *(Wuana et al., 2011; He et al., 2015, Liu et al., 2018).*

Heavy metals and metalloids have been a major threat to human health and the environment due to the lack of biodegradability, toxicity, persistence and bioaccumulation in the food chain. They are responsible for causing various disorders in humans, including diseases such as *Itai-Itai*, *Parkinson's*, *Alzheimer's*, *Wilson's*, *Skogholt's*, *Menkens*, can, also, affect the nervous system, some organs (kidneys, liver, heart), cardiovascular system, can cause autism (*Aspli et al., 2015, Brewer G. J., 2012, Dias et al., 2016, Yassa H. A., 2014, Korashy et al., 2017*).

Various remediation techniques have been highlighted to clean or restore soils contaminated with heavy metals such as surface coatings, soil washing, electro-kinetic extraction, solidification, vitrification, bioremediation and phytoremediation. These techniques can be classified into five categories: physical, chemical, electrical, thermal and biological rehabilitation, or three divisions: based on isolation (eg coating / encapsulation), based on transformation (eg stabilization / immobilization) . In general, these soil remediation methods use different working mechanisms and demonstrate the specific benefits and limits of application. More importantly, these techniques vary significantly in terms of effectiveness and cost of field practice

(*Khalid et al., 2017, Dermont G., et al., 2008, Wuana R.A., et al., 2011, Yao Z., et al., 2012, Khalid S., et al., 2017, Liu L., et al., 2018*).

RESULTS

For decontamination of soils containing heavy metals, in situ and ex situ remediation techniques have been developed to rectify sites contaminated with heavy metals, including surface coating, encapsulation, land deposition, soil washing, soil washing, electro-kinetic extraction, stabilization, solidification , vitrification, phytoremediation and bioremediation. These methods use different containment, extraction / disposal and immobilization mechanisms to mitigate the effects of contamination through physical, chemical, biological, electrical and thermal processes.

Bioremediation

Compost can be utilized for bioremediation of soils contaminated with heavy metals, as a stabilizing technique. It is capable of complex, absorption and precipitation of heavy metals (*Burgos et al., 2010; Park et al., 2011*). Compost showed a positive impact on the immobilization of Zn and Pb, but enhanced the Cu solubility due to organic matter chelation. Humic acids in the mature compost can significantly fix zinc and lead and can lead to a slight mobility of copper and iron in the soil (*Chen et al., 2015*).

Some research found that *Alcaligenes eutrophus* produced siderophores that could form complexes with metals; addition of the bacteria significantly improved water extraction of Cd, Zn, and Pb from a sandy soil. The presence of the iron reducing bacterium Desulfuromonas palmitatis greatly enhanced the release of As in a calcareous soil (*Vaxevanidou et al., 2008*). Many bacteria (e.g., *Bacillus subtilis, Torulopsis bombicola*) could produce biosurfactants such as surfactin, rhamnolipids, sophorolipids, aescin, and saponin to solubilize metals in soils. Certain rhizosphere microbes promote the tolerance of plants to heavy metals and enhance their growth in contaminated soils (*Mishra et al., 2017*). In-situ soil bioremediation to remove Hg via microbial enhanced volatilization is feasible, in which bacteria transform methyl mercury into Hg(II) and reduce it to Hg(0) (*Dash and Das, 2015*, *Liu et al., 2018*).

Phytoremediation

Phytoremediation is to grow plants in contaminated soils, relying on green plants to remove heavy metals (phytoextraction and phytovolatilization) or stabilize them into harmless status (phytoimmobilization and phytostabilization) (*Mahmood et al.,2015, Liu et al., 2018*).

Alaboudi K. A. et al., have demonstrated that sunflower (*Helianthus annuus*) plant can accumulate Pb and Cd in tissues (shoots and roots). However, the accumulation of Cd in plant shoot was more favorable than Pb. The translocation factor emphasis the ability of *H. annuus* for accumulating much amounts of Cd compared to Pb. Additional studies are needed to investigate the phytoremediation performance of *H. annuus* for heavy metals in combination with plant growth promoters and chelating agents in order to maximize the removal efficiency of heavy metals (*Alaboudi et al., 2018*).

Alnus glutinosa (*Common Alder*) and *Betula pendula* (*Roth*) can significantly reduce the concentrations of five key metals (Zn, Cd, Mn, Pb and Cu) in the soil. Fourteen years after tree planting, soil metal loadings, relative to land left under grass, decreased by 52% for Cd (0.043 $mg \cdot kg^{-1}$ per year), 48% for Cu (2.1 $mg \cdot kg^{-1}$ per year), 47% for Zn (7.3 $mg \cdot kg^{-}1$ per year), 44% for Pb. (7.1 $mg \cdot kg^{-1}$ per year) and 35% for Mn (45 $mg \cdot kg^{-1}$ per year). Foliar analysis indicated that trees were directly involved in for drawing down soil metal loadings for all five of the metals. There were significant positive correlations between the age of the trees and the amount of Mn, Zn and Cd (*Alder only*) in leaves. However, there was little other evidence for metal accumulation on site and it is probable that most of the mobilised metals were dispersed into the larger environment by runoff and leaching. More generally, differences in the metal uptake of Birch and Alder suggest that mixed plantings may be more effective than monospecific for forest phytoremediation (*Desai et al., 2019*).

The metal(loid)s As, Hg, and Se may be discharged by accumulator plants (e.g., *Astragalus racemosus*) in gaseous species into the atmosphere. The process is termed phytovolatilization. So far 721 species of plants have been identified as metal hyperacculators (*Reeves et al., 2017*). These plants tolerate high concentrations of heavy metals, grow well in metalliferous soils, and possess distinct capabilities to efficiently absorb particular metal ions from soil, translocate the metals fromroots to shoots, and detoxify and sequester the metals in leaf tissues. For example, *Sebertia acuminate* is a Ni hyperaccumulator tree native to New Caledonia, able to accumulate Ni in its latex up to 26% dry mass (*Jaffré et al., 2013*). Tobacco (*Nicotiana tabacum L.*) is a Cd hyperaccumulator. *Arabidopsis halleri*, *Thlaspi goesingense*, and *Sedum alfredi*i are Zn hyperaccumulators. *A. halleri, S. alfredii, Thlaspi caerulescens*, and *Thymus praecox* are both Cd and Zn hyperaccumulators (*Rascio and Navari-Izzo, 2011, Yang et al., 2017, Liu L., 2018*).

Electrokinetic method

Electrokinetic extraction is to remove heavy metals from contaminated soils by electrical adsorption. When low-density direct current (DC) electricity is applied via electrodes inserted in the ground, cations in the solution phase of the contaminated soil migrate to the cathode while anions migrate to the anode at the attractive force of the established electrical field. Metal contaminants concentrated at the polarized electrodes are subsequently removed by electroplating, (co-)precipitation, solution pumping, or ion exchange resin complexation (*FRTR, 2012*).

Soils with three different organic matter levels (OM0, OM1, and OM2) were prepared, spiked with pollutants, placed in electrokinetic cells, and remediated for 15 days. To improve the remediation process and increase the efficacy of pollutant removal, pH control methods and extracting agents were used. Two non-ionic surfactants, Tween 80 and Brij 35, and one chelating agent, EDTA, were utilized for this purpose.. The order of removal of heavy metals was zinc > nickel > lead, and zinc had the highest removal rate of 61% (*Saberi et al., 2018*).

Soil flushing

Soil flushing is to in-situ remove contaminants from soil by passing an extraction fluid through the soil. The extraction fluid is then recovered, reused, and eventually treated and disposed of. The technique is applicable to homogenous, coarse-textured soilswith high permeability (*CLU-IN, 2017*). In soil flushing, the extraction fluid is typically injected or infiltrated into the soil. To effectively extract heavymetals fromsoil, the extraction fluid has to be designed with particular formula. Various chelating and acidic solutions have been tested, indicating EDTA is the most effective agent. Using batch experiments, *Wuana et al. (2010)* found that at 0.01 M and 1:25 soil/solution ratio, EDTA excelled over citric acid and tartaric acid in extracting heavy metals from a fortified loamy sand (pH 6.1, organic matter (OM) content 8.7%). The solutions demonstrated mobilization efficiencies varying with the metal species in coexistence: Cu > Ni > Zn > Cd > Pb (*Liu L., 2018*).

Chemical immobilization

In-situ chemical immobilization, sometimes termed as in-situ solidification/stabilization (S/S), is to trap or immobilize pollutants in the contaminated soil by introducing chemical agents into the original medium to solidify the soil or convert the mobile pollutant fractions (i.e., soluble and exchangeable forms) into precipitates and/or strongly sorbed moiety. Chemical immobilization does not remove or extract contaminants from soil. Instead, the mobility/solubility of heavy metals and their concentrations in soil pore water are drastically decreased, minimizing their potential transport to plants, microorganisms, and water. Chemical stabilization serves an effective, affordable method for temporarily “fixing” heavy metals in less contaminated farmland soils (e.g., Igeo b 3). Since heavy metals are not removed, the chemical stabilization effect needs to be regularly monitored and evaluated. “Wellmixing” of stabilizing chemicals with contaminated soils is crucial to achieve satisfactory soil remediation effects. As well-mixing cannot be secured in large-scale field practices, the USEPA has not adopted this technique in superfund site cleaning (*Tajudin et al., 2016, Liu et al., 2018*).

Solidification

In ex-situ soil solidification, metal-contaminated soil is removed from site, transported to a treatment facility, screened to exclude coarse materials. The binding materials for contaminant encapsulation include molten bitumen, emulsified asphalt, modified sulfur cement (a thermoplastic material melting at 127–149 °C), polyethylene, pozzolan cement (fly ash, kiln dust, pumice, or blast furnace slag), and Portland cement. If soluble phosphate/lime is used, the material immobilizes the heavy metals in soil instead of solidifying the soil itself. Another option is to directly encapsulate contaminated soils in polyethylene or bitumen wraps to form solidwaste blocks that can be disposed of in a nonhazardous landfill *(FRTR, 2012, Liu. L, 2018*).

Soil washing

Soil washing is a mixed physical and chemical process to remove heavy metals from contaminated soil by washing the soil ex-situ with specially-formulated solutions. Soil washing relies onwashing solutions tomobilize heavymetals by altering soil acidity, solution ionic strength, redox potential, or complexation. An ideal washing solution should dramatically improve the solubility and mobility of heavy metal contaminants yet interact weakly with soil constituents and should be nontoxic and biodegradable. An array of chemicals have been tested to formulate effectivewashing solutions: hydrochloric acid, sulfuric acid, nitric acid, phosphoric acid, fluorosilicic acid, formic acid, acetic acid, oxalic acid, citric acid, tartaric acid, polyglutamic acid, ethylene-diamine-tetra-acetic acid (EDTA), diethylenetriaminepentaacetic acid (DTPA), diethylenetriaminepentaacetic acid (DTPA), ethylenediaminedisuccinic acid (EDDS), carbonate/bicarbonate, sodium hydroxide, calcium chloride, ferric chloride, ammonium chloride, ammonium acetate, dithionite, isopropyl alcohol, subcritical water, and etc (*Fedje et al., 2013, Zhu et al., 2015, Alghanmi et al., 2015, Bilgin and Tulun, 2016, Yang et al.,2017, Liu. L. 2018*).

CONCLUSIONS

An array of remediation techniques has been developed to reduce the hazardous effects and restore the ecosystem functions of the contaminated soils. These techniques involve physical, chemical, biological, electrical, and/or thermal processes to rectify soil contamination by containing (e.g., surface capping, encapsulation, and land filling), immobilizing (e.g., solidification, stabilization, and vitrification), and extracting (e.g., phytoextraction, electrokinetics, soil flushing, and soil washing) the heavy metal contaminants. The applicability of a soil remediation technique is project-specific, influenced by a number of factors including the site and contamination characteristics, remediation objectives, remediation efficiency, cost effectiveness, time, and public acceptability. Treatability studies help select best feasible remediation techniques and should be conducted prior to the full-scale remediation implementation.

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STUDY OF THE SOIL CONTAMINATION INFLUENCE ON FRONT VEGETABLES – REVIEW /
/
STUDIUL INFLUENŢEI CONTAMINĂRII SOLULUI ASUPRA LEGUMELOR FRUNZOASE – REVIEW

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ABSTRACT

Rapid growth in urbanization and industrialization has increased the levels of heavy metals in the environment and consequently in the food chain. Consumption of contaminated food by human beings may pose a serious threat to their health. Vegetables are a major portion of the human diet, providing micro- and macronutrients, fibers, antioxidants, vitamins, etc. Vegetables are often grown in suburban areas commonly contaminated with heavy metals. Depending on the nature of vegetables, some of them have a great potential to accumulate higher concentrations of heavy metals than others.

The present review describes the uptake and accumulation of heavy metals in vegetables and the negative impact of heavy metals on vegetables and human health through their consumption.

REZUMAT

Creșterea rapidă în urbanizare și industrializare a crescut nivelurile de metale grele în mediu și, prin urmare, în lanțul alimentar. Consumul de alimente contaminate de ființe umane poate reprezenta o amenințare gravă pentru sănătatea lor. Legumele reprezintă o parte importantă a dietei umane, oferind micro- și macronutrienți, fibre, antioxidanți, vitamine etc. Legumele sunt adesea cultivate în zonele suburbane frecvent contaminate cu metale grele. În funcție de natura legumelor, unele dintre ele au un mare potențial de a acumula concentrații mai mari de metale grele decât altele.

Prezenta revizuire descrie absorbția și acumularea de metale grele în legume, rolul lor în remedierea metalelor grele din zonele contaminate și impactul negativ al metalelor grele asupra legumelor și asupra sănătății umane prin consumul lor.

INTRODUCTION

Heavy metal elements, such as lead (Pb), cadmium (Cd), arsenic (As), etc., have toxic effects on human health. Toxic metals can accumulate persistently in the body over a lifetime. Pb can adversely influence the intelligence development of children, cause excessive lead in blood, and induce hypertension, nephropathy and cardiovascular disease. Chronic Cd exposure can cause acute toxicity to the liver and lungs, induce nephrotoxicity and osteotoxicity, and impair function of the immune system. The element As is a metalloid and is associated with angiosarcoma and skin cancer. Other metal elements such as copper (Cu) and zinc (Zn) are important nutrients for humans, but excessive ingestion can also have adverse effects on human health. For example, a Cu surplus can cause acute stomach and intestine aches, and liver damage, and Zn can reduce immune function and levels of high-density lipoproteins. Compared with inhalation of soil particles, drinking water, and dermal contact, food consumption has been identified as the major pathway for human exposure to toxic metals (*Alexander et. al., 2006; Mamatha et. al., 2014; Zhu et. al., 2011).*

Vegetables are common diet taken by populations throughout the world, being sources of essential nutrients, antioxidants and metabolites. They also act as buffering agents for acid substance obtained during the digestion process. However, both essential and toxic elements are present in vegetables over a wide range of concentrations as they are said to be good absorber of metals from the soil. Reports have shown that, vegetables grown in heavy metal rich soils are also contaminated (*Lokeshwari and Chandrappa, 2006*).

Vegetables absorb these metals from contaminated soils as well as from polluted environmental deposits through the roots and incorporate them into the edible part of plant tissues or deposit on the surface of vegetables. Some heavy metals such as Cr, Mn, Ni, Zn, Cu, and Fe are considered essential components for biological activities in the body; however, their presence in elevated levels is reported to cause problem to human (*Bagdatlioglu et. al., 2010*).

Green leafy vegetables are an important ingredient of human diet that contains essential nutrients like vitamins, minerals, dietary fiber and antioxidants. Leaves from different plant species such as perennial and annuals are consumed especially in rural areas and there has been observed an increased trend of the consumption among the urban community. Green leafy vegetables are an economic source to ensure the micronutrient intake. Rapid industrialization and the use of natural resources have increased the accumulation of toxic substances like heavy metals in the soil. Heavy metal contamination is a major environmental problem because they are harmful to humans. Plants accumulate these toxic substances in their edible parts (*Amariei et al., 2014; Zhou et al., 2016*).

Zn, Cu, and Fe are essential for various biological activities within human body, but elevated concentrations can have bad consequences on people. Pb and Cd are non-essential and toxic elements associated with many chronic diseases (*Amariei et al., 2014; Prisacaru et. al., 2017; Roba et. al., 2016*).

MATERIAL AND METHOD

Swapna et. al. (2014) studied the level of trace heavy metal contaminants in leafy vegetables viz., Palak (Beta vulgaris), Thotakura (Amaranthus) and Chukkakura (Rumex sp.), soil, and water were collected from three different vegetable farms of Hyderabad (Nagole, Uppal and Edulabad). Leafy vegetables were collected randomly and washed thoroughly under tap water followed by distilled water to remove adsorbed elements. Samples were cut into small pieces; air dried for 2 days and kept in hot air oven at 100°C±1°C for 4 hrs. Dried samples were grounded to powder and then pass through a 1 mm sift. 0.5 g of samples was taken in reference vessels; added 4 mL of HNO_3 and 0.2 mL of H_2O_2 and carousel was positioned into microwave.

The system was pre programmed for 1 min. of microwave digestion at 250W power and another 5 min. at 500 W power and left to automatic ventilation for 10 min. Digested solution was cooled, filtered using Whatman filter paper No. 40 and made up to 100 mL with distilled water and stored in plastic bottles for analysis. Control leafy vegetables were obtained from areas where normal irrigation practices were followed with treated water. Random soil sample of about ½ kg were collected at a depth of 0 - 25 cm from 4 different places and stored in polythene covers. Samples were air dried at room temperature, ground to a fine powder using mortar and pestle and packed in1mm nylon mesh. 0.25 g of soil samples were poured into reference vessels. Then 2.5 ml concentrated HNO3 and 2.5 mL of HF (Hydrofluoric acid) acid was added and inserted into a carousel into microwave unit for digestion. System was preprogrammed for 6 min. of microwave digestion at 300W powers and another 5 min. at 500 W power and automatic ventilation for 10 min. Further solution was cooled, filtered using Whatman filter paper 40 and made up to 100 mL with distilled water then it was stored in pre-cleaned plastic bottles and used for analysis. Control samples were obtained from station where normal practices were followed (*Swapna et. al., 2014)*.

The leaf samples were analyzed for the heavy metals namely Cu, Zn, Pb, Fe, Cd and Mn using Atomic Absorption Spectrophotometer (AAS) (*Swapna et. al., 2014)*.

Prisacaru et. al., (2017) used Green leafy vegetables purchased from two markets sites from Suceava city. The vegetables were spinach (Spinacia oleracea), ramsons (Allium ursinum), lettuce (Lactuca sativa), orache (Atriplex hortensis) and nettle (Urtica dioica), collected in clean polyethylene bags and brought to the laboratory for the analysis. Green leafy vegetables samples were washed with distilled water to remove soil and dirt.

For the determination of heavy metal concentration 3 grams of green leafy vegetables were mineralized in an electric furnace at a temperature of 600°C, for 6 hours. The resulted ash was transferred into a 25 mL volumetric flask, where it was dissolved by adding a mixture of nitric acid 65% and deionized water. All solutions were prepared with reagent grade chemicals and ultra-pure water (18 MΩ cm). Nitric acid was purchased from Sigma Aldrich. The determination of five heavy metals was performed in a mass spectrometer with inductively coupled plasma (ICP-MS) Agilent Technologies 7500 Series (Agilent, USA) (*Prisacaru et. al., 2017)*.

Also, *Raj Shakya and Malla Khwaounjoo (2013)* have used the atomic absorption spectrometer to determine the concentrations of these metals in a total of 45 test vegetables.

In paper of *Gupta et al., (2013),* the atomic absorption spectrophotometry was used to estimate the levels of these metals in vegetables including *Pimpinella anisum, Spinacia oleracea, Amaranthus viridis,* *Coriandrum sativum,* and *Trigonella foenum graecum.* Also, it was calculated the intake of heavy metals in the human diet to estimate the risk to human health, concluding that the vegetables grown in this region are a health hazard for human consumption.

RESULTS

Swapna Priya et. al (2014) showed that highest level (mg/ kg) of Zn (59.76) was observed in Amaranthus and lowest in Chukkakura. Further highest level of Cu (58.36), Fe (597.86), Cr (53.11) and Pb (34.56) was reported in Chukkakura, while it was lowest in Amaranthus.

In paper of *Prisacaru et al., (2017)* samples were analysed in triplicates. From the data presented wes observe that lettuce has recorded the highest moisture and ash content (94.44%, respectively 2.82%). The lowest level of moisture and ash content was obtained in the case of nettle (86.81%, respectively 2.44%).

Raj Shakya and Malla Khwaounjoo (2013) revealed variable metal levels in different types and parts of the vegetable samples under investigation. The levels of Pb in all commodities were ranged between 2.7 and 12.5 mg kg^{-1} in roots of spinach and garden crees while the metal ranged between 5.3 and 32.9 mg kg^{-1} in leafy shoots of spinach and mustard respectively. Cd contents varied from 0.9 mg kg^{-1} in roots of spinach to 12.0 mg kg^{-1} in roots of mustard and from 3.2 to 19.1 mg kg^{-1} in leafy shoots of fennel respectively. Similarly, Zn levels were ranged from 16.8 to 158.7 mg kg^{-1} in roots and from 23.9 to 223.1 mg kg^{-1} in leafy shoots of garden crees and mustard respectively. Among the vegetables, the highest mean levels of Cd (8.9 mg kg^{-1}), Pb (19.2 mg kg^{-1}) and Zn (107.6 mg kg^{-1}) were detected in leafy shoots of mustard and so with the roots (5.6 mg kg^{-1} for Cd and 71.7 mg kg^{-1} for Zn) except for garden crees roots (9.5 mg kg^{-1} for Pb). The contents of As and Cr, however were found below the detection limits in all the test vegetables (Table 1).

Table 1

Details of heavy metals (mg kg-1) recorded in the leafy vegetables collected from different locations

Study area	Vegetables	Heavy metals								Source
		Zn	Cu	Fe	Mn	Cd	Cr	Pb	Ni	
Musi River, Hyderabad, India	Thotakura (Amaranthus)	59.76	37.41	338	7.96	2	24.95	23.26	-	[12]
	Chukkakura (Rumex sp.)	44.59	58.36	597.86	11.36	1.94	53.11	34.56	-	
Suceava, Romania	Nettle (Urtica dioica)	37.67	35.50	228.3	-	2.083	-	30	-	[9]
	Orache (Atriplex hortensis)	26.67	73.67	143.3	-	1.55	-	22.7	-	
	Lettuce (Lactuca sativa)	40.33	30	240	-	2.05	-	31.8	-	
	Ramsons (Allium ursinum)	34.17	27.33	593.33	-	1.65	-	30.2	-	
	Spinach (Spinacia oleracea)	42.33	75	215	-	2.117	-	30.2	-	
Kathmandu, Nepal	Mustard (Brassica campestris)	107.6	-	-	-	8.9	-	19.2	-	[10]
	Garden crees (Lepidium sativum)	31.6	-	-	-	6.6	-	11.1	-	
	Fennel (Foeniculum vulgare)	72.1	-	-	-	8.3	-	10.2	-	
	Coriander (Coriandrum sativum)	101.2	-	-	-	7.7	-	9.5	-	
	Spinach (Spinacea oleracea)	85.8	-	-	-	7.4	-	11.5	-	
Manisa,	Parsley	75.7	18.3	940.2	-	-	-	4.4	-	[3]

Study area	Vegetables	Heavy metals								Source
		Zn	Cu	Fe	Mn	Cd	Cr	Pb	Ni	
Turkey	(Petroselinum sativum)									
	Nettle (Folium urtiace)	65.3	27.4	957.5	-	-	-	24.9	-	
	Peppermint (Menthae pipiritae)	54	11	822.5	-	-	-	19.2	-	
	Spinach (Spinaciae oleracea)	83.4	13	558.4	-	-	-	13.9	-	
	Dill (Anethum graveolens)	36.5	8.7	449.8	-	-	-	15.9	-	
Raipur, India	Amaranth (Amaranthus viridis)	35.01	33.46	-	12.3	-	11	25.6	44	[5]
	Coriander (Coriandrum sativum)	42.97	47.96	-	7.5	-	20.7	24.9	49	
	Trigonella foenum graecum,	51.54	29.57	-	7.8	-	10.9	15.5	40	
	Spinach (Spinacia oleracea)	53.44	16.31	-	10.8	-	31	27.8	32	
	Pimpinella anisum	45.01	28.46	-	9.6	-	21	18.4	34	
Pulivendula – Kadapa, India	Mint (Mentha spicata)	12.027	-	-	-	1.788	1.965	0.942	1.69	[7]
	Spinach (Spinacia oleracea)	14.542	-	-	-	4.941	1.82	1.116	1.374	
Baia Mare, Romania	Lettuce (Lactuca sativa)	Rural : 6.3-55.2 Urban: 6.1-10.9	Rural : 0.8-4.5 Urban: 1.7-2.6	-	-	Rural : 0.08-0.66 Urban: 0.08-0.26		Rural : 0.7-15.6 Urban: 0.7-2.4	-	[11]
	Dill (Anethum graveolens)	Rural : 9.2-10 Urban: 9.2-10	Rural : 1.2-1.5 Urban: 1.9-2	-	-	Rural : 0.02-0.05 Urban: 0.06-0.10		Rural : 0.6-0.7 Urban: 1.6-2.2	-	
	Tarragon (Artemisia dracunculus)	Rural : 11-12.6 Urban: 9.6-13	Rural : 2-2.4 Urban: 2.2-2.6	-	-	Rural : 0.1-0.36 Urban: 0.1-0.31		Rural : 0.8-11 Urban: 0.9-1.2	-	
	Cabbage (Brassica oleracea)	Rural : 4.2-5.7 Urban: 4.2-5.2	Rural : 0.8-0.1 Urban: 0.8-1.1	-	-	Rural : 0.02-0.06 Urban: 0.02-0.05		Rural : 0.6-1 Urban: 0.6-0.9	-	
Istanbul, Turkey	Parsley (Petroselinum crispum)	0.91	0.51	-	-	0.90	0.94	0.91	0.95	[8]

Study area	Vegetables	Heavy metals								Source
		Zn	Cu	Fe	Mn	Cd	Cr	Pb	Ni	
	Cabbage (Brassica oleraceae)	0.97	0.97	-	-	0.95	0.93		0.97	

CONCLUSIONS

From the present studies, it is concluded that a monitoring plan and a health risk assessment are necessary to evaluate the levels of metal concentration in vegetables in order to develop the proper measures for reducing excessive build-up of these metals in the food chain.

From the present studys it can be concluded that heavy metals concentrations in all the vegetables were above the permissible limits set by FAO/WHO for human consumption, the remaining metal levels accumulated in leafy are still not safe for consumption.

Heavy metal intake through the consumption of vegetables may possibly cause numerous health hazards in people.

Heavy metals are one of the major globally distributed toxic pollutants and their removal from contaminated areas are urgently required to reduce their impacts on various food chains and to maintain the concentrations of heavy metals within safe limits.

All vegetables are often grown in suburban areas experiencing high concentrations of heavy metals both through aerial deposition and contamination through soil and irrigation water.

Leafy vegetables are good accumulators of toxic heavy metals due to their higher capacity of absorption both from contaminated soil and aerial deposits. The advantage of high biomass production and easy disposal also makes vegetables useful to remediate heavy metals from a contaminated environment, but the excessive intake and consequent accumulation in human beings through long-term consumption of contaminated food may result in negative effects on human health. They have more potential to accumulate heavy metals from a contaminated environment.

Research has shown that parsley and lettuce proved to be high heavy metals accumulators, fact that indicates that the cultivation and consumption of these vegetables should be highly restricted in the investigated areas.

The results obtained in this study would go a long way in fortifying the scanty baseline data for the assessment of the distribution of heavy metals in leafy vegetables.

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STUDY OF THE SOIL CONTAMINATION INFLUENCE ON ROOTS VEGETABLES (CARROT, CELERY, ONION)
/
STUDIUL INFLUENȚEI CONTAMINĂRII SOLULUI ASUPRA LEGUMELOR RĂDĂCINOASE (MORCOV, ȚELINĂ, CEAPĂ)

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ABSTRACT

The research carried out in the present paper follows the changes in the plants, especially the vegetables, due to the contamination of the soil by exceeding the nitrate, nitrite and ammonium concentrations in the soil, as well as the consequences resulting from this contamination on the agricultural products, that at present the consumption of contaminated agricultural products represents a serious threat to the health of consumers.

REZUMAT

Cercetările realizate în cadrul prezentei lucrări urmăresc modificările la nivelul plantelor, în special al legumelor, ca urmare a contaminării solului prin depășirea concentrațiilor de nitrati, nitriți și amoniu din sol, dar și consecințele rezultate în urma acestei contaminări asupra produselor agricole, având în vedere faptul că în prezent consumul de produse agricole contaminate reprezintă o gravă amenințare la adresa sănătății consumatorilor.

INTRODUCTION

According to the law of minimum and the equal importance of all vegetation factors, plants cannot grow if one of the factors is missing, and the level of biomass production is determined by the lowest element in meeting the physiological requirement given by one of the factors, but also by the way the other factors are in optimal proportions, or they also have deficiencies in fully satisfying the requirements. The development of agricultural plants depends on the whole set of ecological factors, which can provide minimum or maximum production conditions.

The percentage of nutrients in the soil affects both plant quality and crop yield. In permanently cultivated agricultural lands, the soil will be very poor in nutrients, and therefore, inefficient. Hence, farmers fertilize the soil, fight pests, use irrigation systems, and continually improve the entire farming process to make the soil more efficient, increasing crop yield. Of these activities, fertilization remains a priority at all times. However, recent studies show that due to excessive use of fertilizers, additional land is needed to be cultivated so as not to affect public health and the quality of the environment due to the reported excesses.

To reduce and eliminate the adverse effects of synthetic fertilizers on human health and the environment, a new agricultural practice called organic farming, sustainable agriculture or ecology has now been developed.

Organic fertilizers are primarily cost-effective, locally easily available, and preferable compared to chemical fertilizers *(Solomon et al., 2012)*. The organic substance is the basis of soil fertility *(Aboudrare, 2009*). The main advantages of organic fertilizers are that they are particularly ecological, cost-effective, and they have a significant role in plant nutrition *(Mahajan et al., 2008).* Inorganic fertilizers are known for their high costs and their negative effects on the environment, if they are poorly managed *(Morris et al., 2007).*

At the same time, excessive fertilization has led to increased soil salinity, accumulation of heavy metal, water eutrophication and accumulation of nitrates, so it has to be taken into account the occurrence of air pollution with gases containing nitrogen and sulphur, resulting in problems such as the greenhouse effect *(Savci S., 2012*)

Also, a higher than normal concentration of some soil substances, such as nitrates, nitrites, ammonium, pesticides and heavy metals, can lead to irreversible contamination of agricultural products.

Sources of soil contamination with these undesirable substances are multiple. In the case of heavy metals, they can already exist in the earth's crust, but can also be introduced into the soil due to human activities. Soils rich in heavy metals are found especially in areas with heavy traffic, metallurgy and steel industry, improperly closed mines, the use of pesticides containing heavy metals, etc. Using inadequate (over the limit) amounts of manure, nitrogen-containing pesticides, etc., leads to soil contamination with nitrites, nitrates and ammonium.

The presence of high concentrations of nitrates, nitrites or ammonium in plant products has a number of adverse effects on the human and animal body, namely: irritant and congestive effect on the digestive lining, irritant action on the kidney, harmful action on the endocrine glands, hepatotoxic action, and neurotoxic action. The most important consequence of the high intake of nitrates is the formation of carcinogenic substances, namely the formation of nitrozamines which are highly carcinogenic. Most of the vegetable plants have very high demands on mineral elements.

The high density of plants per hectare and the very high biological production recorded in vegetable crops requires optimal supply of the soil with mineral elements. Consumption of mineral elements in vegetable plants is higher than that of other crops, mainly due to higher production volume per unit area. Generally, it is appreciated that most crops consume 2-3 times more substances than grain crops *(Indrea D.,1992).*

The group of vegetables for tuberous root includes: carrot, root parsley, parsnip, root celery of the Umbelliferae family, radish of the Cruciferae family and red beetles of the Chenopodiaceae family.

Root vegetables are biennial plants, except for moonshine radish and some varieties of summer radish, which are annual *(Butnariu H. et al., 1993)*. These are plants that are relatively resistant to low, demanding temperatures, especially in the early stages of growth, relative to soil moisture and light.

Generally, cropping technology of root plants is simple, because, except for celery, they are all grown by direct sowing in the field *(Lagunovschi V., 2013).*

Because the seeds germinate over a long period of time, it is necessary for the soil to be very well prepared and wet. In most species (except radishes), the growth of plants after emergence is very slow, with the danger of crops invading by weeds. For the formation of some quality bold roots, the soil must be light, loose, and well fertilized with chemical fertilizers. With the exception of celery and red beet, in the year of cultivation it is not recommended to apply organic fertilizers, because the roots get the tendency of branching and their storage life reduces.

MATERIAL AND METHOD

Food contamination is a threat to consumers. Accumulation of contaminants in the human body causes a number of more or less serious diseases, depending on the nature of the contaminant and their concentration in the body.

Since the plants often extract contaminants from the soil, continuous monitoring of their constituents must be applied. Thus it is possible to determine the contamination of the vegetal products and the remediation of contaminated soil.

Nitrites and nitrates are natural components of the soil, derived from the mineralization of the nitrate substance of plant or animal origin due primarily to the microorganisms present in the soil.

Vegetables are foods with a special nutritional value due to the permanent source of vitamins, microelements and other nutrients. The disadvantage of consuming these products is that at some point, in their composition appear some compounds that are toxic to the human body: nitrates and nitrites.

RESULTS

In agricultural productivity, soil structure is very important and is considered an indicator. Excessive fertilization, as well as industrial emissions, are factors that cause damage to soil structure. Fertilizers contain especially $NaNO_3$, NH_4NO_3, KCl, K_2SO_4, NH_4Cl, compounds that lead to the degradation of soil and its structure, so it is difficult to obtain a high quality and competitive product on these damaged soils *(Savci S., 2012).*

Nitrates, nitrites and ammonium are dangerous contaminants that, due to the transformations they suffer in the human body, they are able to inhibit hemoglobin, thus preventing oxygenation of the blood. In the case of these pollutants, special care must be taken with the antropic sources of infiltration into the soil of nitrogen. The main sources of nitrates, nitrates and ammonium are manure, noxes from traffic, nitrogen-based fertilizers and pesticides, industrial activities, etc. Although manure is beneficial to soil and plants, care must be taken to the applied amount, because in too large amounts the manure causes burning of plant roots and contamination of soil and groundwater, which are sources of water supply for wells (water used by humans).

Sources of nitrates

One of the nutrients essential to the functioning of the aquatic environment is nitrogen.

Nitrogen may be found in gaseous form (atmospheric N_2, NO_2), dissolved form (NO_2, NO_3, NH_4) or as "solid" form in organic matter.

Nitrate pollution comes mainly from agriculture. Nitrogen is the essential element for life and in water it suffers many chemical and biochemical processes. It occurs mainly as nitrate, nitrate, ammonia, nitrogen gas and is fixed in organic compounds, groups between which there are continuous transformations / transitions, forming the "*nitrogen cycle*". Excess of nitrogen leads to eutrophication, contamination of aquifers, possible damage to human health: methaemoglobinemia in children, gastric cancer.

Sources of nitrates are natural and anthropic. Natural sources are:

- from precipitations: nitrogen oxides from atmosphere, lightning products and fossil fuel combustion;
- the intake through washing from rocks and the ash of burned vegetation;
- from the springs after their deep dissolution in the rocks (nitrate having a high solubility in water);
- from the erosion of soils containing nitrogen. These "natural" sources are often indirectly anthropic.

The "direct" anthropogenic sources are the point ones (wastewater spills containing nitrogenous) and diffuse, mainly nitrogen from agriculture, chemical fertilizers and natural fertilizers - manure applied on fields or from latrines.

Dejections (manure) actually contain urea and ammonium, which are transformed into nitrate by microorganisms through nitrification. For livestock breeding, we can calculate the approximate equivalence of manure production as 1.5 adult cattle = 7 pigs = 100 laying hens.

Ammonia, along with any ammonia fertilizer, when applied is transformed by soil bacteria into nitrates through the process of nitrification. Nitrification is important because plants can only use nitrogen in the form of nitrate. Nitrates are just as harmful to animals and humans.

Frequently, excess of nitrate is found on the field and plants can not absorb it, either because the whole amount is too large, or because it was applied at the wrong time, outside the vegetation period. This happens often by spreading the manure in the field in autumn or winter (many countries prohibit manuring from October 15 to February 15). Thus, excess nitrates get into the soil and into the waters, polluting them.

Root vegetables and green leafy vegetables such as spinach, lettuce and rucola, have the highest level of nitrates. This level depends on several factors, including the amount of fertilizer used or the sunlight (those growing in Northern Europe tend to have the highest level of nitrate).

"For example, the root plants and leaves contain a large amount of nitrates, and these products are usually not labeled. And if the label of water does not specify yhe nitrate and nitrate content, we can not calculate the total amount of toxic substances that we introduce it into the body, "explained the nutritionist Professor. PhD. Gheorghe Mencinicopschi.

Legislation on limiting contamination with nitrates in plant products

Nitrates accumulate non-uniformily in plants, and their amount is changing: in leaves, their percentage is lower, while in the stem is higher. The maximum amount of nitrates accumulates in those parts of plants that are closer to the root. The leaves of dill, parsley, carrot and celery contain 50-60% less nitrates than the stems of these plants, and the red green leaves 70% less than the spine.

Table 1 lists the maximum permitted contents of in the main vegetables and fruits.

Table 1

Maximum permitted contents of nitrate in vegetables and fruits, in Romania

Product	Content of nitrate (mg/kg)
Spinach	2000
Tomatoes	150
Lettuce	2000
Pepper	150
Beet	2000
Potatoes	300
Cucumbers	200
Dry onions	80
Cauliflower	800
Pumpkins	500
Carrot	400
Cabbage	900
Eggplants	300
Apples	60
Pears	60

Next there are analyzed the main elements that are administered to vegetables by fertilization, and the consequences of the excess and the insufficiency of each element on the plants:

Nitrogen is of particular importance for the growth and development of vegetable plants because it participates in the formation of complex substances (enzymes, hormones, amino acids, etc.). When it is found in *excess*:

- stimulates growth (spinach, lettuce, cabbage);
- has an unfavorable action on fructification and fruit quality;
- causes excessive growth at the expense of fructification (for greenhouse cultures, especially for tomatoes);
- leads to the prolongation of the vegetation period;
- leads to delayed fructification and fruit maturation;
- increases the sensitivity of plants to diseases and pests.

When nitrogen is in excess, the plants are dark green, have a buoyant growth, fructification is poor and ripening is delayed.

When nitrogen is *insufficient*:

- plants have poor growth;
- number of flowers is reduced;
- fruits are of small size and poor quality;
- narrowing of follicular limb occurs.

Recognition:

- plants have dark green leaves with reddish ribs;
- follicle is small;
- stem is green and thin.

Nitrogen deficiency in **onion** plants: the leaves are small, thin and yellow-green, rigid position, old leaves fade and die.

Special attention should be paid to all root vegetables in terms of nitrogen fertilization, as they tend to accumulate nitrates, such as the cases of **carrot** and **celery** *(Davidescu and Davidescu, 1992).*

Table 2 shows the nitrate content of the main vegetables:

Table 2

Nitrate content in vegetables (mg. NO_3/kg fresh substance) *(Krug et al., 1986)*

Specification	Species	Value	
		minimum	maximum
Leaf vegetables	Spinach	345	3850
	Lettuce	380	3520
Root vegetables	Beet	150	5690
	Radishes	260	1200
	Carrot	30	800
Vegetables fruits	Beans	80	800
	Green peas	10	120
	Cucumbers	20	300
	Tomatoes	10	100

Phosphorus acts as a regulator of breathing and energy transporter, contributing to the absorption of mineral elements. It has a special role in the period of flower formation and fructification of plants, especially in the species from which the fruits are consumed: tomatoes, peppers, eggplants.

When used in appropriate amounts, phosphorus has the following effects:

- it increases plant precocity;
- it has a positive influence on the quality of vegetables;
- together with K, Ca, Mg, determines plant resistance to drought and frost.

Phosphorus in *insufficient* quantity determines:

- poor development of the root system;
- poor plant growth;
- influences negatively the fructification;
- delays the beginning of ripping;

- has a negative effect on the quality of production, especially of fruits;
- decreases the resistance of plants to diseases and pests.

Recognition of insufficient quantity is made after the following symptoms *(Davidescu and Davidescu, 1992)*:

- the leaves are dark green, then they become bluish, and later they get purple violet shades.

Phosphorus deficiency has different manifestations depending on the species *(Davidescu and Davidescu, 1992)*:

- for onion plants: the old leaves wither and die.
- for celery: dark green colored leaves; roots poorly developed, the plants get a rosette appearance.

Potassium is indispensable to the life of plants, accumulating especially in tissues with intense metabolism and rapid growth. Potassium in *sufficient* amounts:

- contributes to water saving;
- increases resistance to frost and drought;
- stimulates the germination of seeds;
- influences positively the quality of fruits;
- influences the synthesis of nitrogen;
- in the presence of phosphorus accelerates the ripping of fruits;

Potassium in *insufficient* amounts determines:

- weakening of drought and frost resistance;
- disorder of physiological processes.

Recognition of potassium deficiency: colored spots appear on the leaves, and they are at first small, between the ribs, more pronounced to the edge of the leaves. The leaves finally have a yellow-brown coloration, doubled by a massive mortification. Plants become withered.

Lefebre (1987) showed that potassium necessity varies with the intensity of light and the length of the day. K is absorbed at a higher amount at night or under low light conditions. On **onions** and **celery** a deficiency of K causes the diminishing of accumulated reserves and disorganization of supporting tissues:

- **Onion:** the old leaves turn yellow, then the leaves wrinkle, the bulb remains small.
- **Celery:** dark green leaves, then necrotic spots appear; the root remains small, sometimes empty inside *(Davidescu and Davidescu, 1992)*

Calcium has a multiple physiological role, being antagonistic to K, Na and Mg. For optimal absorption, there must be a certain Ca-K and Ca-Mg ratio. It has a special role in the formation of chromoplasts, the synthesis and the regeneration of the protides, the reduction of permeability of the cell membranes, the pH adjustment etc.

In excess, calcium causes an excessive base soil reaction, unfavorable to vegetable plants, causing disturbances in plants supply with other mineral elements. It determines the appearance of characteristic chlorosis (the leaves become yellow because plants can not absorb Fe and Mg).

Calcium in *insufficient* quantity:

- determines the excessive acid reaction of the soil which is unfavorable for many vegetable species;
- leads to changing of Ca / Mg ratio and stops plant growth.

Recognition of Ca deficiency is made after the following symptoms:

- young leaves are twisted, rigid;
- the limb fades to greenish yellow to greenish white, then it becomes brown (in cabbage) or with brown spots (in beet, **carrot, celery**, beans): the stem is small, rigid *(Davidescu and Davidescu, 1992).*

Magnesium is part of the constitution of the chlorophyll molecule, some enzymes, and its lack can slow the process of photosynthesis. It is found in larger quantities in young organs of plants. The presence of Mg in normal amounts is particularly important for protected crops.

When *in excess*, magnesium is a toxic element causing plant death, and the effect is annihilated by the presence of calcium. Optimum Ca/Mg ratio = 3 for vegetables.

Magnesium in *insufficient* amount*:*

- causes disruption of biochemical processes catalyzed by enzymes with Mg and the appearance of specific chlorosis;
- mature leaves get characteristic shades:
  - at first yellow, then with burns in potato;
  - at first purple then orange-reddish - to creamy cabbage, cauliflower;
- the ribs of leaf remain green and the rim bends upwards.

- **Onion**: the leaves bend, break and die; the growth is slowed.
- **Celery**: the leaves become chlorotic; the leaves die *(Davidescu and Davidescu, 1992).*

CONCLUSIONS

Pesticides and nitrates can reach in agro-food products either as a result of their use during plant growing, or as a result of water and soil pollution. Thus, rational use of pesticides and nitrates is a burdensome necessity in providing the population with safe food, with a residual pesticide content that does not exceed the maximum admissible limits. The latter is an indisputable condition because, according to the literature, chronic exposure to low concentrations of pesticides at first sight results in neurological, reproductive and developmental effects, especially in growing organisms.

Sources of soil contamination with these undesirable substances are multiple. Heavy metals can already exist in the earth's crust, but they can also be introduced into the soil due to human activities. Soils rich in heavy metals are found especially in areas with heavy traffic, metallurgy and steel industry, improperly closed mines, the use of pesticides containing heavy metals, etc. Using inadequate (over the limit) amounts of manure, nitrogen-containing pesticides, etc. leads to contamination of soils with nitrites, nitrates and ammonium.

The presence of pesticide residues and other chemicals in food of vegetal origin is a public health problem at global and local level, and one of the main trade barriers.

Although there is legislation setting the maximum allowable limits (MALs) for pollutants, there are still recorded exceedances of those. The main cause of these overrun is the abusive application of fertilizers and pesticides in order to market the largest and most beautiful products without too much effort (eg. agro-technical measures: crop rotation, soil digging against herbs) and without takes into account the amount to be applied / ha, the number of treatments per year, the existing residues from previous application.

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STUDY ON THE INFLUENCE OF SOIL CONTAMINATION ON VEGETABLES
/
STUDIUL INFLUENȚEI CONTAMINĂRII SOLULUI ASUPRA LEGUMELOR

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ABSTRACT

Vegetable crops are some of the most extensive crops in the field of agriculture. Giving the fact that vegetables are consumed both in raw and processed state, the accumulation of metals, pesticides, fertilizers etc. represents a real problem for humans. Soil contamination affects vegetables grown on these soils, ultimately affecting consumers. The paper presents a series of manners in which that soil contamination influences vegetables and ultimately human health.

REZUMAT

Culturile de legume sunt unele dintre cele mai extinse culturi din domeniul agriculturii. Având în vedere faptul că legumele sunt consumate atât în stare brută, cât și în stare prelucrată, acumularea de metale, pesticide, îngrășăminte etc. reprezintă o problemă reală pentru oameni. Contaminarea solului afectează legumele cultivate pe aceste soluri, afectând în cele din urmă consumatorii. Lucrarea prezintă o serie de moduri în care contaminarea solului influențează legumele și, în cele din urmă, sănătatea umană.

INTRODUCTION

Agricultural soil is a vital resource for both humans and animals and performs a key function in food and biomass production. Soil is a "primary sink" for environmental pollutants and is increasingly subjected to different pressures. Agricultural soil is at risk of contamination mainly caused by anthropogenic activities, such as incomplete combustion of wood, chemical manufacturing, oil spills, coal tars, vehicle emissions, power generation, and petroleum refining (*Gan et al., 2009*). Moreover, extensive application of wastewater irrigation, sewage sludge, organic substances and biowaste used as fertilizers appear to be important reasons for the accumulation of PAHs in the agricultural soil (*Khan et al., 2008; Waqas et al., 2014; Chai C. et al., 2017*).

Although vegetables comprise a much smaller proportion of the diet than cereals and potatoes *(Sherlock and Walters, 1983),* vegetables can make a significant contribution to the contaminants intake of humans. Gardens and vegetable crops may be exposed to a higher degree of environmental contamination than most agricultural land. The contamination sources of agricultural and horticultural soils are usually phosphatic fertilizers, atmospheric deposition from industrial sources and sewage sludge *(Hutton and Symon, 1987)*. These lands may also be contaminated by atmospheric deposition from roads and nearby industrial sources, ash from burnt waste and pollution of the site prior to its use for the crops.

The contamination of soil and vegetables with trace elements is one of the most severe ecological problems in developing industrialized countries. Trace elements are released into the environment from natural and anthropogenic activities and accumulated in soil and vegetables through various pathways which ultimately affects the human health *(Kuors et al, 2002).*

Heavy metals are extremely persistent in the environment; they are nonbiodegradable and non thermo-degradable and thus readily accumulate to toxic levels. Heavy metals can accumulate in the soil at toxic levels due to the long-term application of wastewater (*Bohn et al., 1985*). One important dietary uptake pathway could be through crops irrigated with contaminated wastewater. Soils irrigated by wastewater accumulate heavy metals such as Cd, Zn, Cr, Ni, Pb, and Mn in surface soil.

In vegetable food, due to contamination or pollution processes, considerable amounts of heavy metals and pesticides can accumulate, which can reach many paths in vegetables and fruits: raw material, auxiliaries, water used in the processing, corrosion of machinery and containers (*Ghayoraneh, M., Qishlaqi, A., 2017*).

The permanent or occasional use of chemical substances in agriculture can directly or indirectly contaminate products (vegetables). The varied range of toxic agents that reach food products have irritant action on the digestive system, on the liver, heart, etc. Heavy metals can also come from fertilizers and pesticides (fungicides containing mercury, copper, arsenic, zinc). The excess, or in some cases even the presence of heavy metals can cause acute imbalances in the human metabolism. The accumulation of heavy metals in the human body manifest in decreased immunity and through various diseases. Also, the environmental exposure to heavy metals is a well-known risk factor for cancer. The amount of heavy metals in food products is regulated both by national and European norms.

MATERIAL AND METHOD

Heavy metals are hazardous contaminants in food and the environment and they are non-biodegradable having long biological half-lives. The implications associated with metal (embracing metalloids) contamination are of great concern, particularly in agricultural production systems (*Kachenko A.G., Singh B., 2006*) due to their increasing trends in human foods and environment (Fig. 1).

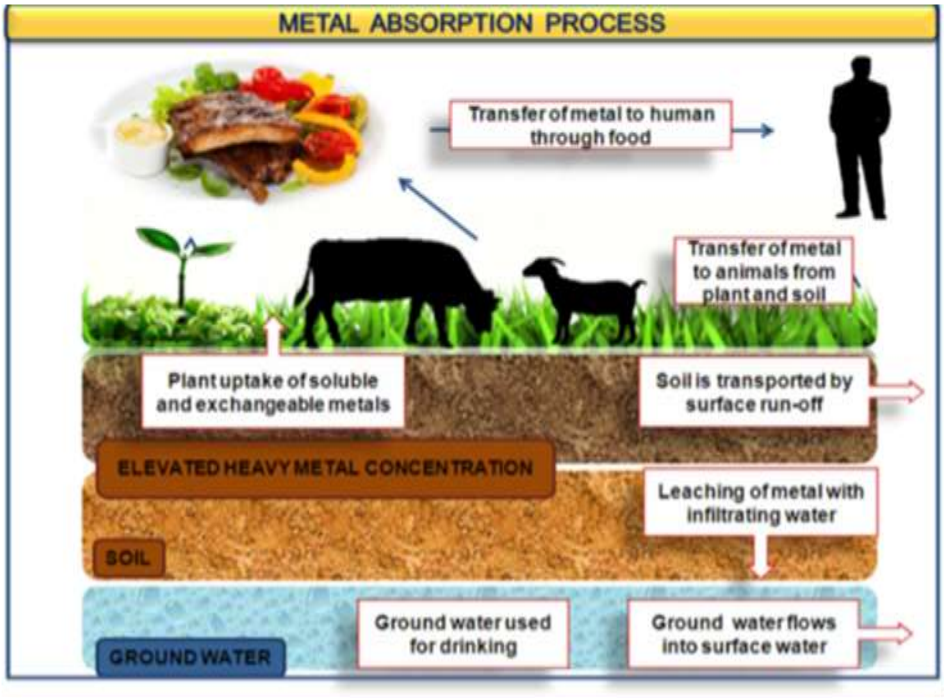

Fig. 1 – Metal absorption process from the environment to the human body through food
(*Singh A., Prasad S. M., 2015)*

Metals most often found as contaminants in vegetables include Zn, Cu, As, Cd, Pb etc. These metals can pose as a significant health risk to humans, particularly in elevated concentrations above the very low body requirements. Metals must be controlled in food sources in order to assure public health safety. Excessive amounts of heavy metals in food cause a number of diseases, especially cardiovascular, renal, neurological, and bone diseases.

It is possible for these metals to reach food chains through various biochemical process and ultimately biomagnified in various trophic levels and eventually threaten the health of human. The contamination of soils and vegetables by heavy metals is also a global environmental issue.

Young children are highly susceptible to metal exposure via hand-to mouth routes it is a known fact that many communities rely on home gardens for dietary vegetable consumption, soil metal contamination is a concern for residents in close proximity to various emission sources.

RESULTS

The effect of contaminant contents in embedded soils is also unclear, indicating that the rate of uptake by root widely vary by soil physicochemical properties and types of plant species (*Alegría et al., 1991; McBride et al., 2014*). The lack of relationship between soil and vegetable contaminant contents further indicates there is also another an important manner of taking contaminants – the stomatal manner, transporting contaminants from sources to vegetable tissues (*Clark et al., 2008*).

Plant uptake of pollutants may occur through various to edible organs. Uptakes include root uptake and atmospheric deposition from gaseous or particulate forms (Fig. 2).

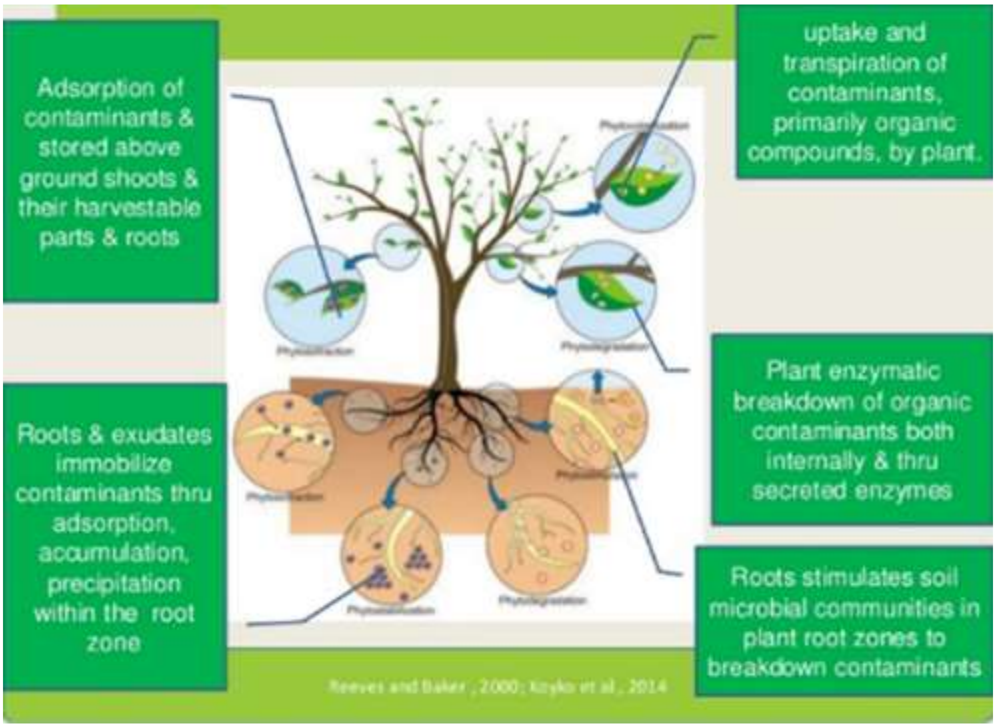

Fig. 2 – Plant uptake from contaminated soils (*Chikukura L., 2015)*

Although some elements (Mn, Zn) are biologically essential for the human body, they can also be harmful. Chronic human exposures to such elements may result in toxicity when concentrations exceed the nutritional homeostatic requirement. Other elements, such as Cd and Pb, are extremely toxic for human health and their consumption should be avoided.

CONCLUSIONS

Contaminated vegetables lead to health issues for consumers of all ages, especially for young people. Vegetable contamination can come from a series of sources, one of the most important one is soil pollution, which leads to the absorption of harmful substances in the plants.

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SITUATION AND PERSPECTIVES ON THE USE OF MONOATOMIC ALCOHOLS IN ENERGETICS / *SITUAȚIA ȘI PERSPECTIVE PRIVIND FOLOSIREA ALCOOLILOR MONOATOMICI ÎN ENERGETICĂ*

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Keywords: *monoatomic alcohols, butanol, methanol, ethanol*

ABSTRACT

Worldwide, the use of monoatomic alcohols (methanol, ethanol, butanol) for combustion in spark ignition engines is becoming increasingly widespread. This article presents the economic and ecological efficiency in using ethanol and butanol for the internal combustion engine (ICE).

REZUMAT

La nivel mondial este din ce în ce mai răspândit utilizarea alcoolilor monoatomici (metanolului, etanolului, butanolului) pentru combustie în motoarele cu aprindere prin scânteie. În acest articol sunt prezentate eficiența economică și ecologică în folosirea etanolului și butanolului pentru alimentarea motoarelor cu ardere internă (MAI).

INTRODUCTION

One of the most prospective renewable energy sources is biomass, used by mankind over the centuries, providing in the past (XVI-XVII) 75%÷80% of total energy consumption. The theoretical calculations of bioenergy specialists show that the global energy potential of biomass is about 1400EJ or about 5 times more than the annual consumption of fossil fuels 300EJ. Today, biomass ranks fourth in all energy sources and provides 1250 million tonnes of conventional fuel per year, which accounts for only 11-15% of all primary energy consumption in the world.

At present, the exhaustion of reserves and the increase in fossil fuel prices lead to the production of renewable energy sources, including biomass, thus leading to constant search for methods of replacing fossil fuels with renewable ones. Biomass is a safe source for producing monoatomic alcohols that are already widely used to feed internal combustion engines (ICEs) mixed with gasoline.

The use of monoatomic alcohols to fuel internal combustion engines tends to become a widespread practice in different countries. Thus, the use of ethanol in powering vehicles was recorded in 1908 when Ford (USA) began producing cars (model T) that could be fuelled with gasoline, ethanol or their blend. Today, the largest ethanol producers are Brazil and the USA. These countries together produce over 85% of the world's ethanol.

The production of ethanol for energy purposes was largely assimilated in the 70's of the last century. At that time, the attention of researchers was focused primarily on the study of the exploitation properties of monoatomic alcohols and methanol-gasoline, ethanol-gasoline blends. Researchers in the US (*Lowus, S.O., Devote, R.S. 1976; Turon, M. 1998; LoRusso, J.A., Tabaczynski, R.J. 1976),* Brazil *(de Carvalho Neto, Carlos Coelho, Schulte, D.O. et al.; Goldemberg, I., Teixeira, C. et al. 2004; Lanzer, T., von Meien, O.F., Yamamoto, C.I. 2005*), Germany (*Schaffrath, M. 1975*) have studied the performance of biofuel engines: starter capacities, energy and economic parameters, chemical composition of exhaust gases, etc.

The experience gained with the use of monoatomic alcohols in the ICE fuelling has shown real possibilities for the use of biofuels. Using them in a proportion of 15-20% in blends with gasoline has practically the same energy and economic performance (engine power, specific consumption of fuel) as in the case of pure gasoline. At the same time, due to increased combustion efficiency of biofuel, the CO_2 and CO concentration in the exhaust gases of engines fuelled with monoatomic alcohol and gasoline blends is lower than of those fuelled with gasoline only.

MATERIAL AND METHOD

The absolute majority of self-propelled means used in the world economy, except for the relatively small number of electric actuators, are equipped with internal combustion engines (ICEs). Internal combustion engines are spark ignition (SI) (gasoline-fuelled) and compression ignition (CI) (diesel-fuelled) engines. At present, most internal combustion engines are fuelled with gasoline and diesel, which are distinguished by high performance but also high costs. Prices for petroleum products gasoline and diesel oil are steadily increasing and are hard to control. To this should be added the fall in oil reserves and the fact that the largest oil reserves are in sensitive geopolitical areas. It is therefore necessary to constantly seek new methods of replacing fossil fuels with renewable fuels. Monoatomic alcohols (methanol, ethanol, butanol) can be obtained either by synthesis of the chemical raw material; by fermenting carbohydrates or starch from plants (first-generation biofuels) or by processing lignocellulosic mass (second-generation biofuels).

Worldwide practice demonstrates that methanol, by virtue of its particular properties, is more efficiently esterified and used in blending with gasoline to form the following products: methyl tertiary-butyl ether MTBE (CH_3-O-C_4H_9) tert-Amyl methyl ether TAME (C_5H_{11}-O-CH_3). The high price of the esters allows them to be used only to improve the octane index of gasoline.

Butanol has properties very close to those of gasoline (Table 1), which gives it a number of advantages such as:

- relatively high calorific value (NCV=36 MJ/kg), which allows existing engines to be fuelled with blends with higher butanol content;
- the possibility of distributing the fuel through the existing infrastructure due to the low stratification capacity of the butanol-gasoline mixture in the presence of water;
- reduced corrosive action;
- the latent heat of butanol vaporization (0.43 MJ/kg) is close to that of gasoline (0.36 MJ/kg) and ensures that the engine starts at lower temperatures than methanol or ethanol.

Table 1

Physico-chemical and exploitation properties of fuels

INDEX	Fuels				
	Diesel	Gasoline	Methanol	Ethanol	Butanol
Concentration of elements, kg/kg of fuel:					
C	0.87	0.855	0.375	0.522	0.649
H	0.126	0.145	0.125	0.13	0.135
0	0.004	-	0.500	0.348	0.216
Molecular weight mc, kg/kmol	180÷200	110÷120	32	46	74
Theoretical quantity of air, kg/kg of fuel	14.0	14.57	6.3	8.83	11.2
Lower combustion heat, MJ/kg of fuel	41.9	42.5	19.5	26.8	36.0
Specific energy, MJ/kg of air	3.0	2.9	3.1	3.0	3.2
Kinematic viscosity, mm^2 /s (at 20°C)	3÷6	0.4÷0.8	0.64	1.52	3.64
Octane index: Research COR,		90÷98	136	129	96 N-bu
Motor COM		80÷87	104	102	78 -tanol
Vapour pressure, kPa		50		23	3.7
Heat of vaporisation, MJ/kg		0.36	1.2	0.92	0.43

Among the disadvantages limiting the use of butanol to the formation of liquid biofuels are the following:

- the viscosity of butanol (3.64 mm^2/s) is almost equal to that of diesel fuel (3÷6 mm^2/s) 2.4 times higher than the viscosity of ethanol (1.52 mm^2/s) and 4.6÷9 times as gasoline (0.4 ÷ 0.8 mm^2/s). High viscosity may cause problems in the fuelling process;
- the current technological processes of butanol production are based on propylene oxide synthesis at 130^0÷150^{0}C and 20÷50 MPa.

The annual production volume of butanol by the largest producer (USA) is about. 1.39 billion litres or US $ 0.37 billion gallons (for comparison in the US, in 2007, 6.5 million U.S. bioethanol gallons were produced).

Due to the complicated technological process of chemical synthesis, butanol production cost obtained is higher than that of petroleum fuels. Therefore, butanol is used only as a diluent.

Until the 1950s, at world level practice, technological processes of biomass fermentation (carbohydrates, starch) with Clostridiumaceobutylicum bacteria were used to produce acetone, butanol, ethanol and other by-products (ABE processes). For economic reasons, these products have been replaced by chemical processes. Because of the increase in crude oil price, the production of butanol from biomass is becoming more and more current. Specialists of some US science centres (Illinois, Ogaio, etc.), of transnational firms (BP, Du Pont, Environmental Energy) are conducting research to develop an efficient fermentation process of butanol from biomass, including cellulose, the reserves of which are very high on the Earth.

Although the fermentation processes of butanol and ethanol are the same, at present there is an essential difference between their costs. The difference is caused by the imperfection of butanol fermentation process and the low yield of the finished product (up to 25% butanol or over 60% ethanol is obtained from the initial biomass amount). Today, the main problem in butanol fermentation is suppression of microorganisms' activity by the obtained butanol itself.

Taking into account the physico-chemical properties of butanol and the need to replace fossil fuels with biofuels, the efforts of the specialists in the field are directed to the development of competitive butanol fermentation processes. It should be noted that today there are no concrete and extensive data on the use of butanol in engine fuelling. This situation fully justifies the realization of a research complex, among which the most important are:

- evaluation of the physico-chemical and exploitation properties of butanol and its blends with gasoline and eco gasoline (ethanol –gasoline blend);
- studying the energetic, economic, ecological characteristics of SI engines powered by fuels containing butanol;
- the assessment of the working capacity of biofuel engines.

Of the monoatomic alcohols, the most used in the amount of fuel is the ethanol (ethyl alcohol C_2H_5OH), which has a product obtained from plants rich in carbohydrates and starch (sugar beet, sugar cane, sweet sorghum, molasses, wheat, barley, rye, corn etc.) through a fermentation process. As a raw material for the production of bioethanol, 61% are plants rich in carbohydrates (Fig. 1).

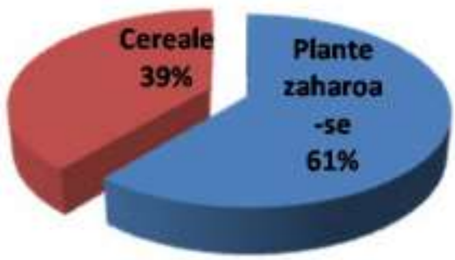

Fig. 1 - The share of raw material in the production of bioethanol

In the last 10÷15 years there has been an essential increase in the use of ethanol as an alternative fuel for car transport. This phenomenon is due to some advantages of ethanol as a fuel, namely:

- reduces greenhouse gas emissions by 35÷45% and more;
- large quantities of raw material are available to produce ethanol;
- the cost price of ethanol, in many cases, is lower than that of fossil fuels.

In the top of the bioethanol producing countries, the United States and Brazil are on the first places; they produced in the period 2004÷2006 approx. 25.4 billion US gallons or 70% of world production, and in 2014 this production in the US and Brazil accounted for 80% of the 24.4 billion US gallons produced in the world (Table 2).

Table 2

Top of the world's largest ethanol producers, billion US gallons [69]

Den. No.	States / Regions	2007	2014
1.	U.S.A	6.5	13.3
2.	Brazil	5.0	6.19
3.	E.U.	0.65	1.45
4.	China	0.5	0.64
5.	Canada	0.21	0.51
6.	Thailand	0.08	0.31
7.	India	0.19	0.87
8.	Other states	0.19	0.87
TOTAL		**13.1**	**24.4**

Brazil's bioethanol industry has been developing efficiently for 30 years; it has a sustainable production program for this biofuel from sugar cane, the plantations of which cover 3.6 million hectares of land, making up 1% of the arable land in this country, with a productivity of up to 5500 litres of ethanol per hectare compared to 3000 litres of ethanol on the same corn surface in USA.

In 2014 Brazil produced 6.19 billion US gallons of ethanol, which constitute 25.4% of the world's bioethanol production. In Brazil, there are no more vehicles to run on pure gasoline. In 1977, the government of the country adopted a decision requiring the use of 20% ethanol and 80% gasoline blends. Today in Brazil, 3 million vehicles are running on bioethanol (100%) and 6 million on ethanol-gasoline blends containing 20÷25% ethanol.

The United States is the largest producer and user of ethanol as biofuel. The use of ethanol for the supply of car transport was recorded in 1908, when Ford (model T) cars were designed and produced, which had the capacity to use gasoline, ethanol or a mixture of them as a fuel .

Today most cars in the U.S. are fuelled with a blend containing 10% ethanol and 90% gasoline. 1900 stations already open ensure distribution of the ethanol-gas blends. Manufacturers of engines for branded vehicles such as Ford, Chrysler, GMS have the option of using the fuel blend (85% gasoline and 15% ethanol).

The main source of bioethanol production in the U.S. is corn, which is almost less profitable than sugar cane.

According to the multiannual data from the world economy [67, 68], almost half of the total ethanol production is obtained from raw material with high sugar content, especially sugar cane, followed by starch cultures, especially corn and wheat (Table 3).

Obviously, the choice of cultures for ethanol production depends on many factors, including pedoclimatic, social, etc. It can be seen that, for the Republic of Moldova, sweet sorghum is a culture of maximum perspective for the production of ethanol.

Table 3

Production volume and cost of ethanol from different types of raw material [59]

Raw material	Production volume, t/ha	Cost, €/m^2	Raw material	Production volume, t/ha	Cost, €/m^2
Sugar beet	2.5÷3.0	300÷400	Wheat	0.5÷2.0	380÷400
Sugar cane	2.5÷3.0	160÷200	Potato	1.2÷2.7	800÷900
Corn	2.5÷3.0	250÷400	Sweet sorghum	3.0÷5.0	200÷300

According to the European Biomass Industry Association (EUBIA), the industrial production of ethanol as biofuel in EU countries began in the 1990s (Fig. 2).

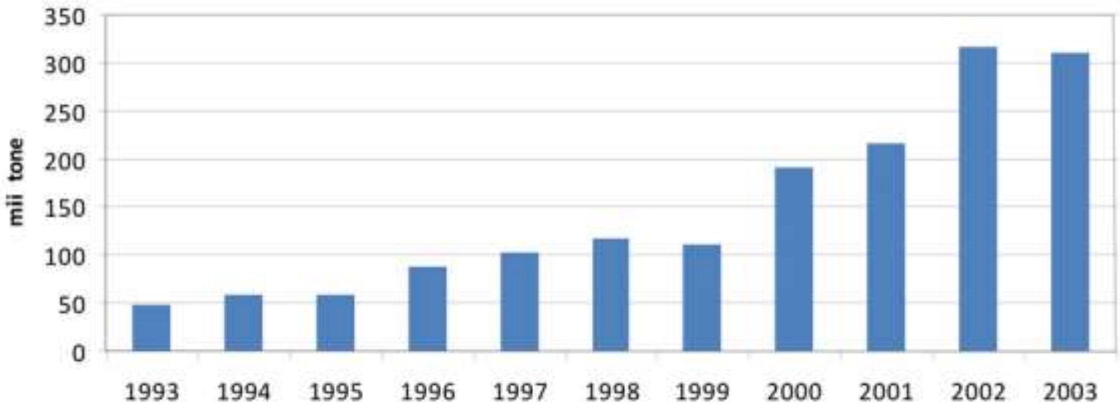

Fig. 2 - The evolution of bioethanol production in the E.U. (source: EUBIA)

In 2014, ethanol production in EU countries amounted to 4336 thousand t = 1449 million US gallons, an increase of 22 times compared to 2000. The largest bioethanol producers in the EU are Germany, Spain and France.

On the European market the demand for bioethanol is much higher than the supply. According to EBIO data, in 2006, bioethanol production in EU countries accounted for 90% of consumption, while in Germany 70%, Spain-60%. The largest consumer being Sweden, with production coverage of 50% of consumption. Thus, this country is the largest user of ethanol as biofuel. Of the total of 1.695 bioethanol-gasoline supply stations in the EU, 1200 are located in Sweden.

In Europe, the main crops for the production of bioethanol are cereals (wheat, rye, barley) and sugar beet. In the structure of production costs for bioethanol from sugar beet and wheat, the cost of the raw material represents 55-80% of the final cost (Table 4).

Table 4

Bioethanol production costs in the EU (Source: EUBIA)

	Ethanol from wheat			Ethanol from sugar beet		
	€/l	€/GJ	€/tep	€/l	€/GJ	€/tep
Raw material	0.4	118.9	790	0.26	12.3	513
Benefits from co-products	0.15	7.1	296	0.03	1.4	59
Total cost of raw material	0.25	11.8	493	0.23	10.9	454
Production cost	0.28	13.3	553	0.22	10.4	434
Costs for blending with gasoline	0.05	2.4	99	0.05	2.4	99
Distribution costs	0.01	0.5	20	0.1	4.7	197
Total cost	**0.59**	**27.9**	**1165**	**0.60**	**28.4**	**1.184**

Depending on the raw material, production technology and bioethanol prices vary from one country to another. In Brazil, the ethanol price is $ 1/gallon (3.785 l) versus $ 1.5/gallon of gasoline. The price of ethanol produced from the other crops is lower than that of gasoline and differs from 0.22 to 0.7 €/litre.

At present, research and development activity in the field of bioethanol focuses on the use of lignocellulosic biomass: wood and forest residues, energy crops (willow, Chinese reed, eucalyptus), agricultural residues (straw, corn, sorghum and bagasse stalks), municipal waste. To produce a ton of ethanol, 3-4 tons of dry or grassy wood material is required.

CONCLUSIONS

1. The analysis of world-wide experience shows that currently the higher demands on the energy market are of solid biofuels (in the form of briquettes and pellets), liquid (ethanol + gasoline blends, fatty acid esters + diesel). Great efforts are being made to develop and implement industrial production technologies for monoatomic alcohols (ethanol, butanol) from cellulose (second-generation biofuels).

2. Although methanol is the cheapest of the monoatomic alcohols, due to its specific essential characteristics, primarily high toxicity, it is more efficient to esterify methanol and use esters in blends with

gasoline. The high price of methanol esters allows them to be used only in small quantities and only to increase the octane index of gasoline.

3. Biofuel production and use technologies used in other countries for their implementation in Moldova's economy require adaptation to local technical, economic and social conditions, staff training, and the creation of technical maintenance service. These require high long-term investments.

4. According to estimates by foreign and native experts, sweet sorghum can become a strategic crop from energy, ecological and economic standpoint for the world economy. For large-scale implementation of sweet sorghum in the domestic agri-food sector, it is necessary to carry out a complex of research-innovation works for the adaptation of sorghum harvesting and processing technology to local conditions.

The use of monoatomic alcohols to fuel internal combustion engines is becoming more and more widespread in different countries. Replacing gasoline and diesel with biofuels of native origin would help solve economic, ecological, political and social problems by: increasing the country's energy security; reduction of greenhouse gas emissions; creating new jobs in the national economy; increasing the profitability of domestic enterprises, including small and medium-sized enterprises.

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GENERAL ASPECTS OF THE EXTREME METEOROLOGICAL PHENOMENON, HAIL / *ASPECTE GENERALE ALE FENOMENULUI METEOROLOGIC EXTREM GRINDINA*

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Keywords: *hail, hail grains, cloud-seeding, anti-hail equipment*

ABSTRACT

Climate and agriculture influence each other. This impact is more than obvious nowadays because climate changes and variability are global. Productivity and quality of fruit and vegetables are affected by periods of increased relative humidity, frost and hail. The major cause of variation in crop productivity and quality, from year to year, is the variability of rainfall. Hail is a solid precipitation. The occurrence of hail is related to the presence of Cumulonimbus clouds, large vertical clouds, inside of which upward and downward currents appear.

REZUMAT

Clima și agricultura se influențează reciproc. Acest impact este mai mult decât evident astăzi, deoarece schimbările climatice și variabilitatea sunt globale. Productivitatea și calitatea fructelor și legumelor sunt afectate de perioade de umiditate relativă crescută, îngheț și grindină. Principala cauză a variației în productivitatea și calitatea culturilor, de la an la an, este variabilitatea precipitațiilor. Bucuria este o precipitare solidă. Apariția grindinei este legată de prezența nori cumulonimbus, nori verticale mari, în interiorul cărora apar curenți ascendenți și descendenți.

INTRODUCTION

Climate and agriculture influence each other. This impact is more than obvious nowadays because climate changes and variability are global.

Climate change is a huge challenge for agriculture, having a direct impact on the productivity of the agricultural sector.The negative effects on agricultural production are influenced by extreme meteorological events.

Productivity and quality of fruit and vegetables are affected by periods of increased relative humidity, frost and hail. The major cause of variation in crop productivity and quality, from year to year, is the variability of rainfall.

Agricultural crops are vulnerable to exposure to limiting vegetation conditions caused by climatic extremes, are sensitive to their fluctuation and variability and depend on their adaptability to periods of thermal and water stress [2].

MATERIAL AND METHOD

The hail is always accompanied by strong showers, winds and lightning and is an extreme weather phenomenon that presents a significant climate risk and which, although it occurs quite rarely, can cause material damage of local or regional proportions in a short time depending on the route followed by the clouds that generated it [3].

This phenomenon occurs between March and October, with the highest production frequency in the summer season and especially during the short-term rainfall specific to this period of the year.

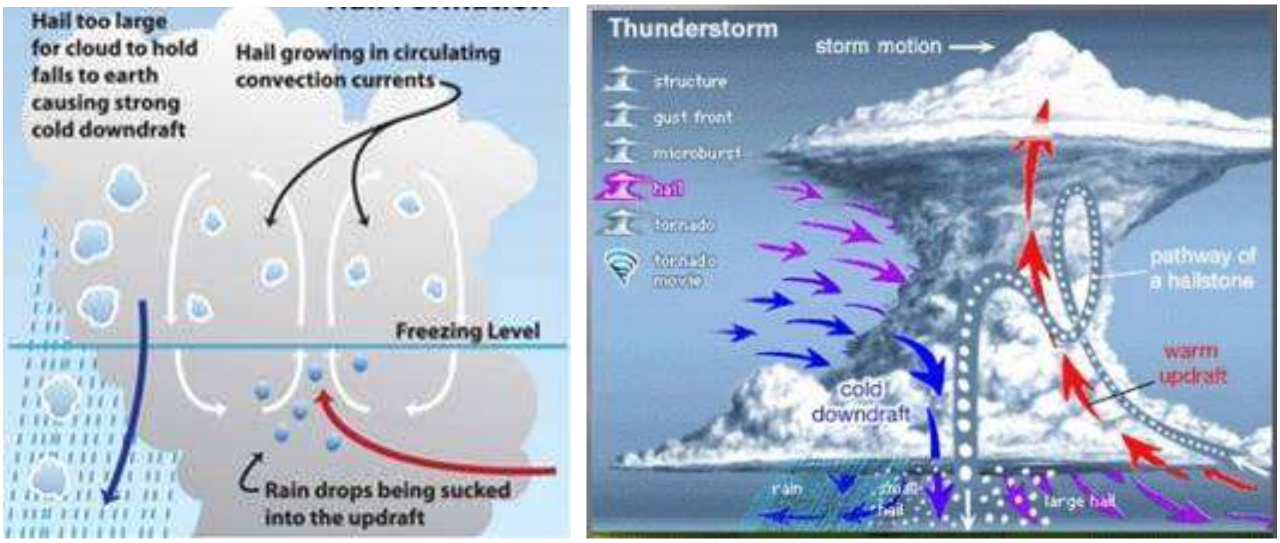
Hail formation

Hail is a solid precipitation. The occurrence of hail is related to the presence of Cumulonimbus clouds, large vertical clouds, inside of which upward and downward currents appear.

a) [1] b) [4] c) [4]

Fig. 1 - Thunderstorms clouds (Cumulonimbus)

The primary form of the hail is represented by a soft sleet drops formed at the top of the cloud by condensation of the water vapour in the cloud and rain drops freezing. From this moment, downward and upward currents carry this fragment both to the base of the cloud (downward currents) and to the upper part of the cloud (upward currents). Thus, in its journey, the sleet drop is covered with transparent ice layers (when brought by downward currents towards the median area) and opaque ice (in the upper part of the cloud where the temperature is lower). As soon as it gains a weight that conquers the upward current force, the hailstone falls to the ground.



a) [6] b) [1]

Fig. 2 - Hail formation

The hailstone size depends on the intensity of the genetic processes of the phenomenon. Thus, the thermal contrast between hot and cold air, the intensity of heat convection upward currents, the intensity of the cold front movement speed and the dynamic convection it generates, the altitude up to which the warm air can be exalted, the vertical sharp development of the hail cloud are important growth factors in hailstone size [3].

Fig. 3 – Hailstones

Hail storms start suddenly, and the duration of the phenomenon is inversely proportional to the size of the hailstones. The shorter the duration of the falls, the larger the size of the hailstones as well as the mechanical influence they exert [7].

Hailstone dimensions are highlighted by the size of the hailstone diameter.

Hailstones are spherical, conical or irregular in appearance and are made up of a nucleus around which several layers of ice appear.

Researches carried out by specialists showed that diameters are smaller (below 5 mm) in the first part of spring and autumn compared to the second half of spring and summer when they can reach exceptional sizes, ranging between 20-30 mm. Such dimensions determine the extent of the risk caused by falling hailstones.

Fig. 4 – Hailstones [8]

Fig. 5 – Section of a “monster hailstone” [9]

Effects and reduction of hail damage

Hail, torrential rains and wind intensifications have adverse consequences on cereal crops, vegetables, vines and fruit trees that have been caught at various stages of development, affecting or stopping their vegetative cycle by seriously injuring foliage, shoots and fruits. When a medium-sized hailstone moving in the air drops to the ground, it reaches a speed of about 180 km/h, while a raindrop hardly overcomes 30 km/h.

Fig. 6 – Hail damage [10]

Depending on the intensity of the phenomenon and the moment of occurrence - in a critical phase of plant development or at the end of the vegetation phase - hail damage can be disastrous ranging from 5 to 100%. Apart from partially or totally destroying the crop of the current year, hail also affects the crop of the next year as a result of the large-scale injury to the vegetative apparatus of the respective crop and their impoverishment in reserve substances. The negative effects of late hail, in the case of vines, last for two years.

On the plant organs affected by hail, a series of parasitic fungi (manna, mould, etc.) get attached very easily, so immediate action is required to save plants that are not yet completely destroyed.

Fig. 7 – Plants affected by hail [4, 11]

In the case of fruit trees, fruit-bearing shrubs and vines, it is recommended to apply fungicide treatments, especially if their bark was destroyed. These prevent the development of certain diseases caused by open wounds in the bark. These treatments are important to be performed within a period of 21-24 hours after the occurrence of the phenomenon.

In the case of the garden, remove the damaged or destroyed elements of the crop in question. Vegetables affected by hail, such as green lettuce, radish or spinach, are picked because they can grow again if the weather improves. Among the most sensitive plants in the garden are tomatoes, peppers and eggplants. Therefore, these vegetables need more attention with the end of the phenomenon. So, pick up the ice pieces that lie among the plants and keep the leaves of the vegetables even if they are ragged. If the plants were laid to the ground and the roots were brought to the ground surface, they are replanted. For vegetables to have a good chance of getting better if weather improves, tomatoes, peppers and eggplants must be supported by poles.

Also, other post-hail gardening activities are recommended: loosening between the rows in the case of corn and plant ridging, applying nitrogen fertilizers, applying a low nitrogen fertilizer to perennial plants and using plants that can no longer be saved in compost.

The only positive effect of hail is the rainfall intake on the active surface, which often interrupts drought periods of high intensity [3].

RESULTS

Given the destructive effect of hailstorms, mankind has, over time, been preoccupied continuously to combat this phenomenon. People tried to combat this phenomenon with empirical or religious means (our Geto-Dacians ancestors were shooting the bow in the clouds to frighten the demons/clouds); they used - in rural communities - church bells and prayers to defend themselves from this phenomenon.

With the technological evolution, as the knowledge about clouds developed, the technology of sounding and determining the general parameters first and later the ones specific to hail-forming clouds, the fundamental research programs were initiated and subsequently the development of systems for combating hailstorms.

Methods of fighting hail:

1. Cloud-seeding is a type of weather change that aims to change the amount or type of precipitation falling from the clouds by dispersing substances into the air that serve as condensation of clouds or ice nuclei, which modifies microphysical processes within the cloud. The usual intention is to increase precipitation (rain or snow), but also to reduce or even suppress hail and fog, also widely practiced in areas and airports where harsh weather conditions occur.

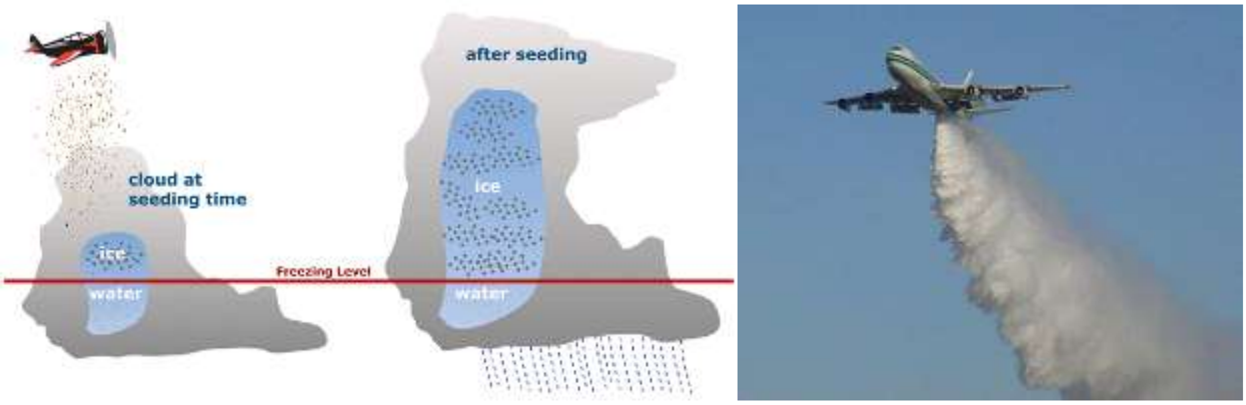


Fig. 8 - The science of cloud-seeding [12, 13]

a) Rocket-based seeding

Anti-hail rockets are built to fly up to 10,000 meters. Once they get there, they release a chemical compound based on silver iodide that aims to transform ice crystals (hail) into water. Then, the rocket self-destructs and just a few small pieces of cardboard get on the ground.

From a technical point of view, it is the most appropriate method for protecting complex relief areas, with large wine and fruit growing areas. This method allows chemical seeding into the potential cloud cell, and the reaction time is much shorter. The disadvantage is the need to achieve a proper density of launch points in the protected area and the need to ensure air traffic security during the intervention.

The system developed in Moldova, Ukraine, Central Asia, Argentina recorded an efficiency of 75-96%.

Fig. 9 – Anti-hail rocket RAG-96 and rocket launcher [10,14]

Fig. 10 - Cessna 441 Conquest II used to conduct cloud-seeding flights in the Australian state of Tasmania [15]

b) Aircraft seeding

If the use of hail control rockets is impossible (absence of rocket infrastructure, ban on rocket launch), this second method can be used as seeding efficiency, which launches the anti-hail equipment from an aircraft. There are three types of such equipment (fig.11):

- pyrotechnic generators on board the aircraft, which produce an aerosol, during the flight, near dangerous clouds;
- cartridges, which could be shot from the aircraft, which produce aerosols during their fall through the cloud;
- jet cartridges that could be shot from the aircraft with the possibility of directly attacking a dangerous hail cell.

Fig. 11 - Aircraft anti-hail technologies [16]

It is an expensive method and requires specific aviation logistics. It poses a danger to the crew that is involved in the intervention activity because it has to act in the storm, below or above the clouds.

It is suitable for the protection against hailstones of large, flat surfaces and in developed aviation countries. This technique has been used mainly in the US, Argentina, China and Germany (Fig. 12). Economic efficiency for this aviation-based technology is up to 40%.

Fig. 12 - Pyrotechnic means used to combat hail by air [17]

c) Ground-based generator seeding

The use of the ground-based generator is done under the coordination and monitoring of the Authority for the Administration of the National Anti-Hail and Rain Simulation System (AASNACP), through operators licensed by AASNACP.

Thus, the ground-based generator begins to work if a potentially hazardous hail condition occurs based on the weather alert a few hours before the potential start of the process.

A propane flame is used to vaporize the seeding solution, which is composed of silver iodine mixed with acetone. Emitted silver iodine particles follow the natural trajectories of atmospheric dynamics and are absorbed by hail clouds through convective air movement in areas of atmospheric instability. These particles are condensation nuclei. In addition, their presence in the clouds causes the droplet size to decrease inside the clouds and thus the likelihood of the formation of large hail nuclei decreases.

The operating mechanism is used in several European countries (Croatia, France, Hungary, Spain, Italy, Switzerland) and even outside the continent (Canada).

Because the operating principle is based on the upward currents that carry the particles in the required areas, the system can be used locally, and the precision of seeding is influenced by the evolution of air currents. It has satisfactory efficiency and low logistics (fig.13). It is an inexpensive means in terms of investment and exploitation.

The location of these units is recommended to be done in the border areas where it is not possible to act with rockets to provide the required anti-hail protection in other locations too, as a complementary protection system.

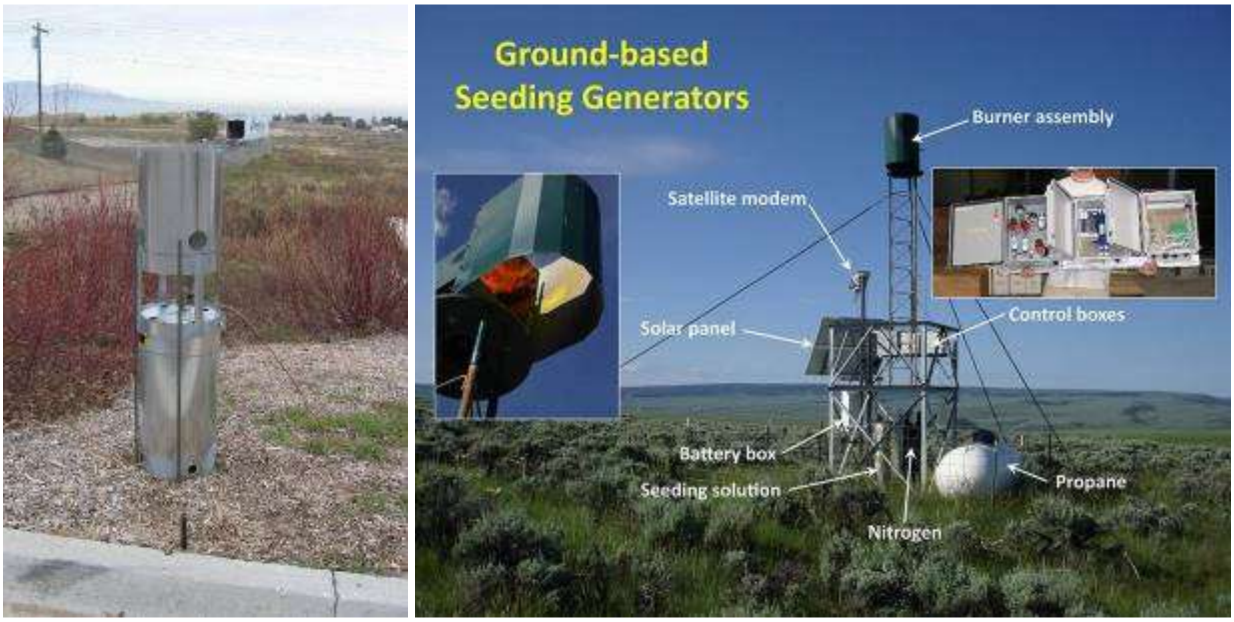


Fig. 13 – Ground-based generator (propane burner) [18,19]

2. Hail cannon

This device emits sound waves towards the clouds in which hail is formed in order to stop the formation of ice particles (Fig. 14).

An explosive mixture of acetylene and air is pushed into the lower chamber of the machine. Some systems also use oxygen under pressure to increase the explosive effect. By suddenly passing this mixture through the strangled part of the machine to the cone, a shock wave is generated, which can be perceived as a strong whistling. The wave propagates, at the sound speed up to 15,000 m, in the clouds above, causing a disruption of the hail particles growth phase.

The system is activated at short intervals of 4 to 7 seconds for the entire period since the storm approaches the cannon's location until it will have passed the protected area. As a result, rainfall that would have fallen as hail falls in the form of rain or sleet. It is essential that the machine is activated during the storm's approach, as shock waves can prevent hail formation but cannot alter the form of hail particles that are already formed.

These systems work with solar panels, with manufacturers claiming that this allows for better protection taking into account the lighting that often accompanies storms that produce hail.

The surface protected by such an isolated system is a circle with a radius of approximately 500 m, the effectiveness of the protection decreasing as the distance from the installation location increases.

To protect neighbouring areas from noise, the installations are surrounded by straw bales. The noise of cannon operation does not disturb the closest buildings, which are at a distance of 400 m.

There are systems controlled by radar systems that replace manual operation, which is of particular importance for areas where hail falls occur at night.

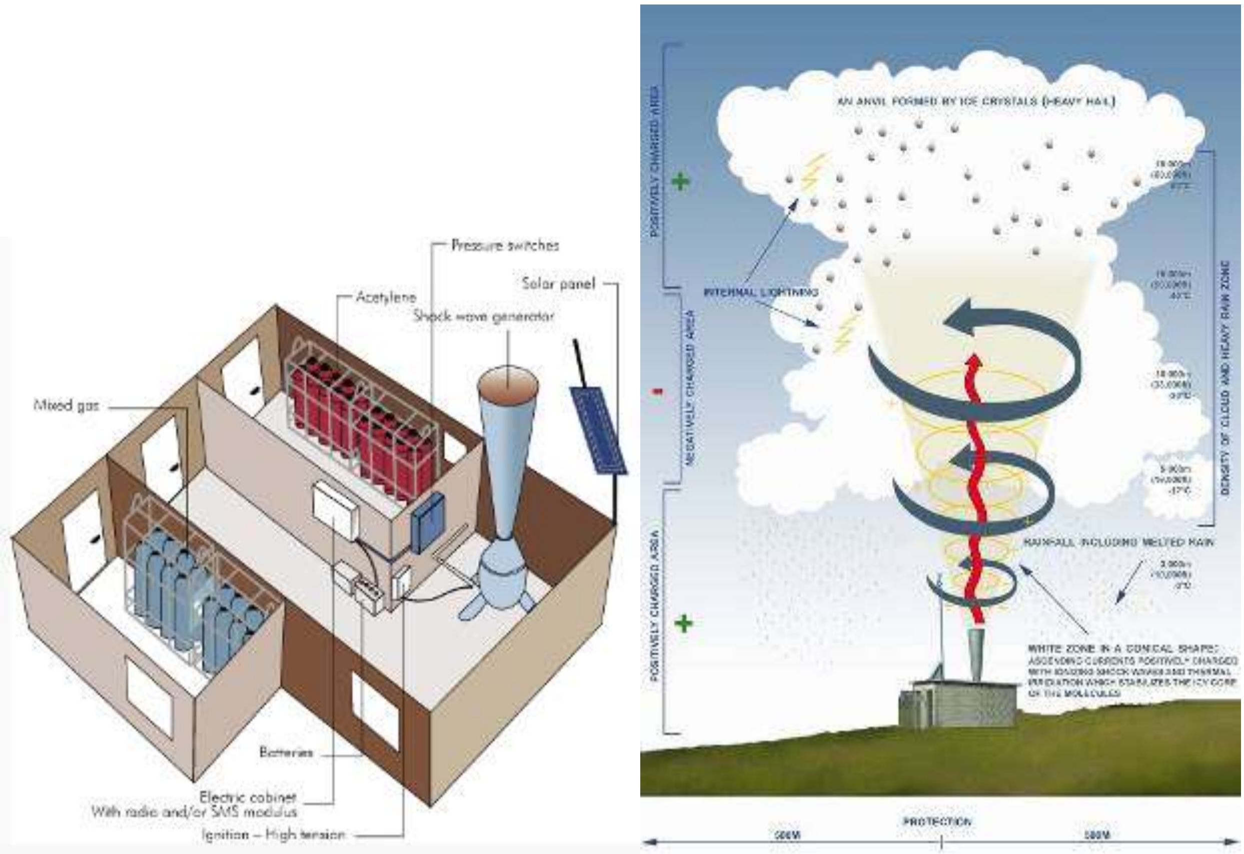


Fig. 14 – Hail cannon technical and operational scheme [20]

Fig. 15 - Placement of hail cannon in the field [21]

3. Hail protection nets

Hail is one of the greatest enemies of the garden, as it causes major damage both among the layers of vegetables, as well as in the orchard and vineyard.

The effects of falling hail may be smaller or bigger, depending on the duration of the phenomenon and the amount of precipitation, and many times, as a result of hail, all vegetable crops are compromised or damaged in large proportion.

In areas with high risk of hail, special hail protection nets can be installed, but after flowering, because installed before, they prevent the bees' flight. The nets are made of materials that prevent hailstones from reaching the crops or even reaching the ground. They can withstand rather heavy loads and have a tilted position for a better discharge of the hail. These are mainly located in the vegetable garden, in the orchard with fruit trees, but also in the area where there are vineyards.

Hail protection nets do not prevent plant growth, so they can become a useful solution in the summer season when the hail frequency is high [1]. This system is a safe means of protection against hail, but the installation and handling costs are very high for large areas.

Fig. 16 - Ways of installing hail protection nets

4. Agricultural crop insurance policy

Beyond the technical protection measures, another form of protection that farmers can adopt against the phenomena that can compromise their crops is the conclusion of a policy of agricultural crop insurance. This policy provides financial protection in case of damage caused by fire or natural phenomena, including hail risk.

It is important to know that crop insurance policies cannot be concluded at any time in the course of a year, but only according to the type of the crop insured. Thus, the orchards are assured for the risk of hail after their full blossoming, the vineyard is insured after the beginning of the budding, the multiannual plantations - after the 15th of April, and the plantations of other field crops - after their emergence.

CONCLUSIONS

Hail can cause major damage when it occurs in the full vegetation season, when hailstone size exceeds 10 mm in diameter, when the duration and density of the hailstones' fall is high, when a persistent ice layer is deposited, when it occurs after dry periods and has as a result of soil erosion.

Hail can affect dwellings, cars, trees can lose their crown, gardens and hundreds of hectares of agricultural land can be destroyed and even human victims can be recorded.

Among the methods listed, rocket seeding is the most operative and efficient, however, due to several specific reasons (the presence of a rocket infrastructure, accommodation of start stations, obtaining a rocket firing authorization, etc.) it is not always possible. The use of ground-based generators is the least efficient. However, it is quite widely used in places where the application of cloud seeding by air is encountering difficulties.

Due to climate change and air pollution, the risk of hail damage is increasing, which requires continuous knowledge and analysis of the peculiarities of this phenomenon and a continuous development of the means of combating the effects produced in the fall region.

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SORGHUM CULTURE, A SOLUTION FOR OBROGEAN AGRICULTURE / *CULTURA DE SORG, O SOLUȚIE PENTRU AGRICULTURA DOBROGEANĂ*

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Key words: sorghum, sowing epoch .technologies

ABSTRACT

Dobrogea is the most drought area of Romania. For farmers from this area, sorghum crop is a solution. In Amzacea, in 2016 there have been experimented new sorghum crop technologies at S.C. Sport Agra Farm. These technologies include the following elements: changing the sowing epoch with one month before the usual period recommended by classical technologies; (beginning of April in order to benefit from the soil's humidity at 4-5 cm depth boosting the germination process); choosing early hybrids in order to avoid the drought season which starts in June; applying adequate crop protection treatments, with pre-emergent and post-emergent herbicides and last generation insecticides. The agricultural crops in this area are not irrigated, so farmer D. Manole proposed a new technology, with the sowing of the crops earlier. This way the plants will benefit from the moisture from the soil accumulated in the winter.

REZUMAT

Dobrogea este cea mai secetoasă zonă a României. Pentru fermierii din această zonă, cultura de sorg este o soluție. În Amzacea, în 2016 s-au experimentat noi tehnologii pentru culturile de sorg la ferma S.C. Sport Agra. Aceste tehnologii includ următoarele elemente: schimbarea epocii de semănat cu o lună înainte de perioada obișnuită recomandată de tehnologiile clasice; (începutul lunii aprilie pentru a beneficia de umiditatea solului la o adâncime de 4-5 cm stimulând procesul de germinare); alegerea hibrizilor timpurii pentru a evita sezonul de secetă care începe în iunie; aplicarea de tratamente adecvate pentru protecția culturilor, cu erbicide pre-emergente și post-emergente și cu insecticide de ultimă generație. Culturile agricole din această zonă nu sunt irigate, prin urmare fermierul D. Manole a propus o nouă tehnologie, cu semănarea culturilor mai devreme. Astfel, plantele vor beneficia de umezeala din sol acumulată în timpul iernii.

INTRODUCTION

Sorgum is recommended for Dobrogea, one arid areas; called the camel of crops due to its drought resistance (*Amsalu et. al., 1998*).

Sorghum requires the following technological elements:

-Selecting early hybrids to overcome the drought periods . There are recommended hybrids with shorter vegetation period (*Poschiscanu et. al., 2015*).Sorghum sowing is recommended in classic technology between 20th April and 10th May (*Trotus et al*.).

-Ensuring a minimum of 120-140 kg / ha of nitrogen (*Owen, 1967*).

The agricultural crops in this area are not irrigated, so the farmer proposed a new technology, with the sowing of the sorgum earlier by about a month.

-The agricultural crops in this area are not irrigated, so the farmer proposed a new technology, with the sowing of the sorgum earlier by about a month.

MATERIAL AND METHOD

Experience has been placed on S.C. SPORT AGRA S.R.L. Amzacea, Constanta district. The experience was situated on a land belonging to the South Dobrogea plateau, represented by cambic chernoziom with a profile deeper than other chernozioms, a blackish-brown soil of 40-50 cm thickness, medium texture (*Demeter T., 2009*). The content of nutrients was: mobile P index - 72; N index - 4; Humus - 3.11; K index - 200; Neutral pH - 7.2. The climate is deeply temperate continental, with an average annual temperature of 10.56 °C, with a high temperature in the period 20th June to 15th August. Quantity of precipitations and air temerature during the vegetation period was presented in Table 1.

Table 1

Precipitations and air temerature during the vegetation period *(Amzacea, Constanta 2016)*

	Month								
	Jan.	**Febr.**	**March**	**Apr**	**May**	**June**	**July**	**Aug.**	
Periods	The growing season 2016: Precipitation (mm) for 10-day periods								Sum
1-10	0	12.0	10.0	0	60.0	3.5	56.0	4.0	145.5
11-20	95.0	18.5	19.0	0	21.0	20.0	0	0	173.5
21-30	15.0	0	15.0	20.0	16.0	0	0	0	66.0
Sum	110.0	30.5	44.0	20.0	97.0	23.5	56.0	4.0	385.0
	Average 1961-2010 : monthly values of precipitation (mm)								Sum
	27,7	24,0	29,1	31,8	37,7	47,1	38,9	37,4	273,7
	The growing season 2016: Mean air (°C) for 10-day periods								Mean
1-10	2.5	4.1	6.8	10.3	13.9	19.8	22.6	23.2	12.9
11-20	4.8	5.2	7.9	12.9	16.8	21.4	24.2	22.6	14.57
21-30	4.3	5.4	10.2	13.5	18.7	22.1	23.8	21.4	14.92
Mean	3.9	4.9	8.3	12.2	16.5	21.1	23.5	22.4	14.1
	Average 1961-2010 : monthly values of mean air temperature (°C)								Mean
	0,4	0,9	4,4	9,7	15,3	19,4	21,9	16,9	12.12

As written in Table 1, year 2016 provided higher amount of rainfall in May - July, 176,5 mm higher than the multiannual average. These precipitations favored the development of sorghum crops.

Regarding the sorghum crop, the main technological links pursued by the research team consisted of the following:

• Choosing early hybrids to overcome the burning periods that occur between June 5 - August 20-25.

• Recommendation of shorter vegetation hybrids

• Sowing the sorghum in Apri 4 2016, not between April 20th-May 10th according to classical technology (*Trotus et. al., 2015*).

• Providing a minimum of 120-140 kg / ha of nitrogen

• Treatment of seeds before sowing with chemicals containing thiamethoxam to combat pests in the early stages of vegetation,

• Pre-emergence herbicide with Frontier forte 1l / ha and post-emergence with Ceredin Super 40 SL 1 l / ha (Micheal J. & col. 2005.

Experiments in plots were made on 2195 sqm.

RESULTS

The experiments were carried out in 2016 on 6 hybrids, ES EULALIS, ES FOEHN, ES TYPHON, ES ALBANUS, ES ARMORIC OND SE ARKANCIEL, as shown in Table 2.

The data obtained in the experimental year 2016 are presented in Table 2. The sowing took place this year on April 4, and the hybrid Arkanciel was sown on 4 April and 4 May. This way the plants will benefit from the moisture from the soil accumulated in the winter.

From the data presented, it can be seen that this year, through earlier sowing, large production increases of over 10000 kg / ha were obtained. This year, with the Arkanciel hybrid, sown on 4 April, an increase of 3436 kg / ha was obtained All of these data show that sorghum is a valuable alternative crop for this dry area.

Table 2

Demonstrative plots for sorghum crop - Amzacea 2016

Hybrid	Pre-emergent plant.	Surface sqm	Seeds /ha	Sowing date	Emergence date	Yields kg / ha
ES EURALIS	Wheat	2195	220000	4 April	14 April	10439
ES FOEHN	Wheat	2195	220000	4 April	14 April	11504
ES TYPHON	Wheat	2195	220000	4 April	14 April	8859
ES ALBANUS	Wheat	2195	220000	4 April	14 April	10130
ES ARMORIK	Wheat	2195	220000	4 April	14 April	10645
ES ARKANCIEL	Wheat	2195	220000	4 April	14 April	10336
ES ARKANCIEL	Wheat	2195	220000	4 May	16 May	6900

Fig. 1 - Experimental field-sorg

CONCLUSIONS

At Sport Agro Amzacea, there have been experimented and improved sorghum crop technologies. These technologies comprise the following technological elements:

Selecting early hybrids to overcome the drought periods that occur between the 10th of June until the 25th of August. There are recommended hybrids with shorter vegetation period. Changing the sowing age - the hybrids were sown one month earlier (April 4, 2016). The agricultural crops in this area are not irrigated, so the farmer proposed a new technology, with the sowing of the two crops earlier by about a month. Recommendation of shorter vegetation hybrids. The results from comparative crops have demonstrated sorghum with outstanding yields of over 10 t / ha.

ACKNOWLEDGEMENT

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TECHNOLOGY AND EQUIPMENT USED FOR OBTAINING OF SUBSTITUTES AND WASTES RESULTING FROM THE CAPITALIZATION OF ENERGY CROPS
/
TEHNOLOGII ŞI ECHIPAMENTE UTILIZATE PENTRU OBŢINEREA SUBPRODUSELOR ŞI DEŞEURILOR REZULTATE DIN VALORIFICAREA CULTURILOR ENERGETICE

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Keywords: *technology, harvesting combine, sorghum strains, quality*

ABSTRACT

Sugar harvesting was first manually and then semi-mechanized, so that today is totally mechanized, because yields per hectare are high and on the other hand the harvested sorghum, cut to 50-80 mm, needs to be processed as quickly possible, in order not to alter the juice - the main product used in the food industry. The paper presents some aspects regarding the cultivation of sugar sorghum in Romania and worldwide, respectively the latest equipment used in the world for the harvesting of sugar sorghum.

REZUMAT

Recoltarea sorgului zaharat s-a realizat la început manual, apoi semi-mecanizat pentru ca astăzi să se realizeze în totalitate mecanizat, deoarece producţiile la hectar sunt ridicate şi pe de altă parte sorgul recoltat, tăiat la dimensiuni de 50-80 mm trebuie procesat cât mai rapid, pentru a nu se altera sucul – principalul produs care se utilizează în industria alimentară. Lucrarea prezintă câteva aspecte privind cultivarea sorgului zaharat în România şi pe plan mondial, respectiv cele mai noi echipamente utilizate pe plan mondial pentru recoltarea sorgului zaharat.

INTRODUCTION

Sorghum bicolor (L) Moench originates in Africa (Ethiopia and Sudan), inscriptions about sorghum culture dating back over 2700 years, being discovered in a Syrian palace. The sorghum is part of the cereals included in the group of millet, with the common characteristic that they have smaller seeds than cereals commonly grown in large crops such as wheat, rye, barley, etc. (*Vlăduţ et al., 2012; Vlăduţ and Bungescu, 2003*).

Sorghum culture is widespread in Africa, Asia and even America, being a source of food, energy and raw materials in the light industry (braids, roofs, brooms, beverages, etc.). The sorghum is particularly tolerant of soil and climate, with a very high survival capacity, resisting the arid areas of the Sahara, Ethiopia, Kenya, Mozambique, Somalia, etc. Among the sorghum sorghum species are Sorghum vulgare and Sorghum cultivated respectively for the seed, Sugar Sorghum, Sudan grass (as forage), and for braids and brooms. The common sorghum (*Sorghum vulgare*) cultivation has a total expansion of about 44.000.000 ha, the annual average production being estimated at 1179 kg/ha, and global production estimated at 52.000.000 tons. Of the total annual cultivated 53.3 % serving in human food, 39.4% used for animal feed and 2% in light and food industry (*Vlăduţ et al., 2012)*.

Sorghum is the second most important feed grain grown in the U.S. in terms of planting acreage, and is also planted in areas in India and countries in Africa. Grain sorghum is a high biomass, plant which can produce not only grains but also bagasse, both can be served as resources for ethanol production. However, currently there is only one species of sorghum, Sweet sorghum has the potential to mass produce ethanol and three different components which can be used for ethanol production: grain, bagasse, and the juice (*Grigore et al., 2018; Sarath et al., 2008*; *Li et al., 2013*). The juice extracted from the plant stalks contains plenty of sugars, such as sucrose, glucose, and fructose, which can be directly converted via biological fermentation process into ethanol (*Nuanpeng et al. 2016; Oprescu et al., 2018; Techaparin et al., 2017*). Sweet sorghum is an important crop, and as fuel prices increase and water usage for irrigation becomes more limiting, its importance is expected to increase furthermore (*Ren et al., 2012*). Sweet sorghum exhibits several better characteristics over the other energy crops (drought and salt tolerance, has a short period of growth - up to 4 months and requires less water and fertilizer), leading to a low cost of production (*Pilap et al. 2018; Calviño and Messing, 2012*).

The economic importance of sorghum is quite significant given that 16% of the total cereal consumption in the world is represented by sorghum. In developed agricultural countries, sorghum represents about 25% of total cereals, with world grain production rising over 50% since 1960 (in the US, wheat and maize, grain is the most important cereal). Globally, sorghum is the fourth grain crop as a territorial extension, productivity and utility, its importance also deriving from its exceptional resistance to dryness caused by stress. On the other hand, sorghum is more tolerant to stress caused by floods than maize, but to shorter floods. It grows successfully on any soil but best develops on medium-textured soils, especially on sandy terrains. The sorghum is tolerant to the wide range of pH.

In Europe the greatest tradition in sorghum cultivation and the use of juice obtained by squeezing is Italy, during the Second World War the main direction of use was the production of ethyl alcohol which, together with gasoline, was used as aviation fuel 20% alcohol and 80% gasoline).

Currently it is grown on large areas in Africa and Asia and in Europe in the Russian Federation (210593 ha), France and Italy (about 45000 ha), Romania (9045 ha), etc. (*http://www.fao.org*).

In Romania, it is not known precisely when this plant was brought and cultivated, during the Second World War, the plant is cultivated in the areas of Bessarabia, Dobrogea, Prahova, Danube Plain and Banat.

Table 1

Countries with the largest areas cultivated with sorghum in 2016 *(http://www.fao.org)*

Crt. No.	Country	The cultivated area [ha]
1.	Sudan	9157680
2.	Nigeria	5816163
3.	India	5650000
4.	Niger	3604676
5.	United States of America	2494100
6.	Ethiopia	1881971
7.	Burkina Faso	1651961
8.	Mali	1560121
9.	Mexico	1513015
10.	Chad	1191355
11.	Cameroon	855854
12.	Tanzania	781885
13.	Argentina	673550
14.	Brazil	558189
15.	China	535463
16.	Australia	520527

Sweet Sorghum, is an ideal energy crop because it possess the following traits that would enable it to accumulate biomass: high conversion efficiency of light into biomass energy, high water use efficiency and high leaf level nitrogen use efficiency (*Taylor et al, 2010*), ability to grow in marginal land areas (*Zhang et al, 2012*), and a relatively high tolerance to soil constraints such as salinity and water concentration (*Dalla Marta et al., 2014*).

MATERIAL AND METHOD

Sugar has a high yield per hectare, usually at least 40 t/ha, reaching up to 80 t/ha, which leads to large quantities of handmade material that can be harvested very hard.

For this reason, harvesting of sweet sorghum is recommended to be done mechanically (with combine) when grown on large surfaces, the harvested material must be transported urgently to the place of processing (pressing) if it is chopped because the juice from the stems in contact the air is oxidized and altered if it is not processed quickly.

RESULTS

The mechanized harvesting of sweet sorghum was first made in the USA, cultivating large areas of this crop, at this time being the largest producer of sorghum in the world, although there are other African countries that cultivate larger areas but obtain more productions small per hectare.

As a result, John Deere, the world's largest manufacturer of agricultural machinery, has adapted the feed combines to harvest sorghum and has finally developed specialized combines, the CH 570 (Fig. 1) being one of them.

Fig. 1 – **Self-propelled John Deere CH570 for harvester sweet sugar cane and sweet sorghum (*https://www.deere.com*)**

John Deere CH570 harvester combine is provided with efficient front end for smooth uniform feed, reducing cane losses and soil content and a large cab integrates the latest technology with unparalleled comfort. John Deere-exclusive floating crop divider and contour basecutter height-control technology reduces soil content and cane / sugar sorghum loss and used a harvester activity monitor (H.A.M.) which will monitor harvester activities to improve operations. The CH570 crop dividers, side knives, knock down rollers, and floating sidewalls were redesigned for a smooth, uniform feed, reducing cane losses and soil content.

The inside scrolls were angled toward the inside to improve feeding in heavy cane; as a result, the crop-divider knockdown rollers are no longer needed and the outside scrolls are standard to prepare the operator for different circumstances. The length of the scrolls was increased so the separation of lodged tangled cane begins closer to the ground. Harvester activity monitor (H.A.M.) will monitor harvester activities to improve operations (Fig. 2).

Fig. 2 – **Harvester activity monitor (H.A.M.) (*https://www.deere.com*)**

On the H.A.M. screen, operators can identify areas of inefficiencies and take corrective actions that will reduce logistics cost. The H.A.M. accumulates information for:

- Harvesting time and distance traveled
- Headland turnaround time and distance traveled
- Time and distance traveled on the road
- Harvester idle time while waiting for transport or other
- Total time that engine is running and distanced traveled

Data is accumulated from the original start at the factory and from the last reset done. The information can be downloaded for further analysis using the USB data logging port.

Harvest Monitor screen

On-screen live cane flow

Fig. 3 – **On-screen monitoring (*https://www.deere.com*)**

While harvesting, the display will show:

- Harvester pour rate (ton/h)
- Extraneous matter (trash percentage)
- Fuel consumption (L/ton or gal./ton)
- Yield (ton/ha or ton/acre)
- Transport load count
- Live elevator cane flow video

Average, best, and current values of extraneous matter, fuel consumption, and pour rate are displayed instantaneously or as historical figures. Also available on the display is a summary report of all data.

Pour rate is defined as how fast the cane flows through the machine and is measured in tons per hour (ton/h). A soft key enables the operator to toggle between elevator hours (elevator pour rate) and total harvester hours (harvester pour rate). This soft key also changes the reading of fuel consumption using either elevator or total harvester hours.

CaseIH is an important producer of harvester combine for sugar cane / sorghum, one of the best combines from point of view of performances are the model CaseIH A8000 (Fig. 4).

Fig. 4 – **Self-propelled CaseIH A8000 for harvesting of sweet sugar cane and sweet sorghum** (***https://www.caseih.com***)

The technological innovations offered by this type of harvesters combine provide not only high productivity and availability, but also contribute to delivery of a raw material in accordance with industry specifications.

Ensuring efficient fuel consumption, the A8000 Series harvesters are equipped with the Smart Cruise intelligent engine, which optimizes fuel usage and makes harvester operation even simpler. Values such as harvesting in the most adverse conditions, simplicity of operation and maintenance, quality of raw materials, low operating cost and excellence in after-sales service give Case IH the best cost-reduction technologies.

The Extreme Chopper enables harvesting with greater speed, even in high productivity areas, and plant cane, result being a greater operational yield and lower fuel consumption (litres/tonne of sugarcane harvested). The Extreme Chopper provides 39% more power compared to the earlier chopper, increased chopper drum speed from 180 rpm to 205 rpm, and billet length adjustment from the cab.

To facilitate operation, the cab enables the operator to electronically control steering and the transmission with a single joystick. This eliminates the levers on track machines and the steering wheel in tyre machines. Besides reducing the effort required of the operator, this system makes it possible to manoeuvre in smaller areas, without putting excessive stress on the chassis.

In China the company JingGong build small self-propelled tracked combines that cut the whole stalk of sweet sorghum (Fig. 5).

Fig. 5 – Self-propelled tracked combines for cut the whole stalk (*https://jg-excavator.en.made-in-china.com*)

Another medium capacity combine model is manufactured by SIHNO MACHINERY LIMITED (Fig. 6) which is provided with an advanced hydraulic system for cutting / harvester sugar cane and sweet sorghum.

Fig. 6 – Self-propelled combines with advanced hydraulic system for cutting / harvester *(https://sihno-machinery.en.made-in-china.com)*

The company Guangzhou Laurel & Honesty Holdings manufactured a self-propelled combine of 44 kW (Fig. 7), which cut the whole stalk of sweet sorghum and leave them on the ground.

Fig. 7 – Self-propelled combines with advanced hydraulic system for cutting / harvester (*https://laurel-generator.en.made-in-china.com*)

CONCLUSIONS

Small / medium-sized combine harvesters for cutting whole sorghum / cane stalks are relatively many, especially in China, and this type of combine is intended for small-sized farmers who want to store them and then process them.

When there are large holdings of several thousand hectares, John Deere CH570 and CaseIH A 8000 autoclaved combs are combined with large capacity transport systems (tractors and trailers), which allow the harvesting and rapid transport of harvested material, minced at sizes 40-50 cm, directly in the processing to obtain juice, alcohol, etc.

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SWEET SORGHUM – AN ALTERNATIVE FOR ROMANIAN FARMERS IN THE CONDITIONS OF THE CURRENT CLIMATE CHANGE
/
SORGUL ZAHARAT – O ALTERNATIVĂ PENTRU FERMIERII ROMÂNI ÎN CONDIŢIILE SCHIMBĂRILOR CLIMATICE ACTUALE

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ABSTRACT

Cultivation of sugar sorghum is a widespread tradition throughout the country, for the usefulness and especially the profitability of this culture. Sugar sorghum is a highly favored and sought fodder plant, with multiple nutritional qualities, being consumed fresh, silage, or as grist, from which starch, alcohol, etc. can be obtained. This paper presents some uses of sorghum, which through its multiple uses can be an alternative to technical plants cultivated frequently in our country.

REZUMAT

Cultivarea sorgului zaharat este o tradiție răspândită pe tot teritoriul țării, pentru utilitatea și mai ales profitabilitatea culturii. Sorgul zaharat este o plantă furajeră foarte apreciată și căutată, cu calități nutritive multiple, fiind consumat proaspăt, însilozat sau sub fomă de măciniș, din el putându-se obține amidon, alcool, etc. În această lucrare se prezintă câteva utilizări ale sorgului, care prin multiplele utilizări poate constitui o alternativă la plantele tehnice cultivate în mod frecvent în ţara noastră.

INTRODUCTION

Sweet sorghum is a genus of plant of the Poaceae family. The main representative, Sorghum bicolor, is the main cereal for bread in Africa, South Europe, Central America and South Asia. The sorghum is a perennial herbaceous plant, with a height of up to 2.5 m, and on the outside it resembles corn. The stem is straight, dry, with nodules and has a well-developed root that penetrates deep into the soil. Leaves are alternate, broad, pubescent, with sharp edges, green. Flowers are placed in bunch, straight, bent or bent, with a length of up to 70 cm. The fruit is an acacia, oval, hollow or covered with white, pink, red or yellow skin. Sugar sorghum blooms in June - July. Originally from Equatorial Africa, it is also spread in India and China, where it has grown for more than 3000 years. The crop was brought in Europe in the XVth century (*Vlăduţ et al., 2012; Vlăduţ and Bungescu, 2003*).

The sorghum is called a camel plant because it grows where no other plant would resist. It is cultivated in areas with few and often irregular rainfalls. Secondary roots are twice as large as corn at the same age.

Sorghum is a grassy, technical and fodder crop. Depending on the uses, there are several sorghum species for: grains, sugar, brooms and animal feed (*Grigore et al., 2018; Sarath et al., 2008*; *Li et al., 2013*). Worldwide, sorghum is one of the most important cereals, with approx. 44 million ha cultivated (*Vlăduţ et al., 2012)* in USA, India, Nigeria, Australia, Argentina, also in Europe: Italy, Turkey, Greece, France, Romania, Bulgaria, Hungary, or in the Russian Federation, Ukraine (*fao.org*).

The multiple uses of this plant are as follows:

- sorghum grains are used directly in human nutrition in the regions of Africa and Asia;
- absolutely delicious popcorn from sorghum seeds can be obtained;
- syrups or even sugar substitutes can be produced;
- in the industry for starch extraction, alcohol and beer production;
- wine and vinegar can be obtained from sorghum;
- with a nutritional value close to corn, sorghum grains have a wide use in animal feed: fattening cattle and poultry;

- sorghum hay is superior to corn hay, as it contains large amounts of calcium, phosphorus and carotene;
- in silo form, sorghum has the same value as silo corn and is very easy to enslave due to the high carbon content of carbohydrates;
- biofuel: ethanol can be obtained from sorghum;
- raw material for the manufacture of brooms;
- in some parts of the world, sorghum is used to make furniture.

All these products obtained from sorghum have the major advantage of growing the plant on less fertile soils combined with minimal requirements of this plant against water. The sorghum is more tolerant than corn to the stress caused by shorter floods. It grows successfully on any soil but it develops best on medium-textured soils, especially on sandy soils. The sorghum is tolerant to the wide range of pH.

In countries with developed agriculture, was sought to obtain hybrids with high uniformity, early maturity, small size (to facilitate easy mechanization of maintenance and harvesting). In Romania it is not known exactly when this plant was brought and cultivated. The literature mentions that in 1936, "it was cultivated a hectare with gaolian and in all it succeeded", the initiative being of the quoted author, who remained impressed by a battle episode in 1904 in the Russo-Japanese war, when the Japanese were masked by a dense crop of cualiang (the name of Manchuria Sorghum). During the Second World War, the plant is cultivated in the areas of Bessarabia, Dobrogea, Prahova, Danube Plain and Banat.

In Banat, in the plain area, the cultivation and processing of sugar sorghum is known in the villages of Uivar, Pustinis, Liebling, Foieni, Ionel, Covăciţa, etc. since the beginning of the 5th decade of our century (*USABT, 1991*). In Romania, the sorghum meets favorable conditions of culture in the areas of 20-22°C isotherms for the summer months and the isochies between sea level and 500 - 600 m altitude.

Preferred soils for sorghum are those with deep neutral or alkaline reaction. On compact, cold or underground ground water, yields are diminished (*Zhang et al., 2012*).

The sorghum should not be absent from the rotation made on the sandy, alkaline and saline soils, or on the sloping soils, due to its high adaptability to drought (sweat rate 158-274), alkalinity (pH 5-9) and soil salinity or in prevention of deflation on sandy soils.

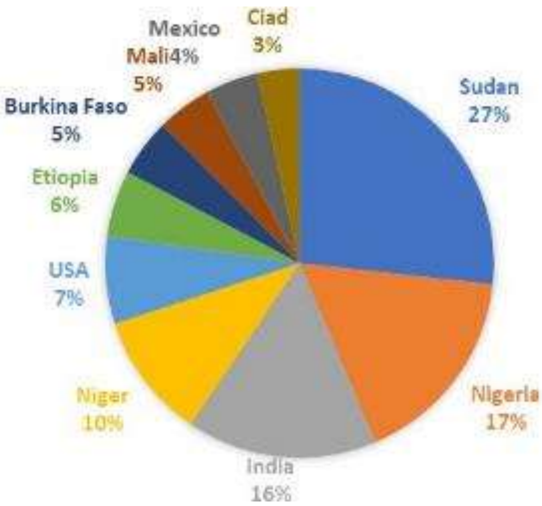

Fig. 1 - FAO databases with the first ten contries in word with the largest areas cultivated with sorghum in 2016 (*fao.org*)

MATERIAL AND METHOD

For years, the southern and south-eastern agricultural areas have been hit by drought. Climate change over the last decade, characterized by the strong and sudden frequency of the climate, has negatively affected the productivity of all agricultural crops. That is why, in the created situation, it is necessary to implement crop varieties, which in harsh climates would ensure productive yields.

Sorghum grains, sugar sorghum, technical sorghum, Sudan grass and sorghum hybrids are crops positive for drought and high temperatures, that can bear salinated soils, have good fooder capacity, a wide use for food purposes, and a great perspective as an energy source (*Pilap et al. 2018; Calviño and Messing, 2012*).

Surely, sorghum crops meet these strict requirements because, compared to other agricultural crops, for the formation of one kg of dry weight the sorghum uses much less moisture of 271 liters, while the alfalfa requires 850 liters, oat 635 liters, wheat 505 liters, sugar beet 475 liters, corn 372 liters (*Ren et al. 2012*).

Research, as well as the results obtained in the production, reveals that in the climatic conditions characteristic of the southern and central part of Romania, sorghum crops can ensure the stability of the higher crops of grains and of the vegetal mass, as well as of the increased quantities of sugar.

Taking into account the low profitability of vegetative production of degraded soils, sandy or saltings, in their case spring cultivation with sorghum it is welcomed (*Oprescu et al, 2018; Dalla et al., 2014*), in this case achieving to raise the production of grain and green mass on the mentioned areas, thus contributing to the rehabilitation of cattle and poultry livstock in the country.

Sorghum seeds, according to their nutritional qualities, are similar to corn, barley or other cereals. In many countries, large quantities of sorghum are used in daily food as feedstocks in: groats, flour, starch, alcohol, beer, etc., as well as compound fooder or biofuel.

RESULTS

Use of sorghum for food production

Sugar sorghum has a worthwhile nutritional value, which recommends it for people's nutrition. The high nutritional value of sorghum provides 43% of the daily protein dose. One of the less known information about sorghum is that it contains almost double the essential amino acids compared to quinoa and more than that is known as a good and accessible vegetable protein source. For vegetarians and vegans, sorghum has an important nutritional value because they can not take their protein from animal food.

Sorghum is one of the best sources of dietary fiber: one portion provides 48% of the daily recommended fiber consumption and 48% carbohydrates in the daily dose required. Dietary fibers help the digestive system to function properly, preventing digestive problems such as bloating, cramping, stomach pain, constipation, diarrhea and flatulence.

The sorghum contains a wide variety of beneficial phytochemicals that act as antioxidants in the body, such as tannins, phenolic acids, anthocyanins, phytosterols and policosanols. Studies have shown that whole grains, in general, and sorghum in particular, are correlated with the reduced risks of some forms of digestive tract cancer, colon cancer or esophageal cancer. These antioxidants are found in sorghum brans. Antoxidants eliminate the free radicals in the body that make healthy cells turn into cancer cells.

It can provide 47% of the daily iron requirement, 55% of the daily phosphorus dose and 19% of the potassium. The iron contained in sorghum protects the body against anemia, an adequate amount of iron and copper favoring the production of red blood cells, increases blood circulation, promotes hair growth and increases energy level. It also improves the cognitive power and optimal functioning of the brain and neurotransmitters that depend on phosphorus. Phosphorus helps to control emotions, and phosphorus deficiency is associated with decreased cognitive power and age-related neurodegenerative disorders such as dementia and Alzheimer's disease. It reduces cholesterol without affecting good cholesterol (HDL). Sorghum beans can control bad cholesterol (LDL) levels. The high amount of fiber helps lower bad cholesterol (LDL), thus contributing to heart health. It prevents heart attacks, atherosclerosis and strokes.

The sorghum contains a large amount of tannin that restricts the absorption of starch by the body, thus regulating glucose and insulin levels. The sorghum helps balance these levels, eliminating sudden increases in blood glucose and also it prevents diabetic shock. Sorghum has a low glycemic index.

It ensures heart's health by controlling the blood clotting process. Ethanol extracted from sorghum grains has a strong anticoagulant action and so sorghum can be recommended as a good source of antithrombotic nutrition. It has anti-inflammatory effects due to high phenolic content. By measuring the polyphenolic compounds of the various types of sorghum, it has been found that the black sorghum and sumac sorghum varieties have significant levels of antioxidants. These polyphenolic compounds are found naturally in plants and are designed to protect them against pests and diseases. Many fruits contain these compounds, but sorghum brans have proven to be the richest and cheapest source.

The sorghum does not contain gluten and therefore it is recommended in the diet of people with celiac disease / gluten intolerance. Celiac disease occurs due to food intolerance, namely intolerance to gluten. Gluten is a protein found in wheat, barley and rye. It is well known that wheat, so implicitly gluten, is found in many foods, which makes the symptoms of the disease, in the case of celiac disease, worsen.

The sorghum helps to relieve nausea, inflammation of the small intestine, pain and gastrointestinal lesions caused by gluten. The high content of vitamin B6 (34% of the body's daily dose per 100 g) makes it an ideal food for people who often have mood swings. Vitamin B6 plays a huge role in producing neurotransmitters like brain serotonin, which controls the mood. Vitamin B6 is essential to prevent mental suffering, depression, anxiety and fatigue. Vitamin B6 also contributes to the production of hormones in the brain that have the role of controlling mental illness and mood disorders. Studies show that vitamin B6 supplements help to change the mood.

The sorghum is rich in manganese, a vital component of thyroxine, which is an essential hormone in the thyroid gland, favoring its good functioning. A balanced functioning of the thyroid gland favors eliminating extra pounds, reducing appetite and balancing metabolism. The sorghum also contains magnesium, which helps to maintain optimal calcium levels by increasing calcium absorption in the body. These two minerals are essential for the development of bone tissue and for accelerating the healing process for the elderly. This makes age-related illness such as arthritis or osteoporosis avoided.

The sorghum has not been genetically modified, and other genetically unmodified grains are: amaranth, buckwheat, oats, quinoa, rye, etc.

The sorghum is a versatile cereal, which can be prepared similarly to rice or corn and in some countries is consumed as porridge or boiled in various dishes (*nutritiondata.self.com*).

It can be eaten before the beans are dried (as corn) because it is sweet. Like corn, sorghum has sweet endosperm with 30% glycogen content.

Fig. 1 – Sorghum grains

Fig. 2 – Sorghum pop-corn

Fig. 3 – Sorghum biscuits

Sorghum flour - is used as an ingredient in the manufacture of gluten-free products such as: bread, pasta, spaghetti, biscuits, etc. Sorghum flour is used as an ingredient in gluten-free flour mixtures, along with starch and baking agents. Used as a main ingredient, sorghum flour is only recommended for dried confectionery products such as biscuits (*Pramod et al., 2012*).

However, in order to obtain good results, it is recommended to mix sorghum flour with tapioca starch, because the texture and volume are improved. To improve the moisture content, more oil or eggs must be added. Apple cider vinegar or ascorbic acid can also improve the volume of doughs made with sorghum flour.

In sugar sorghum strains there is up to 20% sugar and given this high index, sugar sorghum is mainly used for the production of syrups and even sugar, by pressing the strains (Fig. 4 and Fig. 5), the jam, the alcohol, different sweets (*Taylor et al, 2010*).

Fig. 4 – Sorghum syrup

Fig. 5 - Manual press for sugar sorghum

In addition, plant strains are used in the production of fooder, vitamin complexes, and food additives. The sorghum strain contains large amounts of sugar. The largest amount of plant material is concentrated after flowering. Sugar sorghum is very popular in production because it produces good harvest and does not impose large soil demands, climatic conditions (other than the required thermal energy), tolerates drought, shows high yield even in marginal soils (Fig. 6). Hence, interest in this plant has recently increased in all countries with appropriate climatic conditions. The cost of sorghum sugar reaches only half the price of the same product made from sugar cane and beet. When cultivating this crop, much less pesticides are used, which is due to the high resistance of plants to diseases and pests. Thus, the product based on sorghum is more environmentally friendly and healthier.

There is a type of sorghum that can make popcorn like those of corn. The grain of sorghum used for popcorn is smaller than popcorn corn, but popcorn is as crisp and delicious as corn.

Sugar sorgghum is widely used as animal feed and produces silo and hay (Fig. 7), rich in nutrients. The most optimal for feeding in the field of animal husbandry is the mixed silo of sorghum and corn (5-50 %).

Fig. 6 - Harvesting of sorghum grains

Fig. 7 - Harvesting of sorghum for animal feed

The sorghum also has the property that it can be frozen and reheated without losing its taste and texture. Unlike other cereals, the sorghum behaves well when it is frozen and then returned to the original state, so it can be prepared in advance with different spices and then stored in the freezer for later use.

Use of sorghum for animal feed

The sorghum can completely replace animal feed because it has equal or higher nutritional qualities than corn. The digestibility of the sorghum is about 86% of the dry matter. It has a higher protein level than corn.

Starch and fats. The starch and sorghum content of sorghum is similar to corn. Moreover, the advantage of sorghum is the high protein content. It is also a source of soluble vitamins.

Energy value. The digestible energy of sorghum is quite high, as well as the digestibility of proteins and amino acids. The flexibility offered by sorghum in formulating prescriptions allows the nutritionist to lower costs and maintain the same growth rate. For swine growth, the energy content of sorghum is practically equal to that of corn: 3.931 kcal / kg SU in sorghum, compared to 3.924 kcal / kg SU in corn (source: INRA), and for sows: sorghum - 4.002 kcal / corn - 4.081 kcal / kg SU (source: INRA). The introduction of sorghum into the food of the swine has reached 50%. The fat content of sorghum is similar to that of corn, but with the better fatty acid profile. The fatty acid profile of swine ration influences the quality of the carcass. Sorghum fatty substances contain fewer unsaturated fats. The advantage of sorghum compared to corn has been confirmed for broilers, the most used cereals in feed ration being corn, wheat, barley, rice and sorghum. In addition, sorghum is the most energy-consuming cereal product. Protein digestibility and amino acid level are almost identical for sorghum and corn.

Some studies have shown that grain sorghum can be incorporated into the whole animal, unprotected, without causing any loss of digestibility. Also, up to 55% of sorghum can be fed into turkey feed recipes and up to 70% in broiler chickens and laying hens. In feeding cattle for meat, cereals are the most common source of energy. The presence of starch has an essential role in increasing animal performance. Therefore, the high content of sorghum starch, which is at the same level as corn, makes it useful in cattle-fodder feed. Sorghum ferments slower than other grains, but the calculated rate of digestion of crude protein, starch and dry matter is the same for both corn and sorghum (*Herrera - Saldana, 1990*).

Sorghum contains more crude protein than corn. In the feeding of dairy cattle, barley, wheat, corn and grain sorghum are potential sources of energy. Sorghum is a preferred crop when the water resources of the area are limited. Cereals are the main source of starch in the feeding of dairy cattle, to obtain a high level of milk production. The presence of starch in the rumen of ruminantsis is the first step in improvement of milk production. In this case, sorghum grains are a very important source of starch. Fermentation of sorghum is slower than other cereal products but is complete after 48 hours of introduction into the rumen.

Sorghum grains have a high phosphorus content

Definitely, nutritionists and producers of compound feeders agree that sorghum has its place in animal feed, having a quality already proven. Moreover, savings can be made by using sorghum in recipes, while maintaining a high level of nutritional qualities. On the other hand, the main concern of the manufacturers of compound feeds is the lack of grain sorghum in the market, which presents the risk of an imbalance of recipes. Therefore, at this time, sorghum is used less as compared to corn.

The sorghum for silo is excellent for use in animal husbandry due to the following characteristics: excellent palatability, high digestibility (60%) and high sugar content (22%). BMR Gold X is suitable for obtaining hay and is an excellent solution for IInd crop. It has a production potential of up to 80000 kg of green weight / ha, and in the crop conditions of 2015, in Romania, yields of over 70000 kg of green weight / ha have been achieved. The recommended seed density is 280000 germinable grains / ha.

Biofuel from sorghum

The oil crisis is a global problem, creating urgently the need for new energy sources. Alcohol can partially replace oil, and the challenge is how to get high volumes of alcohol. Sorghum is an effective material in alcohol production.

Alcohol production using sorghum grains

Due to the high starch content, sorghum grains are an important source of alcohol. Normally 1000 kg of sorghum grains can produce 390 liters of alcohol.

Sorghum is considered one of the most valuable sources of biofuel, and especially sugar juice is used (*Nuanpeng et al. 2016; Oprescu et al., 2018; Techaparin et al., 2017*).

Scientists have demonstrated the benefits of using sorghum for the production of biofuels: bioethanol, biogas, solid fuel as briquettes. The benefits of using this bioenergy culture include:

- high productivity;
- easy crop care;
- drought resistance;
- resistance to diseases and pests;
- cultivation does not require the use of special equipment.

The main raw material for the production of biofuels is corn. However, according to research by American scientists, sorghum is more efficient and more economical. In America and China, programs have been introduced to develop a technological process for the large-scale application of sorghum for the production of biofuels.

Once the sorghum biomass is used and the energy is extracted by hydrolysis and fermentation processes, to obtain combustible products, such as ethanol, or chemicals such as acetone, the remaining plant material can be further used to produce even more energy through anaerobic fermentation with production of biogas and very valuable organic fertilizer for the production of agricultural biomass.

The central objective of the global economy for a sustainable future must be the strategic integration of different biotechnologies based on two concepts: biorefineries as industry for the future and sustainable agriculture by preserving existing bioresources. Perhaps the greatest difficulty is to connect different biotechnologies to develop a sustainable and efficient eco-bio-technology.

Thus, unfamiliar sorghum has a huge potential for use in the food, perfume, medical, bioenergetics and animal husbandry industry. In addition, the plant has high content of nutrients and vitamins. Since this plant is not yet known to a wide range of people, it is possible to firmly place its niche in the business sphere on the basis of its application.

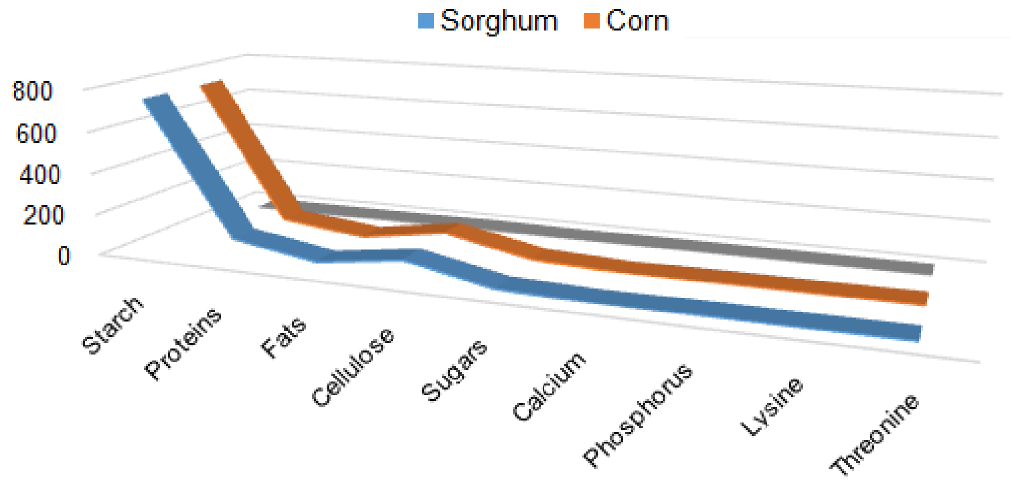

Fig. 8 - The nutritional composition of sorghum compared to corn

It is known that biogas production must be the last link in the concept of bio-refinery, so residues and by-products resulting from the production of other biofuels (bioethanol) can be fermented anaerobically, resulting in methane, an additional amount of energy. The mineral and organic substances resulting from the fermentation process will be reintroduced into the soil by applying the digestate as a fertilizer with an important nutrient content. This approach will help to avoid the depletion of soil nutrients, an important aspect to support the "renewable" concept. If soil quality is affected by the intensive cultivation of various plants for a long time, the depleted soil will become unsuitable for agriculture, so the applied technology will be unsustainable and the production of biomass will be inefficient, so the energy source becomes non-renewable.

Spirits beverages made from sorghum

At the base of obtaining ethyl alcohol is the alcoholic (anaerobic) fermentation of sugars by the use of yeasts using selected strains. Alcoholic fermentation results in the formation of ethyl alcohol and CO_2 as the main compounds. The fermentation time is 48-72 hours, depending on the temperature. In the case of obtaining molasses, the amount of yeast used for fermentation is higher.

The brewing industry has been known for thousands of years, Babylonians and Sumerians being the first to make its manufacture. Beer is a highly appreciated beverage, with a large variety of blonde and brown beers on the consumer market, with high or low alcohol content (even zero). From sugar sorghum it is possible to make beer (Fig. 9) (*http://nutritiondata.self.com*) or different kinds of alcoholic beverages (Fig. 10) (*http://nutritiondata.self.com*).

Fig. 9 - African beer made from sorghum
(*http://nutritiondata.self.com*)

Fig. 10 – Spirits beverages made from sorghum
(*http://nutritiondata.self.com*)

Raw material for beer production:

- in Europe: barley;
- in Asia (India): rice;
- in Africa and Asia: sorghum (rich in nutrients).

Manufacture of sorghum plywood

The cellulose content of the sorghum strain is very high; it has about 48% of its dry weight. Sorghum strains can be used to produce sorghum plywood (Fig.11). By comparing the plywood made from residual resins and the sorghum plywood, the sorghum plywood has several advantages:

A. high mechanical strength;
B. better insulation capacity;
C. very durable;
D. reduced specific weight;
E. forests are preserved.

The material used to produce sorghum plywood is the sorghum strain. Sorghum is an annual plant with many varieties grown all over the world, making it simply used as a raw material for plywood production.

On the other hand, sorghum strains are by-products of the plant after harvesting the grains. Using sorghum stems to make plywood will save woody material. Because sorghum plywood is a substitute for wood, it can conserve hectares of forests. Sorghum plywood can be used in construction, in the manufacture of doors, furniture and decorative materials.

Fig. 11 - Conglomerate plywood for furniture manufacturing *(fao.org)*

Manufacture of paper from sorghum

Leaves and stems are raw materials for paper manufacture, which can be used for writing (raw material paper), wrapping paper and other products. In addition, residues of sweet sorghum stems remaining from the production of sugar are also used in papermaking.

By comparing other materials from which paper can be obtained, sorghum leaves and strains are easily converted into paste. The sorghum paper process uses only a small amount of chemicals to obtain paper. However, the paper obtained from the sorghum leafs and stems shows strong transparency and high brittleness, low bending strength and is very brittle after drying.

CONCLUSIONS

Based on the above informations, the following conclusions can be drawn on the characteristics of sugar sorghum:

- has drought resistance and short-term water excess;
- has resistance to high temperatures during the hot summers;
- has low soil nutrient requirements, is cultivated on sandy or salty soil;
- has low requirements for the use of expensive fertilizers (nitrogen, phosphorus, potassium, etc.);
- hybrid varieties are very resistant to diseases and pests;
- sorghum is an organic plant, absorbs three times more carbon dioxide than the forest;
- sorghum is a very valuable nutritional plant, it does not contain gluten, and sugar used as sweetener does not harm those who have diabetes;
- sorghum can be used in the manufacture of alcoholic beverages (beer and ethyl);
- sorghum can be considered a very valuable feed, rivaling with corn;
- sorghum can be used in industry as raw material for the production of biofuel, bioethanol, biogas or plywood for construction;

- works of crop establishment, maintenance, harvesting and conditioning of sorghum can be carried out using the existing machines on the vegetable farms which are the same as those used for the cultivation of corn;
- sorghum is a heat-loving plant;
- sorghum requires great attention to post-emergence maintenance

Hence, it can be observed that sugar sorghum can be considered for cultivation on larger surfaces in our country, being an alternative to frequently cultivated cereals and technical plants, because it has some characteristics that recommend it before them.

ACKNOWLEDGEMENT

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CONSIDERATIONS ON OBTAINING OF ALCOHOL FROM SWEET SORGHUM / *CONSIDERAŢII PRIVIND OBŢINEREA ALCOOLULUI DIN SORGUL ZAHARAT*

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ABSTRACT

Sweet sorghum has many uses in the food and chemical industries due to its high sugar content, from the juice obtained by pressing of stems being obtained raw alcohol and further, by various technologies: ethanol, bioethanol, etc. This paper presents some aspects regarding the conditions, characteristics and technologies that make the sweet sorghum an important plant for the production of alcohol.

REZUMAT

Sorgul zaharat are numeroase întrebuinţări în industria alimentară şi chimică datorită conţinutului ridicat în zahăr, din sucul obţinut din presarea tulpinilor obţinându-se alcool brut şi apoi prin diverse tehnologii: etanol, bioetanol, etc. În această lucrare se prezintă câteva aspecte privind condiţiile, caracteristicile şi tehnologiile care fac din sorgul zaharat o plantă importantă pentru obţinerea alcoolului.

INTRODUCTION

The alcohol and yeast industries are mainly based on the fermentative activity of yeast, which converts fermentable sugars from the substrate into ethyl alcohol as the main fermentation product and respectively biomass (*scribd.com*).

The word alcohol comes from the Arabic word al-kohol, meaning thing, subtle object, and is for the first time cited in Europe in the 13th century by the Italian alchemist Taddeo Aldoretti (Firenze).

In the 13th century, alcohol was produced for the first time by synthesis or by the composition of elements obtained from mineral substances. At present, large amounts of alcohol are produced both naturally and synthetically.

Worldwide, ethyl alcohol is currently produced mostly by fermenting of leaven containing fermentable sugars, with the help of yeast. Ethyl alcohol obtained by biotechnology is also called bioalcohol, thus distinguishing from the ethyl alcohol obtained by synthesis. Refined ethyl alcohol has various uses in different industries. In the food industry it is used for the production of alcohol beverages and vinegar, in the chemical industry for the production of synthetic rubber and as a solvent, in the pharmaceutical industry for the preparation of certain substances (ether, chloroform), and in medicine as a disinfectant, known as medicinal alcohol or alcohol (further mentioned as spirit).

Depending on its quality, the neutral alcohol is used for a variety of applications (*scribd.com*):

• Neutral alcohol is the basis for aromatic alcoholic beverages, vinegar and a wide range of chemical and pharmaceutical products and processes;

• Very neutral alcohol - with the highest purity and defined taste profile, is used in the production of alcoholic beverages, such as vodka;

• Dehydrated neutral alcohol, which is virtually water-free, is used in chemical, pharmaceutical and cosmetic products.

The spirit industry is mainly based on the fermenting activity of yeasts, which converts fermentable sugars from the substrate to ethyl alcohol as the main fermentation product and respectively biomass.

The notion of spirit is the common name of the alcohol produced by the industrial process, by this understanding a mixture of ethyl alcohol (up to a concentration of 96.5% by volume), water and other elements. It is a colorless liquid, with specific smell, burning taste, miscible in any proportion with water, and flammable. Thus, the refined ethyl alcohol, also called refined spirit, which is obtained as the main product in spirit factories, has an alcoholic concentration of about 96% vol. In spirit technology is also found the notion of absolute or anhydrous ethyl alcohol, which actually means the chemical substance as such (100% ethyl alcohol).

Absolute alcohol, at a concentration of 99.8% vol., is used as fuel in petroleum-free countries, in a mixture of 20 ÷ 30% with gasoline to which will increase its octane rating. The most ambitious program for using alcohol for energy purposes is Brazil, which, under the name PROALCOOL, aims to replace 15 ÷ 21% of the amount of gasoline with alcohol obtained from sugar cane. In Japan, the RAPAD (Research Association for Petroleum Alternatives Development) program was developed, aiming to obtain ethanol and acetone-butanol-ethanol through biotechnological processes that use cellulose as raw material (*Ştefan L., 2017*).

In France, the Carburol program aims at obtaining ethyl alcohol from beet and butanol from straws. In New Zealand, studies have been conducted to produce ethanol from lactoserum.

The notion of yeasts include both compressed yeast used in the bakery industry as a biological loosener, and also fodder yeast, which is widely used to supplement the protein deficiency worldwide for animal feed.

Depending on the nature of the useful substances they contain, the raw materials used in the manufacture of alcohol can be classified as (*Ştefan L., 2017*):

- starch raw materials: cereals: corn, rye, wheat, barley, oats, rice, sorghum, etc., potatoes, roots and tubers of tropical plants: manioc roots, bathe tubers, etc.
- sugar raw materials: beet, sorghum and sugar cane, beet and sugar cane molasses, grapes, fruits, sweet grains, etc.
- cellulose raw materials: wood waste of fir, spruce, beech, etc., bisulfite lyes resulting from the manufacture of cellulose.
- raw materials containing inulin and lichenin: topinambur tubers, chicory roots, Icelandic mussels.

The listed raw materials do not exhaust the totality of raw materials that can be used in the production of alcohol; research is conducted to discover new sources of raw materials from which alcohol can be obtained in economic conditions.

The most used raw materials are molasses, cereals and potatoes, and the processing the raw materials, results in residues and waste.

MATERIAL AND METHOD

With high yields per hectare (40-80 t/ha) and high sugar content in stems, sweet sorghum is a very important plant for agriculture, food, chemical and pharmaceutical industries.

One of the methods of capitalizating thesweet sorghum is the processing of the juice obtained from the pressing of the stems, by various technologies to obtain the alcohol, which can further be converted into ethanol, bioethanol, etc.

RESULTS

A. Bioethanol

Bioethanol is obtained by microbial fermentation of sugars extracted from crops rich in sugar and starch, or from non-food lignocellulosic biomass. To be economical and competitive as an alternative fuel, the bioethanol must be produced either from non-edible crops or from low-cost biomass, i.e. lignocellulosic materials, as sustainable substrate, to eliminate conflicts (*Vicenza F., 2013*).

Bioethanol is ethanol produced by distilling the fermentation product of simple sugars (glucose, maltose, and raffinose). These simple sugars are obtained from (*Negro et al., 1999*):

- sugar plants (sugar beet, sugar cane,sweet sorghum);
- starch plants (corn, wheat, potato);
- lignocellulosic material (residual biomass).

Starch and lignocellulosic material (in fact hemicelluloses and celluloses) are converted to simple sugars by enzymatic degradation (hydrolysis).

The solution of fermentable sugars is treated with beer yeast (or, in advanced technologies, with *Zygomonas mobilis* bacteria) and left to ferment. Alcoholic fermentation takes 2-3 days in case of yeast, several hours in case of bacteria. The tanks in which the fermentation takes place must be cooled, because by fermenting of each kg of fermentable sugar, 133 kcal is released. Carbon dioxide formed during this time can be collected in gas meters (and should be collected because otherwise it contributes negatively to the greenhouse effect).

By alcoholic fermentation is produced a liquid, called leaven, containing up to 18% alcohol, the rest being water, small amounts of glycerin, and alcohols: propyl, butyl, amyl, etc. This liquid is subjected to a first distillation, resulting in 90% crude ethanol. The distillation residue is called marc and is used as animal feed because it contains proteins, fats etc.

The raw alcohol is subjected to rectification, in rectification column, to obtain as a distillation product an alcohol of 95.6%, and as a distillation residue glycerin and fusel, an oily liquid consisting of higher alcohols (propyl, butyl, amyl).

The 95.6% alcohol is an azeotrope mixture, with boiling point at 78.15 °C; therefore, to obtain a pure alcohol (absolute alcohol, required to be used as bioethanol) no further distillation may be yet used (for the azeotrope to be distilled as a pure substance), but special dehydration methods are applied (e.g. treatment with substances which easily combine with water, such as calcium oxide, calcined calcium sulfate, etc.) followed by distillation.

The production of biofuels involves a whole chain, which starts with the farmer who cultivates the energy plant and ends up with the fuel pump.

Biofuel production results in the following by-products:

- Biodiesel from rapeseed: glycerin, rape cakes;
- Bioethanol from sweet sorghum: sorghum bagasse (sugar squeezed sorghum stems), fermentation yeast / marc;
- Bioethanol from corn: corn marc, fermentation yeast.

Technology to obtain ethanol from sweet sorghum

The flow diagram of the alcohol production process is shown in Figure 1. The mixture must be pressed twice, moistened between first and second time with water to dilute the pulp contained in the sweet liquid (maceration), the maximum possible storage being about 90- 93% of the total sugar content of the stems. The extracted juice passes through the filter, where the impurities are separated (*Kashapov et al., 2016*).

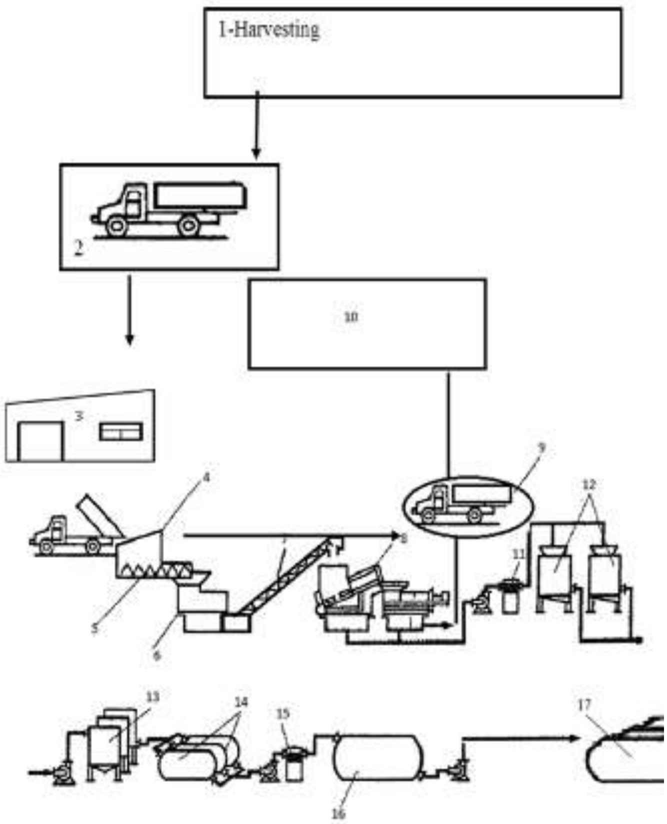

Fig. 1 - Diagram of process flows of alcohol production (*Ştefan L., 2017*)
1 - harvesting; 2 - transport truck; 3 - machine weighing; 4 - funnel; 5 - conveyor belt; 6 - breaker; 7 - screw conveyor; 9 - transport truck; 11- filter; 12 – storage tanks; 13 – capacities for maturing of the finished product; 14 - evaporator; 15 - thin filter; 16 - distribution; 17 – storage

Sweet sorghum from world agriculture occupies over 30 million hectares. Sugar content of sweet sorghum juice is not inferior to that of sugar cane, but juice differs in composition. Sugar cane contains only sucrose (crystalline sugar), while sweet sorghum juice contains sucrose, and in addition glucose and highly soluble starch, which interferes with crystallization. Additionally, an important feature is that sweet sorghum belongs to plants with photosynthesis C4 and, therefore, the photosynthetic potential is 2-3 times higher than that of spring wheat, soy grains and sugar beet. The maximum number of sugar accumulation coincides with the wax phase and the full maturity of grains. From one hectare of sweet sorghum sowing, can be obtained 5-7 tons of sugar and 15 tons of paste and 3-5 m^3 of alcohol (*Kashapov et al., 2016*).

Under the conditions of our country, sweet sorghum has the highest yield for the production of bioethanol (*eco-research.eu*).

B. Sugar sorghum

The sorghum (Sorghum bicolor (L) Moench) originates in Africa (Ethiopia and Sudan), as inscriptions about sorghum culture date back to 2700 years, being discovered in a Syrian palace (*Vlăduţ et al., 2004*). In the last 25 years, sweet sorghum (Figure 2) is cultivated only experimentally in Romania. This is an annual plant, resembling to corn, very drought-resistant, with a rapid vegetative cycle, with much lower requirements for fertilizers than corn.

Fig. 2 - Sweet sorghum crop

Sweet sorghum is characterized by its height and the production of carbohydrate-rich biomass. The sorghum stem is squeezed, similar to sugar cane, releasing sweet juice with high sugar levels (12-20%) composed mainly of sucrose, glucose and fructose, good substrates for ethanol fermentation, and leaves behind lignocellulosic biomass, bagasse (*Serna-Saldivar et al., 2012*).

The main arguments in support of the expansion of whole cultivation and industrialization of sweet sorghum in Romania are:

- there are extensive areas of agricultural land, unexploited or inefficient, that can be made more efficient by massive sorghum crops, and thus new jobs can be created;
- the cultivation of sorghum can produce very large amounts of biomass (80-120 t/ha) containing 15-25% sugar (5-7 t sugar/ha), renewable raw material for the chemical, petrochemical, agricultural, food and pharmaceutical industries.

By the total industrialization of sorghum can be obtained: bioethanol (biofuel for transport means, mobile and fixed agricultural machinery); syrup; vinegar and food alcohol; cellulose and paper; acetic acid and ethylene; natural fibers, vegetable proteins, feed for animal husbandry, etc.

Biofuel produced from sorghum is environmentally friendly, contributing to the reduction of carbon dioxide emissions, the main responsible for the greenhouse effect suffered by the earth's atmosphere over the last period of time.

Together with the production of rapeseed oil, estimated at one tonne per hectare, the two types of biofuel complement the spectrum of energy requirements of agricultural farms, the two plant species being complementary to the cropping of crops.

The residue or pulp (bagasse) remaining after extraction of the fresh juice from the stems contains about 31-35% cellulose and a number of other sugars convertible to bioethanol after enzyme hydrolysis with specific enzymes. It has a higher biological value for animals than cane sugar (*Wu et al., 2010; Venkata et* *al., 2012*), from every 10 tons of crushed sweet sorghum being obtained 5-6 tons of wet bagasse (*Negro et al., 1999*).

The sorghum bagas can also be used in the production of cellulose. Cellulose obtained from sorghum has a quality similar to that of hardwood (lower species) for the production of cellulose. Production of bleached cellulose per hectare of sweet sorghum is cheaper and 2.5-3 times higher than the usual one-hectare of forest.

Industrial technologies can use existing plants or less adapted plants in the chemical industry, that do not produce toxic waste or unusable residues.

According to the technical and economic estimates, bioethanol fromsweet sorghum could be produced in Romania using conventional technologies, at a total price of less than 200 euro per ton, including customs duties, transport costs, commissions, etc., a competitive price on the European market, in the case of obtaining a production of about 5 tonnes of ethanol per hectare.

Sweet sorghum juice contains sugar cane, glucose, fructose, amino acids, nitrogen, salt and ash. They are beneficial for the growth of microorganisms.

Technological processes for alcohol refining from juice processing obtained by pressing sweet sorghum stems

Some countries, rich in agricultural resources, vigorously exploit carbohydrate crops and starch crops for alcohol production and the development of alternative fuels. Ethanol-based fuel is on sale in Brazil, America, etc. China is an agricultural country, but its resources are still not abundant. Therefore, in China it is not possible to develop alcohol resources from simple grains, so China has successively grown varieties of sweet sorghum, these varieties have fine properties to be abundant in both grain and sugar - the seeds can be used as cereals, animal feed, materials and so on; the juice of the stem can be fermented to refine the alcohol. Varieties offer a material basis for exploiting an alternative fuel in China (*fao.org*).

Currently, the cheapest alcohol is produced in Brazil from sugar cane. This is the simplest and cheapest technology for producing sugar and alcohol. It consists of the following cycles: removal of the leaf from the stems, pressing of stems until the juice is released, adding the yeast juice and sugar, seoaration of the alcohol by distillation (*Kashapov et al, 2016*).

There is a large amount of sugar in sweet sorghum stem juice. The sweet sorghum stem juice is rich in fermenting sugar and is a desirable material for alcoholic fermentation.

The production of alcohol from fresh sorghum stem as a raw material does not require a complicated technology and expensive equipment, and the production period is short due to some procedures that are left out. It is a method of producing low-cost alcohol.

In terms of starch content, early October is the best time to harvest sorghum, as the amount of starch is higher. Starch can be used to produce alcohol by fermentation. The sweet sorghum juice contains a large amount of fermentable sugar. The sugar content varies depending on soil conditions and sweet sorghum varieties.

✓ ***Technologies for sorghum juice extraction***

A. Juice extraction technology with a single press with three shafts (rolls) - Figure 3.

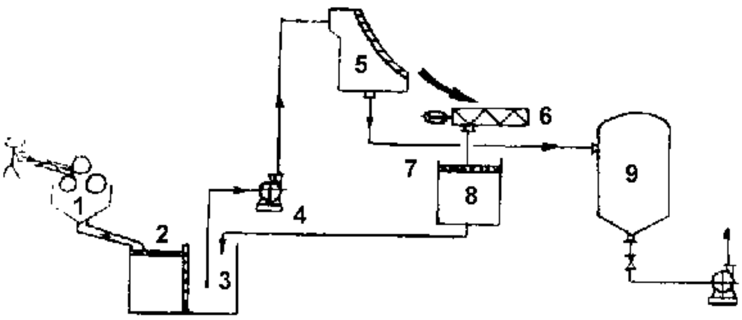

Fig. 3 - Juice extraction technology with a single press (*Ștefan L., 2017*)
1 - three-roller press; 2 - mesh filter; 3 - juice storage channel; 4 – juice pump; 5 - curved sieve; 6 - screw conveyor; 7 - mesh filter; 8- juice channel; 9 - juice storage tank; 10 – juice pump

Obtaining of raw sorghum juice with the roller press

In Figure 4 is represented the technological diagram of a station forsweet sorghum juice production.

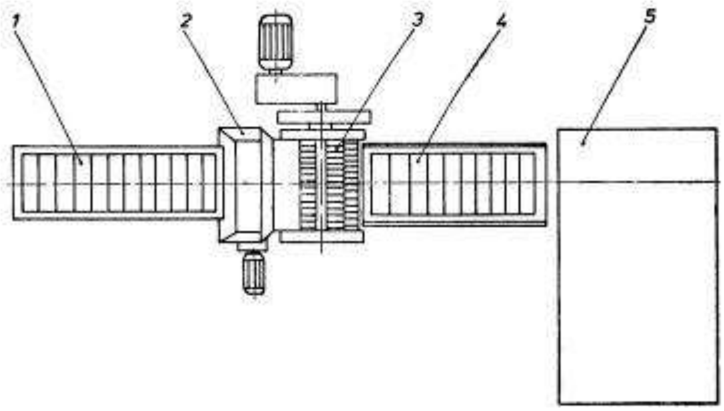

Fig. 4 - Technological diagram of a station forsweet sorghum juice production (*Ştefan L., 2017*)

1 - stems reception system; 2 – inlet hopper of squeezing machine; 3 - equipment for squeezing stems ofsweet sorghum; 4 - exhaust conveyor; 5 - storage platform for the green squeezed mass

The stations for sorghum juice extraction are recommended to be located in the center of the cultivation basin, meaning both the topographical position or the status of the access routes from the production plots to the station, as well as the provision of electricity, running water and rational evacuation possibilities extracted juice and squeezed green mass.

The collector basin, which is a technological annex to it, due to its relatively small capacity, requires a continuous evacuation in a short-term storage and preservation buffer tank, from where the juice is transported in suitable means of transport (auto reservoirs) and then shipped to industrialization units.

Within the station, it is necessary to have a receiving system for chopped stems (Figure 4, item 1) brought by the appropriate vehicles from the field. The capacity of the receiving system is correlated with the capacity of the squeezing (pressing) machine as to allow its continuous operation between successive shipments. The reception system for chopped material must allow uniform feeding of the pressing machine, either directly by spilling the chopped material into the press hopper, or by means of a conveyor, preferably with belt, suitably located between the receiving system and the press hopper.

Obtaining of ethyl alcohol by fermentation

- Yeasts and microorganisms that influence fermentation

Alcohol can be produced by fermentation, based on the property of some selected yeasts to convert fermentable sugars to alcohol and carbon dioxide, a phenomenon called alcoholic fermentation.

The term fermentation originates from the effervescence of the liquid subjected to fermentation (similar to a boiling) caused by the release of carbon dioxide. The result of an alcoholic fermentation is appreciated by the amount of alcohol obtained from the fermented sugar.

In addition to yeasts, which predominate in quantity, in fermentation environments there are other microorganisms in a higher or lower quantity, in ratio to the preoccupation that exists in a plant to combat them.

Foreign microorganisms consume the useful substance (fermentable sugar) and by their metabolic products can lead to the loss or even the inactivation of the yeast, the effect being the decrease in the yield in alcohol. In the technological process of alcohol production can be encountered: yeasts, bacteria and molds.

Yeast used in the fermentation industry for the production of alcohol, bakery yeast and beer yeast are unicellular microscopic plants, of the size of 6-10 μ and do not contain chlorophyll. They are part of the *Saccharomycetaceae* family, the genus *Saccharomyces*, the species *Saccharomyces cerevisiae*.These yeasts are also called true yeasts, having the characteristic that they energetically and completely ferment the sugar. When selecting the yeast used in the fermentation industry, this is the basic criterion.

Selection is accomplished by isolating a single cell, for which are created conditions for multiplication in the laboratory, in sterilized liquid media until a pure laboratory culture is obtained.

The pure laboratory culture is then multiplied into 2-3 phases in the factory, until the amount of yeast required to ferment the leaven.

According to the fermentation type, two types of cultivated yeast are distinguished: lower fermentation and higher fermentation, based on the fact that the lower fermentation yeast used in the brewing process forms floccous sediment in the fermentation tanks. For these lower fermentation yeasts, the optimum temperature is between 8-12 °C, producing a small amount of alcohol.

As a consequence, in the production of alcohol is used high fermentation yeast, dispersed evenly throughout the mass of the fermenting liquid, the optimum temperature being between 25-30 °C, resulting in a higher net amount of alcohol as compared to the lower fermentation yeast. The fermentation capacity of yeast depends on its content in enzymes, especially the content of the zymase (*Apostol et al., 1969*).

Multiplication of yeast cells ceases to an alcoholic concentration of 4-5%, but yeast that has a good fermentation capacity must continue fermentation to an alcoholic concentration of about 10%. Yeast activity is influenced by several factors:

- structure and enzymatic functions of the yeast cell;
- fermentation capacity of yeasts;
- temperature;
- pH-ul mediului;
- sugar concentration;
- alcoholic concentration;
- oxygen.

In the alcohol and compressed yeast industries, there must be a permanent concern for combating foreign microorganisms, which are also called microorganisms of infection.

As already mentioned at the beginning of this chapter, cultured yeast turns sugar into alcohol and carbon dioxide. In comparison, foreign microorganisms consume the sugar existing in the environment, and thus decrease the alcohol yield.

Foreign microorganisms that are involved in the production of alcohol and compressed yeast are wild yeasts, bacteria and molds (*Apostol et al., 1969*).

Processes of alcoholic fermentation

Ethyl alcohol from raw sorghum juice can be made by industrial processes of alcoholic fermentation of the following types (*Vlăduţ et al., 2004*):

A. Discontinuous process of alcoholic fermentation;

B. Semicontinuous process of alcoholic fermentation;

C. Continuous process of alcoholic fermentation without thermal sterilization.

A. Discontinuous process of alcoholic fermentation

The fermentation of raw sorghum juice that contains directly fermentable carbohydrates and biologically active compounds necessary for the multiplication of yeast cells to ethyl alcohol and carbon dioxide takes place in the presence of the "zymase" enzyme produced by the *Sacharomyces cerevisiae* yeast species adapted for raw juice. This industrial process has a productivity of 1.5÷2 kg of ethyl alcohol/m^3 of reactor.

a) Laboratory phase. This includes the preparation of culture media and yeast cultures. At this stage, a factor of greatest importance is the sterilization of both culture and inoculum media. Sterilization is performed to avoid the penetration of other microorganisms in the environment, which once emerged in laboratory cultures will grow and multiply in the industrial phase, producing dangerous infections that endanger fermentation, implicitly reducing the yield of ethyl alcohol.

b) Industrial phase. This consists in the development of yeast cultures in prefermentation, the fermentation of the juice in the fermentation tank, the distillation of the leaven and the refining of the spirits.

B. Semicontinuous process of alcoholic fermentation

This process has a yield of 3÷4 liters of ethyl alcohol/m^3 reactor and provides the alcoholic fermentation in the presence of bakery yeast.

C. Continuous process of alcoholic fermentation without thermal sterilization

The most widespread method is the fermentation without reuse of yeast in the fermentation process. This process allows keeping a good sterilization of the environment over a long period of time, ensuring increased alcohol yields (*Vlăduţ et al., 2004*).

Batch (intermittent) fermentation technology (fermentation cycle of about 70 hours) or continuous fermentation technology with single concentration (fermentation cycle of about 24 hours) can be used to ferment alcohol from sweet sorghum juice. The advanced technology of fermentation in fluidised bed with stable yeast, which has been developed in recent years by Shenyang Agricultural University and the Institute of Applied Ecology, shortenes the alcohol fermentation cycle to 4-5 hours, thus greatly increasing the rate production of alcohol.

- ***Continuous fermentation technology of sweet sorghum juice***

Since sorghum sweet juice can flow gently, the continuous fermentation method of the microorganism can be used. Compared to discontinuous (intermittent) fermentation, continuous fermentation is faster in the fermentation process, has a higher usage ratio of equipment, saves more labor and material resources and has a low consumption of production. In 1985 and 1986, Shenyang University of Medicine managed to refine alcohol from juice of sweet sorghum stem by the continuous technology with single concentration (*fao.org*).

The equipment of this technology is: yeast tank, fermentation tank (Figure 5), heating and sterilizing tank, foam collector, juice storage tank, 11 well storage tank and air purification system, pumps, flowmeter, gas flow meter, etc.

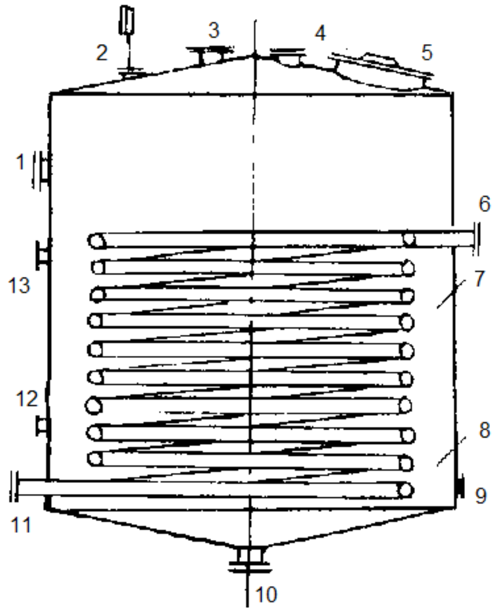

Fig. 5 - Scheme of the fermentation tank (*fao.org*)

1 - inlet; 2 - pressure measuring socket ; 3 - CO_2 socket; 4 - window; 5 - entrance for man; 6 - cooling water outlet; 7, 8 - thermometer socket; 9 - steam and gas inlet; 10 – juice outlet; 11 - cooling water inlet; 12, 13 - sampling hole

- ***Continuous fermentation technology through fluidised bed with stable yeast***

Fermentation technology through ***fluidised bed with stable yeast*** is an advanced biological technique, compared to batch fermentation and / or continuous fermentation with single concentration. This new fermentation technology has the following advantages: fast speed of the fermentation cycle, high yield, easy to achieve automation, production capacity 10 - 20 times greater than that of the batch fermentation. The fermentation cycle is shortened to 4.5 hours, because the stable yeast is constantly reproduced and the yeast life is prolonged, the environmental pollution is attenuated.

The technological process includes the CO_2 circulation system, the juice flow system, the filling system, the beer outlet system, the cooling and heating system, the measuring instruments and the particle production system. The CO_2 circulation system consists of: foam collector; gas-liquid separator; cooling and purification tank; gas compressor; gas storage tank under pressure; flowmeter; gas room. The system for juice drainage and filling consists of a juice storage tank; juice pump; filter; position tank; flowmeter; fluidized bed reactor with three units (*fao.org*).

Distillation system

Once the sweet sorghum juice has been fermented to become beer, the distillation system is required to distill and refine the alcohol over 95% (v/v). The distillation column can be chosen in accordance with conventional beer distillation technology. Figure 6 shows the technological process of alcohol distillation (*scribd.com*).

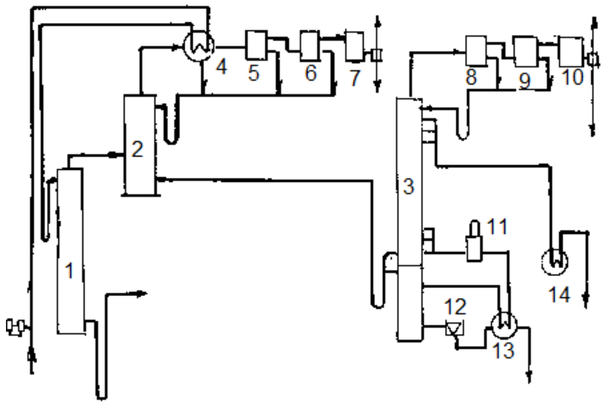

Fig. 6 - The technological process of alcohol distillation (*scribd.com*)

1 - crude distillation column; 2 - aldehyde removal column; 3 – purification column; 4 - preheater; 5, 6, 7, 8, 9, 10 - condenser; 11 - petroleum refinery; 12 - water drain pipe; 13 - heat exchanger; 14 - cooler of finished product

CONCLUSIONS

Thesweet sorghum is one of the plants with a very high potential for development due to the multiple uses as an energy plant or for food purposes, in our country this being recommended by:

- there are extensive areas of agricultural land, unexploited or inefficient, that can be made more efficient by massive sorghum crops, and thus new jobs can be created.
- the cultivation of sorghum can produce very large amounts of biomass (80-120 t/ha) containing 15-25% sugar (5-7 t sugar/ha), renewable raw material for the chemical, petrochemical, agricultural, food and pharmaceutical industries.
- through the total industrialization of sorghum can be obtained: bioethanol (biofuel for transport means, fixed and mobile agricultural machinery), food alcohol, vinegar, syrup, paper, cellulose, natural fibers, vegetable proteins, animal feed, etc.
- biofuel resulting from sorghum is environmentally friendly and contributes to the reduction of carbon dioxide emissions, which is primarily responsible for the greenhouse effect suffered by the earth's atmosphere over the last period of time.
- sorghum bagasse can also be used successfully to obtain cellulose; cellulose obtained from sorghum has a quality similar to that of deciduous wood for the production of cellulose.

ACKNOWLEDGEMENT

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COMBINED SYSTEM FOR THE PRODUCTION OF THERMAL ENERGY USING SOLAR AND BIOMASS ENERGY
/
SISTEM COMBINAT PENTRU PRODUCEREA ENERGIEI TERMICE, UTILIZÂND ENERGIA SOLARĂ ŞI CEA DIN BIOMASĂ

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Keywords: *solar, energy, biomass, combined system*

ABSTRACT

The use of renewable energies is a feature of contemporary society, confronted with the decrease of classical resources, rising fuel prices and the pollution generated by their burning. However, the use of renewable resources to provide energy needs is still far from its full potential; this is also due to the lack of efficient conversion tools that exploit different resources in mono-source or combined systems. The article presents the main components of such a combined system in which solar energy and biomass energy are exploited in a complementary way. The system is to be tested at the experimental model level, with components made on a small scale.

REZUMAT

Utilizarea energiilor regenerabile este o caracteristică a societății contemporane, confruntată cu scăderea resurselor clasice, creșterea prețurilor combustibilului și a poluării generate de arderea acestora. Totuși, utilizarea resurselor regenerabile în asigurarea necesarului de energie este încă departe de potențialul său maxim; aceasta se datorează și lipsei unor mijloace eficiente de conversie, care să exploateze diferite resurse, în sisteme mono-sursă sau combinate. Articolul prezintă componentele principale ale unui astfel de sistem combinat, în care se exploatează energia solară și energia din biomasă, într-o modalitate complementară. Sistemul urmează a fi testat la nivel de model experimental, cu componente realizate la scară redusă.

INTRODUCTION

The production of energy from clean, renewable sources is a desideratum of the modern world, and more and more countries are proposing targets in this respect. However, in the context of the continued growth of installed capacity and energy production (of various types) from renewable sources, there are also negative aspects such as the increase for the first time in the last 4 years of CO_2 emissions (by 1,4%); one of the reasons for this growth is the total energy demand, which continues to expand after 2009. Only in 2017, this growth was 2.1%. At the same time, the renewable energy sector supports nearly 11,000,000 direct jobs worldwide *(IRENA, 2018).*

At 2017, renewable energy accounted for 18.2% of total global energy consumption, out of which modern systems covered 10.4%, and 7.8% was the traditional use of biomass (for heating and food preparation) through processes generally characterized by low energy efficiency and high CO_2 emissions. With regard to domestic water heating and home heating, the inefficient use of biomass can be partially replaced by the use of solar thermal panels, a field where 35 GWth was added to existing capacities only in 2017 *(Cristescu et al., 2017; 2018)*. Also, significant quantities of thermal energy can be produced by high efficiency biomass use processes, such as gasification followed by combustion. Under certain conditions, as a result of the gasification and partial burning of the biomass, a biochar can be obtained, which can be used as a soil amendment *(Murad, 2016).*

The use of energy modules with gasification combined with solar panels is a step forward in covering the demand for heat at low prices and in an environmentally friendly way *(Srinivas and Reddy, 2014).* Given that the main components become more financially accessible, such systems are only conditioned by the existence of sufficient primary energy sources; at our country level, solar radiation has very good values in most regions, and biomass can be found both in primary form and processed in the form of pellets / briquettes at affordable prices.

MATERIAL AND METHOD

The combined use of solar energy and energy from biomass has the main advantage of increasing the total amount of heat available to the consumer, by ensuring adequate dimensioning of the energy autonomy associated with thermal energy (domestic hot water and heating) *(Atnaw et al., 2017).*

Considering the novelty of the solution, the realization of a combined prototype system that can be introduced into the manufacturing process must go through an experimental model phase. The experimental model follows the structure of the final product, consisting of two sources of thermal energy, namely:

- The system of converting solar energy into thermal energy by means of evacuated tube collectors, forming a solar panel
- the biomass energy conversion system by means of an energy module based on a gas generator by the TLUD (Top-Lit UpDraft) process and a burner *(Murad et al., 2013; Saravanakumar et al., 2007).*

The parts of the combined system, which includes the two conversion systems, are presented below.

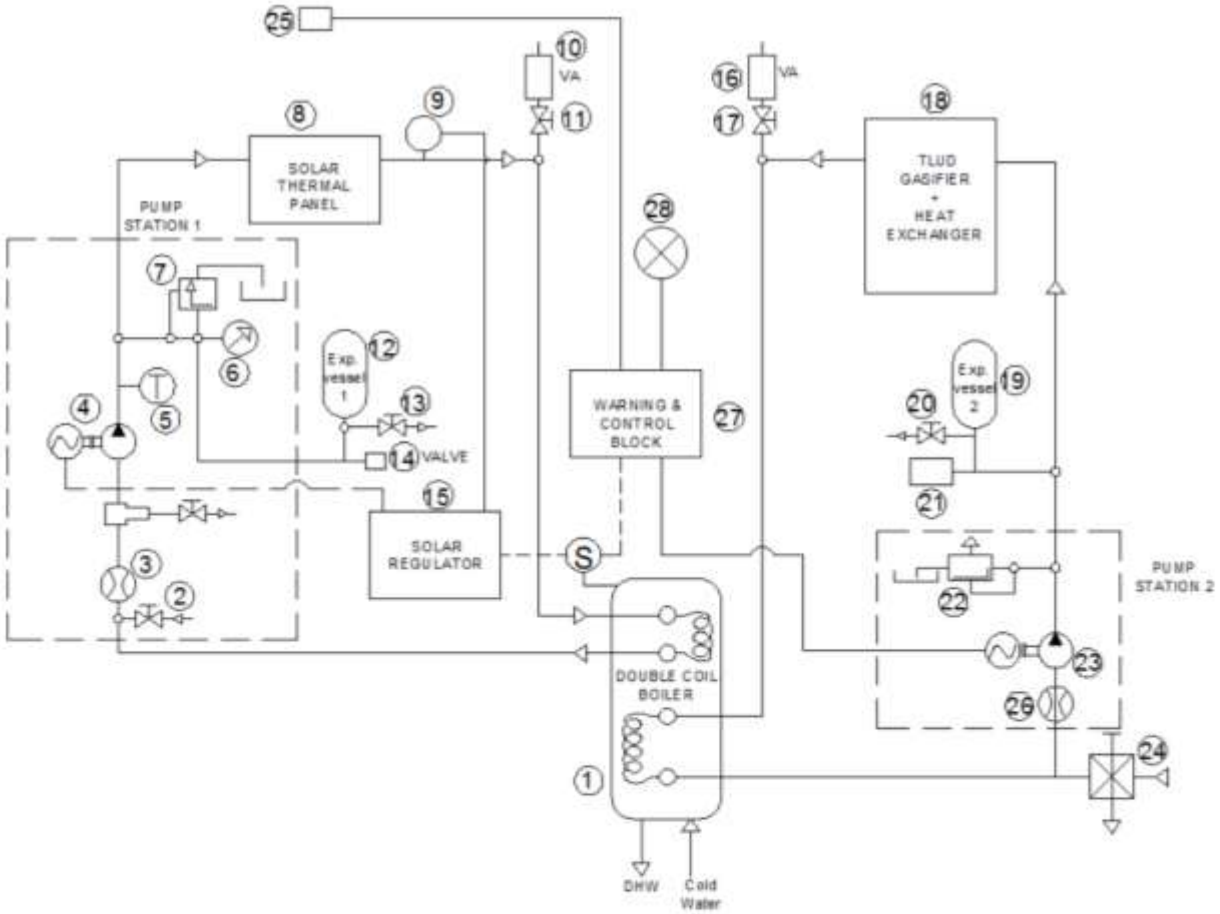

Fig. 1 - Scheme of the combined system

Table 1

The composition of the scheme is given in the following table

1. Double coil boiler	15. Solar regulator
2. Filling valve	16. Ventilation valve
3. Flowmeter 1	17. Shutter tap
4. Solar panel recirculation electropump	18. TLUD Gasifier
5. Thermometer up to 100°C	19. Expansion vessel
6. Manometer Ø100 - 10 bar	20. Drain valve
7. Safety valve	21. Valve
8. Thermal solar panel	22. Safety valve
9. Temperature sensor	23. Energetic module recirculation pump
10. Ventilation valve	24. 3-way tap for filling and flushing
11. Ball tap	25. Photovoltaic cell
12. Expansion vessel	26. Flowmeter 2
13. Drain tap	27. Warning and control block
14. Valve	28. Warning lamp

The operation of the system is as follows: The thermal energy produced in the solar panel is transferred by means of the pumping group 1, which trains a caloportor fluid in a closed circuit between the solar panel and the bivalent boiler; In the boiler, it dissipates the heat in the cold water that turns into domestic hot water (DHW) with the help of the coil. This first circuit contains all the thermo-hydraulic components required: valves, expansion vessel, manometer, thermometer, etc. Pump group control is given by the solar controller, which constantly compares the temperatures measured by the sensor S on the boiler and the sensor (9) at the top of the solar panel respectively. As long as the sensor on the panel records a higher temperature, it controls the fluid flow between the panel and the boiler.

The control and warning block receives, in addition to the temperature information, information about the amount of light incident on the panel; from a certain predetermined level, the block warns through the lamp (28) that the solar panel no longer contributes to the heating of the water, and therefore it is necessary to start the energy module. For the experimental model phase, startup is done manually by the operator.

During combustion, the pumping group 2 transfers heat from the heat exchanger area to the boiler via the second coil. The hydraulic circuit is similar to the first.

The two systems will be executed for low power, their role being to validate by experiment the possibility of the cumulation of thermal energy from two sources.

The main components of the combined system are the solar thermal panel and the gas generator. Their main features are presented below.

To convert solar energy we will use a medium-performance thermal solar panel with vacuum tubes with the following main features:

Table 2

Solar thermal panel features

Number of tubes	10
Panel width	890 mm
Panel length	2030 mm
Total surface	1,81 m^2
Effective absorption surface	0,94 m^2
Material for tubes	Borosilicate glass
Material for the collector	Al / Cu / Glass / Mineral wool

Panels use Heat Pipe technology; the vacuum tubes of the panel consist of 2 concentric glass tubes between which it is vacuum. The inner tube is surrounded by a dark absorbent surface that transmits the thermal energy to the copper pipe through which a thermal agent flows. The vacuum between the two tubes contributes to the increase of the efficiency and the temperature, reducing the losses.

The main dimensions of the vacuum tube are the diameter D_t = 58 mm and the length L = 1812 mm. According to the technical data provided by the manufacturer, at an average solar radiation of 1000 W / m^2, a tube heats 10 l of water per day, from 15 to 50°C.

Therefore, the amount of heat transferred to the water will be:

$$Q_t = m \cdot c \cdot \Delta t = 10 \cdot 4180 \cdot 35 = 1{,}463 \cdot 10^6 J, \quad (1)$$

where c = 4180 J / kg · K este the specific heat capacity of the water.

For a panel of 10 elements, the energy produced will be:

$$Q_p = Q_t \cdot 10 = 1{,}463 \cdot 10^6 \cdot 10 = 14{,}63 \cdot 10^6 J = 14{,}63\ MJ \quad (2)$$

If the energy is expressed in kWth, then we will have:

$$Q_p = \frac{14630000}{3600000} = 4{,}06\ kWth \quad (3)$$

The energy module is based on a gas generator, where the gasification is made following the top Lit Updraft front feed. The dimensions of the generator are reduced, corresponding to its role as an experimental model. An isometric view of the generator is shown in the following figure.

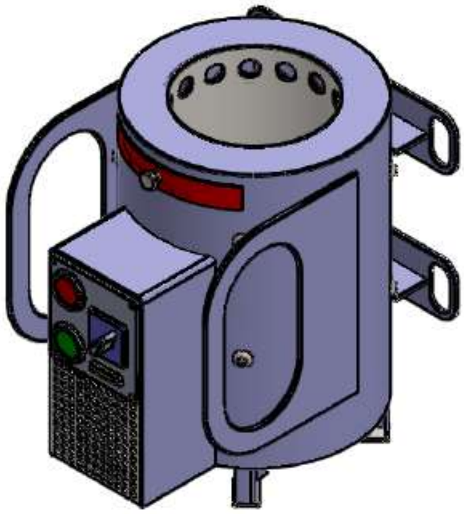

Fig. 2 - TLUD combustion gas generator

The main dimensions of the generator are: Reactor diameter $D_r = 10\ cm$

Biomass layer height (load height): $H_{rbm} = 15\ cm$

Reactor section: $S_r = \frac{\pi \cdot D_r^2}{4} = \frac{\pi \cdot 10^2}{4} = \frac{314}{4} = 78{,}5\ cm^2$. (4)

Biomass volume in the reactor: $V_{rbm} = H_{rbm} \cdot S_r = 0{,}15 \cdot 78{,}5 = 1178\ cm^3$. (5)

Biomass layer density: ρ_p= 600 kg/m^3 = 0,6 g/cm^3 (pellets).

Initial mass in the reactor: $M_{bmo} = \rho_p \cdot V_{rbm} = 0{,}6 \cdot 1178 = 706{,}5\ g$. (6)

The specific hourly gasified biomass consumption is 85 kg / m^2 · h; therefore, for the surface of the reactor we will have a specific consumption of:

$$C_{hbmg} = 85 \cdot 0{,}00785 = 0{,}667\ kg/h \quad (7)$$

The running time will be: $T_g = \frac{600}{667} = 0{,}9\ h\ (\sim 54\ min.)$ (8)

Energy from gasified biomass will be *(Grîu, 2014; Gudîma, 2018):*

$$Q_{bmg} = M_{bmo} \cdot P_{Cibm} = 0{,}7065 \cdot 17 = 12\ MJ \quad (9)$$

Heat output of hot gases: $P_g = \frac{Q_{bmg}}{T_f \cdot 3{,}6} \cdot \eta_{gTLUD} = \frac{12 \cdot 0{,}93}{0{,}9 \cdot 3{,}6} = 3{,}44\ kWth$, (10)

and the burner's thermal power, which takes into account the efficiency of combustion of the combustible gas ($\eta_{ard} = 0{,}95$) and the insulation yield (losses to the outside – $\eta_{izol} = 0{,}96$), will be:

$$P_{arz} = P_g \cdot \eta_{ard} \cdot \eta_{izol} = 3{,}44 \cdot 0{,}95 \cdot 0{,}96 = 3{,}13\ kWth \quad (11)$$

The solar energy conversion system also contains a solar regulator and a pumping group that transfers the heated fluid into the solar thermal panel to the tank, where it flows through one of the two coils. With the help of the serpentine, the fluid dissipates heat energy to the cold water that turns into domestic hot water. Similarly, the heat generated by the combustion of the gas is transferred to a closed-loop fluid flowing through the second coil of the reservoir.

RESULTS

The combined system is designed to be based on the solar thermal panel, and the energy module, which has a limited time function (in this case about 1 hour), adds extra energy during times when solar radiation is insufficient. In the experimental model phase, the energy module enters into operation at the decrease of the solar radiation which is indicated by a cell that measures the light radiation, and at the decrease of the water temperature in the tank, measured with a sensor located at the top of the tank.

The role of this experimental model is to validate the feasibility of the idea of obtaining and using the thermal energy from two renewable sources; the following activities foresee the development of a calculation methodology for the quantities of heat produced by each source as well as the amount of useful energy accumulated in the bivalent boiler within a one-day cycle. During the day, when there is solar radiation, the heat will be stored in the boiler, produced from this first source; when the radiation does not have the effect of heating the water in the boiler, the energy module enters into operation, which by burning a quantity of biomass equal to the load capacity for a charge produces a quantity of thermal energy that is added to the initial heat.

At this stage it is predicted that the energy produced from biomass will be approx. 75% of the energy produced by vacuum tubes (10 tubes); if it is found that the energy produced by the solar panel exceeds the estimated quantity (if the experiment is to perform on a day with solar radiation above the annual average taken into account), the number of active tubes will be reduced by removing them from the hydraulic circuit.

The energy produced from the two sources, without taking into account heat losses at this stage, is the sum of the energies produced by the two energy conversions:

$$Q_T = Q_P + Q_{bmg} = 14{,}63 + 12 = 26{,}63 \text{ MJ} \tag{12}$$

Considering that the boiler has a capacity of 80 liters, the boiler water temperature increase will be:

$$\Delta t = 26{,}63 \text{ x } 10^6 / (80 \text{ x } 4180) = 79{,}6^oC \tag{13}$$

If the water temperature at the boiler entrance is considered as approx. ti = 15^0 C, the final boiler water temperature will be at the end of the day:

$$T_F = t_i + \Delta t = 15 + 79{,}6 = 94{,}6\,^oC \tag{14}$$

which recommends the use of a smaller number of vacuum tubes to avoid the boiling temperature of the water.

CONCLUSIONS

The system proposed at experimental model level aims to validate the possibility of thermal energy accumulation from two sources: solar radiation and biomass, the conversion being done by means of a solar thermal panel with vacuum tubes, respectively with an energy module based on the TLUD principle.

The exploitation of the two sources is managed in this experimental phase by a control and warning block, which warns of the moment when the solar radiation can no longer increase the water temperature in the boiler, and it is therefore necessary to put into operation the biomass based energy module.

This has a limited operation over time due to the small amount of biomass it can be charged. Increasing the amount of gasified biomass would lead to a significant expansion of the total amount of thermal energy, concurring with the achievement of a combined system capable of ensuring the energy autonomy of a consumer.

ACKNOWLEDGEMENT

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ASPECTS REGARDING THE APPLE'S BEHAVIOUR OF IDARED AND GOLDRUSH VARIETIES DURING THE STORAGE
/
ASPECTE PRIVIND COMPORTAREA MERELOR DIN SOIURILE IDARED ŞI GOLDRUSH PE DURATA PĂSTRĂRII

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Key words: *apples, storage, storage conditions, biochemical components*

ABSTRACT

This paper will present the biometric apple's data of the two varieties: size, shape, weight and the results related with the level of the recorded losses during the storage of apples, depending on the storage conditions (warm storage: 20-22°C, warm storage with air ionization; storage in refrigeration conditions: 10-12ºC, storage by refrigeration, modified atmosphere, refrigeration conditions storage: 3-5ºC) and period of storage.

REZUMAT

În această lucrare vor fi prezentate datele biometrice ale merelor din cele două soiuri: mărime, formă, masă şi rezultatele privind nivelul pierderilor înregistrate pe durata păstrării merelor în funcţie de condiţiile de păstrare (păstrare la cald: 20-22°, păstrare la cald cu ionizarea aerului; păstrate în condiţii de refrigerare: 10-12 ºC, păstrate prin refrigerare, atmosferă modificată, păstrate în condiţii frigorifice: 3-5ºC) şi durata păstrării.

INTRODUCTION

The apple (malus domestica) represents the most well-known and widespread fruit culture within the temperate climate (*Fianu A.M., 2009*).

Apples are the one of the basic components of the modern people's food, representing a ready-made food in the nature that can be eaten in fresh shape, or in form of juice, compote, jam, cider, marmalade, etc. (*Gherghi A., 1983*)

Romania is one of the countries of Europe where fruit growing is well represented by the culture of a variety of species and varieties. In present, the most widespread varieties of apple cultivated in Romania and resistant to diseases are: Idared, Goldrush, Golden Delicious, Jonagold, Florina, Starkrimson, Generos, Romus, etc. (*Fianu A.M., 2009; Branişte and Militaru, 2005*).

To assess the quality and nutritional value of apples, must be considered not only of the physical and sensorial characteristics (size, shape, colour, specific weight, structural and textural firmness, flavor, taste, etc.) or technological ones (storage capacity, resistance in transportation and handling, presence of diseases or pests, etc.), but also biochemical properties: the content in water, dry substance, sugar, acids, vitamins, etc. (*Salunkhe D.K., Kadam S. S., 1998*).

The storage capacity is dependent on the quality of the raw material intended for storage and of the storage conditions. This paper presents aspects regarding the influence of storage technology on the storage capacity of two varieties of apples, Idared and Goldrush, cultivated at the Research and Development Institute for Fruits Growing - Maracineni.

MATERIAL AND METHOD

The apple experience includes a number of 10 experimental variants. At the base of organization, the experience on variants was the variety used and the storage conditions. The apples from the harvest-2016 introduced in experimentation come from ICDP-Maracineni. The scheme for organizing the experience for apple's storage is shown in Table 1.

Before the introducing to storage were performed biometric measurements, considering: the average fruit's weight, height, diameter and shape index.

Table 1

Experimental scheme for apple's storage

Variant	Variety	Storage conditions *)
V1	**GOLDRUSH**	20-22ºC
V2	-idem-	20-22 ºC +RI
V3	-idem-	10-12 ºC
V4	-idem-	10-12 ºC+AM
V5	-idem-	3-5 ºC
V6	**IDARED**	20-22ºC
V7	-idem-	20-22 ºC +RI
V8	-idem-	10-12 ºC
V9	-idem-	10-12 ºC+AM
V10	-idem-	3-5 ºC

*) Legend: AM = modified atmosphere; RI = ionizing radiation

Were determined the initial level and the evolution of some biochemical components during the storage: soluble dry substance, total sugar, total acidity and vitamin C. Aspects regarding to organization of apple's experiences are presented in Figure 1.

Fig. 1 - Aspects regarding to organization of apple's experiences

RESULTS

The results obtained regarding the biometric data are presented in Table 2.

Table 2

Biometric data of apples

No.	Variety	Length, height (mm)	Width, diameter (mm)	Shape index	Average weight (g/pcs)
1	GOLDRUSH	64.8	72.5	0.89	150.0
2	IDARED	66.5	83.3	0.80	210.8

The table shows that the size and weight of the Idared variety of fruits were superior to the Goldrush variety. The data related to the losses during the storage of 60 days in the case of storage at temperatures of 20-22°C, 120 days at 10-12°C and 180 days at temperatures of 3-5°C, are presented in Table 3.

Table 3

Losses during the apple's storage (%)

Variant	Variety	Storage conditions (°C)	Storage period (days)	Weight losses (%)	Spoilage losses (%)	Total losses (%)
V1	**GOLDRUSH**	20-22	60	9.49	6.67	16.16
V2	- idem-	20-22 +RI	idem	11.22	3.33	14.55
V3	- idem-	10-12	120	19.09	20.00	39.09
V4	- idem-	10-12 +AM	idem	1.61	66.67	68.28
V5	-idem-	3-5	180	12.87	20.00	32.87
V6	**IDARED**	20-22	60	9.52	33.33	42.85
V7	- idem-	20-22 +RI	idem	11.08	15.00	26.08
V8	- idem-	10-12	120	25.72	40.00	65.72
V9	- idem-	10-12 +AM	idem	1.55	50.00	51.55
V10	- idem-	3-5	180	18.83	36.67	55.50

The Goldrush apple's aspect kept at the ambient temperature (20-22°C) is presented in Figure 2 and the ones preserved by refrigeration (10-12°C) and AM are shown in Figure 3.

Fig. 2 - Goldrush Apple's aspect kept in ambient temperature (20-22°C)

Fig. 3 - Goldrush Apple's aspect kept by refrigeration (10-12 ºC) and AM

The Goldrush apple's aspect kept for 180 days under freezing conditions is shown in Figure 4.

V5- Goldrush variety (detail)

Fig. 4 - Goldrush Apple's aspect kept by freezing conditions (3-5 ºC)

The results regarding the initial level and the evolution of the chemical components during apple's storage are shown in Table 4.

Table 4

Level and evolution of some chemical components

Variety	Storage conditions (°C)	Soluble dry substance (%)	Total Acidity (%)	Total Sugar (%)	Vitamin C (mg/100g)
GOLDRUSH	initial	12.5	0.42	6.50	3.53
- idem-	20-22	13.2	0.45	8.70	6.20
- idem-	20-22 +RI	13.9	0.77	9.88	5.09
- idem-	10-12	12.4	0.38	8.78	6.90
-idem-	10-12 +AM	11.9	0.42	7.05	5.93
- idem-	3-5	11.9	0.21	8.21	6.28
IDARED	initial	12.0	0.56	7.05	2.80
- idem-	20-22	9.5	0.42	7.14	5.57
- idem-	20-22 +RI	8.5	0.70	8.50	2.92
- idem-	10-12	8.9	0.35	6.87	3.74
- idem-	10-12 +AM	9.9	0.45	7.29	6.86
- idem-	3-5	10.4	0.28	6.40	5.90

The results regarding the initial level and the evolution of apple's firmness during the storage are shown in Table 5.

Table 5

Initial level and the evolution of apple's firmness during the storage

Variant	Variety	Storage Temperture (°C)	Pulp's firmness*) (kgf/cm²)	Decreased storage firmness (%)
-	GOLDRUSH	**iniţial**	**5.90**	**0**
V1	- idem-	20-22	4.11	30.34
V2	- idem-	20-22 +RI	4.26	27.80
V3	- idem-	10-12	3.23	45.25
V4	- idem-	10-12 +AM	-	-
V5	- idem-	3-5	2.92	50.51
-	IDARED	**iniţial**	**5.96**	**0**
V6	- idem-	20-22	3.88	34.90
V7	- idem-	20-22 +RI	3.50	41.28
V8	- idem-	10-12	2.89	51.51
V9	-idem-	10-12 +AM	3.39	43.12
V10	- idem-	3-5	3.16	46.98

*) Determination with the Effe-gi penetrometer (with long piston with diameter of 11.3mm)

The results show that the apple's firmness has been considerably reduced during the storage, but differently depending on the variety and the storage conditions. Thus, the firmness of the apples was reduced on average by 36.70% after 60 days at ambient temperature storage and by 41.36% in the case of using the ionized air. After 120 days of refrigeration storage, apple's firmness decreased on average by 51.79% and after 180 days of freezing storage by 51.48%. Apples of Goldrush variety maintained their firmness at ambient temperature and at refrigeration temperatures and the Idared variety by freezing storage.

CONCLUSIONS

From the observations made during the storage of apples under different conditions, it becomes evident that, generally, apples from the harvest of 2016 were susceptible at storage, recording a high volume of loss by spoilage and, implicitly, of total losses. Apples kept in ambient temperature conditions have been positively influenced by ionizing radiation treatment, while in the hermetic space with modified atmosphere there have been average losses by spoilage twice more comparing with the apples kept at the same temperature, but in a free atmosphere.

Among the varieties studied, resulted that in almost all storage conditions, the Goldrush variety proved to be superior to the Idared variety, showing inferior values, particularly of spoilage and total losses.

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VARIATION OF CONTENT IN WATER-SOLUBLE VITAMINS, VEGETABLES AND FROZEN FRUITS DURING STORAGE
/
VARIAŢIA CONŢINUTULUI ÎN VITAMINE HIDROSOLUBILE, AL LEGUMELOR ŞI FRUCTELOR CONGELATE, ÎN TIMPUL DEPOZITĂRII

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Keywords: *water-soluble vitamins, vegetables, fruits, freezing, storage*

ABSTRACT

Vitamins are biologically active organic compounds, essential miconutrients involved in the metabolic and physiological functions of the human body. Frozen vegetables and fruits are an important source of minerals, water-soluble vitamins, phenolic compounds, carotenoids and dietary fiber and should therefore occupy an important place in a healthy diet. This paper presents the variation of the content in water-soluble vitamins of frozen vegetables and fruits during storage. During storage, frozen vegetables and fruits taken in the study show distinct decreases.

REZUMAT

Vitaminele sunt compuşi organici biologic activi, micronutrienţi esenţiali implicaţi în funcţiile metabolice şi fiziologice ale organismului uman. Legumele şi fructele congelate sunt o sursă importantă de elemente minerale, vitamine hidrosolubile, compuşi fenolici, carotenoizi şi fibre alimentare şi, de aceea, ar trebui să ocupe un loc important într-o dietă sănătoasă. În această lucrare este prezentată variaţia conţinutului în vitamine hidrosolubile, al legumelor şi fructelor congelate, în timpul depozitării. În timpul depozitării, legumele și fructele congelate luate în studiu, prezintă scăderi diferențiate.

INTRODUCTION

Fruits and vegetables have long been a nutritious and healthful part of the human diet because they are low in calories and fat, and are important sources of vitamins, minerals, and fiber *(Kyureghian et al., 2010).* Vegetables and legumes represent one of the most important components of the human diet. Being informed about their characteristics can improve the health benefits, helping to reduce the risk of cardiovascular disease, type II diabetes and some cancers *(Fabbri and Crosby, 2016).*

Vitamins are biologically active organic compounds, essential micronutrients involved in the metabolic and physiological functions of the human body. Frozen vegetables and fruits are an important source of minerals, water-soluble vitamins, phenolic compounds, carotenoids, and dietary fiber and should therefore occupy an important place in a helthy diet. The advantage of frozen fruits and vegetables is that they usually are picked when they're ripe, and then blanched in hot water to kill bacteria and stop enzyme activity that can spoil food *(Kantor, 2017).*

Santos et al. (2012) performed sequential determination of fat- and water-soluble vitamins in green leafy vegetables during storage. The most abundant free vitamins found in leafy vegetable products were vitamin C, provitamin A and vitamin E. The highest content of vitamin C and provitamin A was recorded in the case of pea leaves:154 mg/g fresh weight and 14.4 mg/100 g fresh weight, respectively. The lamb's lettuce was the vegetable with the highest content on vitamin E (3.1 mg/100 g fresh weight).

Bouzari et al. (2014) have evaluated vitamin retention in eight fruits (strawberries, and blueberries) and vegetables (corn, carrots, broccoli, spinach, peas, green beans), in refrigerated and frozen storage. Based on the study, the authors have shown that frozen vegetables and fruits are a viable alternative to those fresh, in terms of nutritional value. In frozen samples of the commodities analyzed, riboflavin, α-tocopherol, and ascorbic acid, not only were found in equivalents quantities to those in fresh samples, but in many cases there were found in much higher quantities than those of fresh samples. Instead, in many of the commodities studied, β-carotene, which was drastically degraded, over frozen storage.

This paper presents the results of the research undertaken to determine variation of the content in water-soluble vitamins of frozen vegetables and fruits during storage.

MATERIAL AND METHOD

Within the Pilot Experiments Plant for Fruits and Vegetables Processing there were achieved the following frozen vegetables and fruits: green peas, green beans, spinach leaves, red peppers, broccoli, carrots, parsley leaves, bilberries, raspberries, strawberries, sea buckthorn and sour cherries.

Determination of the water-soluble vitamins in frozen vegetables and fruits was performed by high performance liquid chromatography coupled with mass spectrometry. Vitamin C and hippuric acid (internal standard) were detected and quantified in negative electrospray ionization mode (ESI-). Vitamins of B group (B2, B3, B5, B6, B7) and hippuric acid (internal standard) were detected and quantified in positive electrospray ionization mode (ESI+).

The frozen vegetables and fruits of this study were analyzed to determine the content in water-soluble vitamins, at initial time of storage and during storage at temperature - 16°C, every 2 months.

RESULTS

Variation of content in water-soluble vitamins of frozen fruits, during storage

Frozen raspberries are distinguished by content in vitamin C and vitamin B7, which varied during storage in the following ranges: 25.75-23.50 mg/100 g (vitamin C) and 5.25 – 4.89 mg/100 g, respectively (vitamin B7) (Fig. 1). During storage, content in vitamin C decreased by 8.75%. Content in vitamin B3 of raspberries is low (0.150 mg/100 g at initial time of storage) and after 6 months of storage decreased by 6.05%.

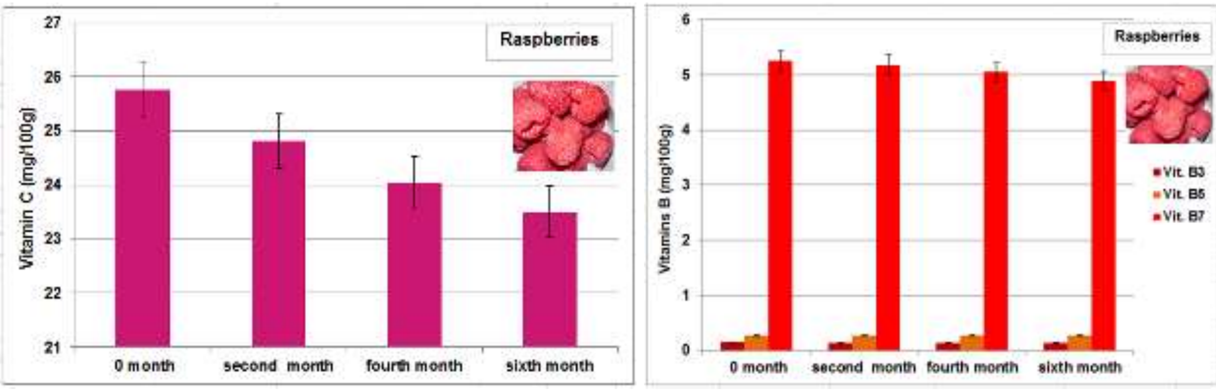

Fig. 1 - Variation of content in water-soluble vitamins of frozen raspberries during storage

Frozen strawberries are an important source of vitamin C (32.78 mg/100 g at the beginning), vitamin B7 (5.18 mg/100 g) and vitamin B3 (2.75 mg/100 g). During the storage period these vitamins showed differentiated decreases as follows: 10.06% for C, 8.75% in case of vitamin B7 and 7.87% in case of vitamin B3 (Fig. 2).

Frozen bilberries and sour cherries have a similar content in water-soluble vitamins at the initial storage time:

- ✓ Vitamin C: 2.63 mg/100g (bilberries) and 2.75 mg/100g (sour cherries)
- ✓ Vitamin B5: 0.27 mg/100g (bilberries) and 0.18 mg/100g (sour cherries)
- ✓ Vitamin B7: 3.56 mg/100g (bilberries) and 3.96 mg/100g (sour cherries)

After storage, the decrease of the content in vitamin C of the two frozen fruit species was similar (10.26% in the case of bilberries and 10.65% in the case of sour cherries), while vitamin B7 recorded a higher decrease in case of sour cherries (8.33%), comparative to bilberries (5.15%). Content in vitamin B3 decreased by 7.25% in case of bilberries and 6.11% in case of sour cherries, respectively (Fig. 3).

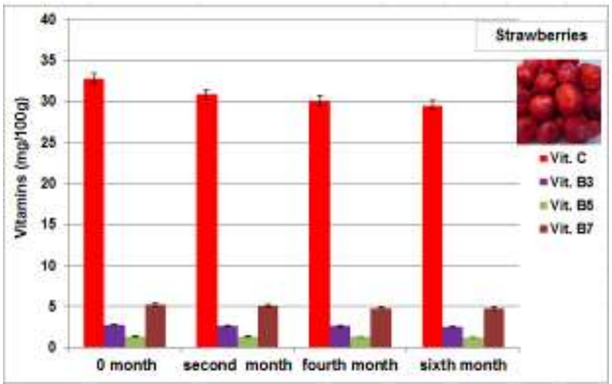

Fig. 2 - Variation of content in water-soluble vitamins of frozen strawberries during storage

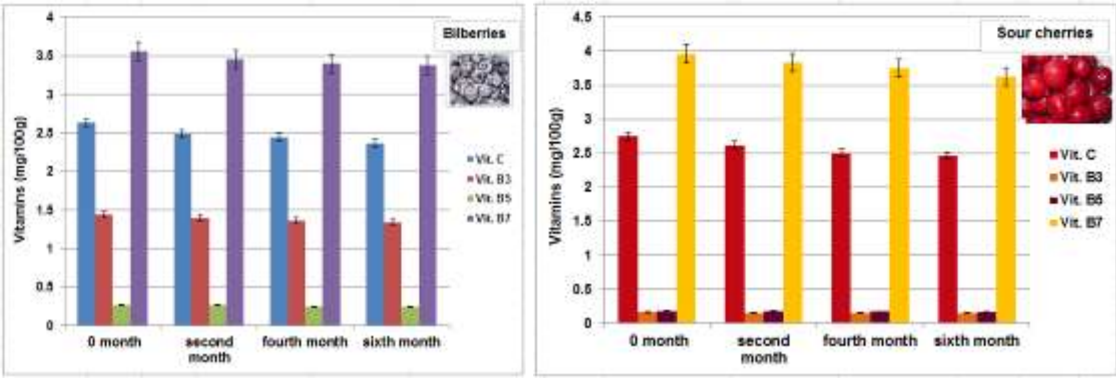

Fig. 3 - Variation of content in water-soluble vitamins of frozen bilberries and sour cherries during storage

Frozen sea buckthorn is distinguished by content in water-soluble vitamins. The highest content was recorded in case of vitamin C (108.45 mg/100 g, at initial time of storage) and of vitamin B7 (3.25 mg/100 g, at initial time of storage). Content in vitamin B3 and B5 recorded close values at initial time of storage (vitamin B3: 1.08 mg/100 g); vitamin B5: 1.27 mg/100 g). After storage, content in water-soluble vitamins of frozen sea buckthorn recorded a differentiated decrease, ranging from 5.51 to 9.24% (the minimum value was recorded in case of vitamin B5, and the maximum one in case of vitamin C) (Fig. 4).

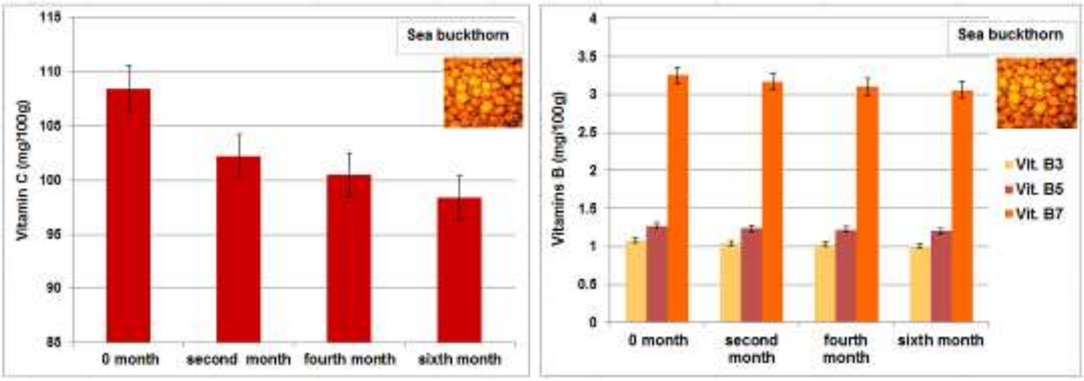

Fig. 4 - Variation of content in water-soluble vitamins of frozen sea buckthorn during storage

Variation of content in water-soluble vitamins of frozen vegetables, during storage

The content in water-soluble vitamins of frozen vegetables is lower compared to that of frozen fruits. This is explained by the specific content in water-soluble vitamins of each species, but also by the fact that for freezing fresh vegetables are subjected to technological operations of blanching-cooling. In this study, the blanching of the fresh vegetables was carried out with water at 100°C. Although blanching causes a reduction of the content in water-soluble vitamins of vegetables, this operation is necessary as it provides reduction of vegetable volume and the removal of air from the tissues, the inactivation of oxidative enzymes, but an additional wasching of them.

In case of frozen spinach, at initial time of storage there were quantified the following water-soluble vitamins (Fig. 5): vitamin C – 20.55 mg/kg; vitamin B2 – 8.45 mg/kg; vitamin B3 – 2.15 mg/kg; vitamin B5 – 1.12 mg/kg; vitamin B6 –1.45 mg/kg; vitamin B7 – 90.75 mg/kg. During storage, water-soluble vitamins recorded differentiated decreases as follows: 10.85% in case of vitamin C; 4.61% in case of vitamin B2; 5.55% in case of vitamin B3; 7.14% in case of vitamin B5; 6.20% in case of vitamin B6; 7.20% in case of vitamin B7.

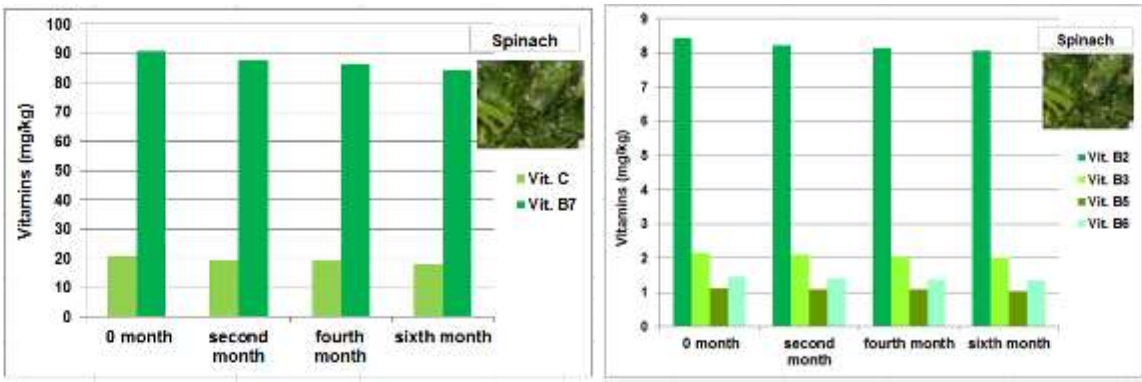

Fig. 5 - Variation of content in water-soluble vitamins of frozen spinach during storage

Frozen green peas are distinguished by content in vitamin C, vitamin B3 and vitamin B7 (at initial time of storage: vitamin C - 33.20 mg/kg; vitamin B3 – 9.75 mg/kg; vitamin B7 – 92.54 mg/kg). Also, content in vitamins B2 and B5 recorded close values (vitamin B2 – 1.85 mg/kg; vitamin B5 – 1.54 mg/kg). During storage, content in vitamin C decreased by 14.20%, and that of vitamin B5 by 7.14%. Content in vitamins B2, B3 and B7 recorded relative close decreases in the range 6.20 to 6.87% (the minimum value was recorded in case of vitamin B7, and the maximum one in case of vitamin B3) (Fig. 6).

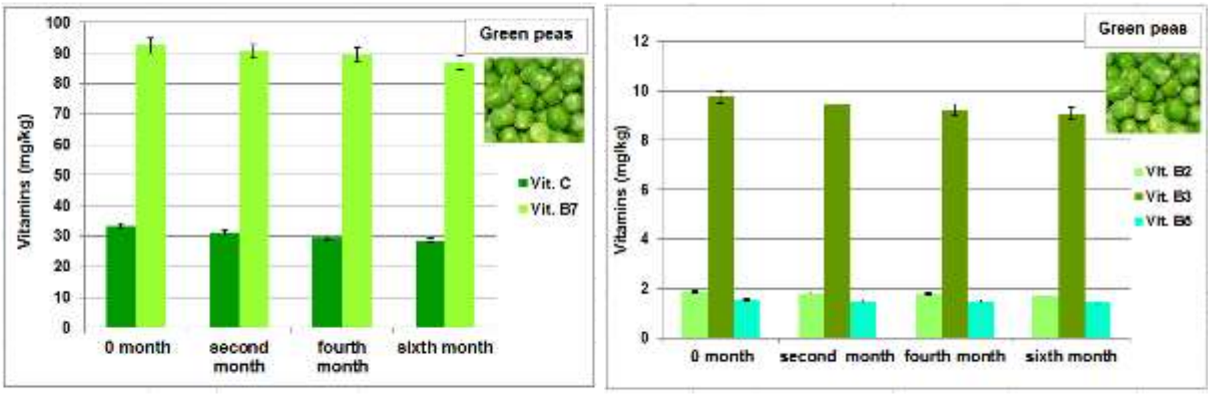

Fig. 6 - Variation of content in water-soluble vitamins of frozen green peas during storage

Frozen broccoli is an important source of vitamin C (165.32 mg/kg), vitamin B3 (2.85 mg/kg) and vitamin B7 (60.43 mg/kg). Vitamins B2 and B5 recorded a lower content (vitamin B2 – 0.55 mg/kg; vitamin B5 - 1.55 mg/kg). During storage, content in vitamin C recorded the highest reduction (13.60%), while the content in vitamins of B group recorded decreases in the range 5.05 to 8.12% (the minimum value was recorded in case of vitamin B5, and the maximum one in case of vitamin B7) (Fig. 7).

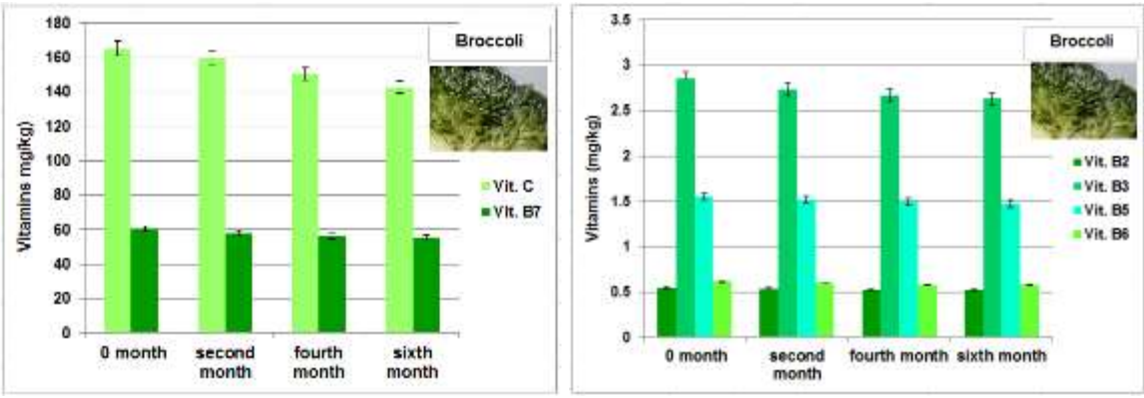

Fig. 7 - Variation of content in water-soluble vitamins of frozen broccoli, during storage

Frozen red peppers have a high content in vitamin C (480.25 mg/kg) and vitamin B7 (25.85 mg/kg). During storage, content in vitamin C decreased by 10.75%, and content in vitamin B7 by 7.54% (Fig. 8).

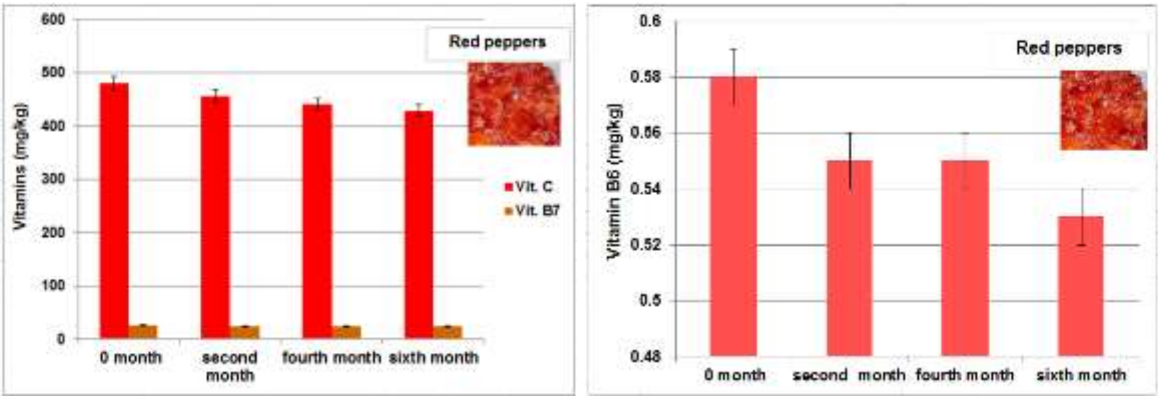

Fig. 8 - Variation of content in water-soluble vitamins of frozen red peppers during storage

Frozen parsley leaves are an important source of vitamin C (990.75 mg/kg) and vitamin B7 (82.75 mg/kg). Vitamins B2 and B6 had a low content of 0.44 mg/kg and 0.67 mg/kg, respectively.

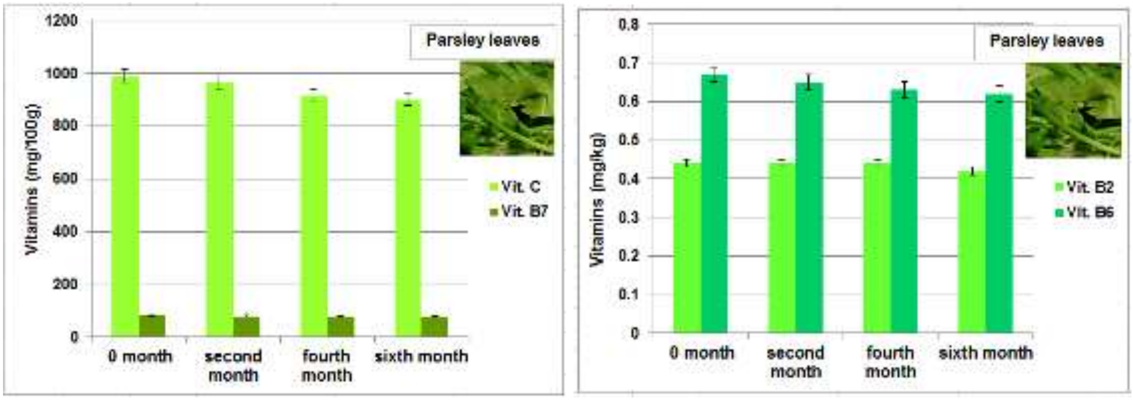

Fig. 9 - Variation of content in water-soluble vitamins of frozen parsley leaves during storage

After storage, content in vitamin C of frozen parsley leaves decreased by 9.20 %, and that of vitamin B7 by 6.20% (Fig. 9).

Frozen green beans taken in study had a significant content in vitamin B5 (30.25 mg/kg), vitamin C (9.42 mg/kg) and vitamin B3 (2.55 mg/kg). Content in vitamin B2 was low (0.85 mg/kg). After storage, content in vitamin C decreased by 12.95%, content in vitamins B recorded a decrease in the range 5.88 to 6.87% (the minimum value was recorded in case of vitamin B2, and the maximum one in case of vitamin B5) (Fig. 10).

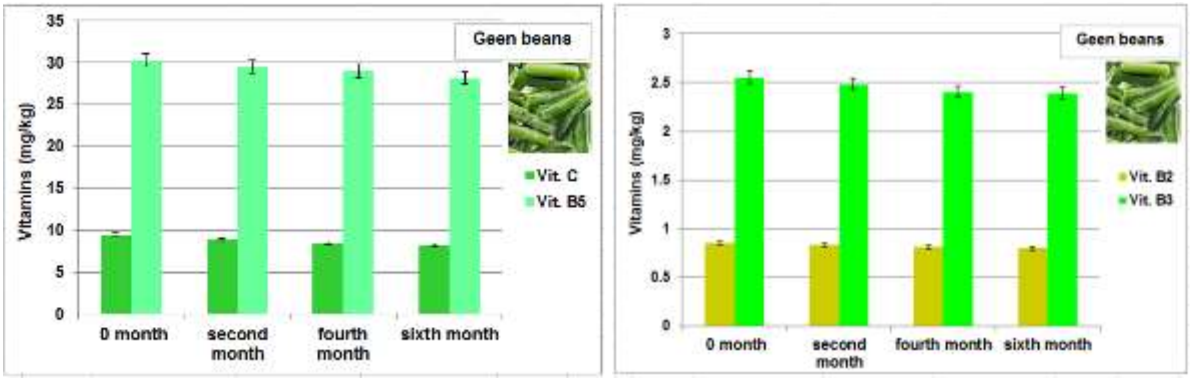

Fig. 10 - Variation of content in water-soluble vitamins in frozen green beans during storage

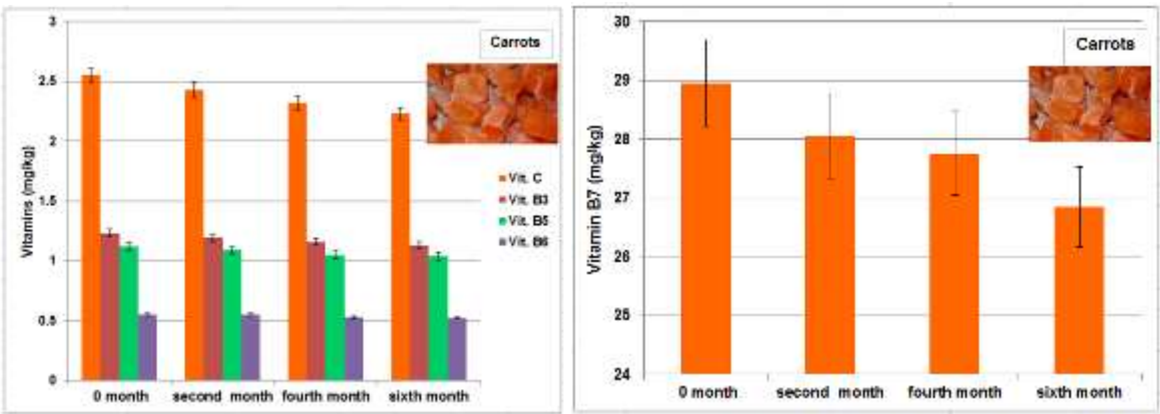

Fig. 11 - Variation of content in water-soluble vitamins in frozen carrots during storage

Frozen carrots are distinguished by content in vitamin B7 (28.95 mg/kg). Content in vitamin C of frozen carrots was 2.55 mg/kg, and content in other vitamin of B group recorded at initial time of storage the following values: vitamin B3 – 1.23 mg/kg; vitamin B5 – 1.12 mg/kg; vitamin B6 – 0.55 mg/kg (Fig. 11). After storage, content in water-soluble vitamins of frozen carrots recorded a decrease in the range 5.24 to 12.55% (the minimum value was recorded in case of vitamin B6, and the maximum one in case of vitamin C).

CONCLUSIONS

Following the performed analyses, a differentiated decrease of content in water-soluble vitamins of the frozen fruits taken in study, was recorded during storage period (6 months), as follows:

- ✓ 8.75 – 10.65% in case of vitamin C (the minimum value was recorded in case of frozen raspberries, and the maximum one in case of frozen sour cherries)
- ✓ 6.05 – 7.87% in case of vitamin B3 (the minimum value was recorded in case of frozen raspberries, and the maximum one in case of frozen strawberries)
- ✓ 5.35 – 7.25% in case of vitamin B5 (the minimum value was recorded in case of frozen strawberries, and the maximum one in case of frozen bilberries)
- ✓ 5.15 – 8.75% in case of vitamin B7 (the minimum value was recorded in case of frozen bilberries, and the maximum one in case of frozen strawberries)

Also, in the study undertaken, during the storage period (6 months), in the case of frozen vegetables, a differentiated decrease of the content in water-soluble vitamins was found as follows:

- ✓ 9.20 – 14.20% in case of vitamin C (the minimum value was recorded in case of frozen parsley leaves, and the maximum one in case of frozen green peas)
- ✓ 4.30 – 6.42% in case of vitamin B2 (the minimum value was recorded in case of frozen parsley leaves, and the maximum one in case of frozen green peas)
- ✓ 5.55 – 8.50% in case of vitamin B3 (the minimum value was recorded in case of frozen spinach leaves, and the maximum one in case of frozen carrots)
- ✓ 5.05 – 7.14% in case of vitamin B5 (the minimum value was recorded in case of frozen broccoli, and the maximum one in case of frozen green peas and frozen spinach)
- ✓ 5.24 – 7.80% in case of vitamin B6 (the minimum value was recorded in case of frozen carrots, and the maximum one in case of frozen red peppers)
- ✓ 6.20 – 8.12% in case of vitamin B7 (the minimum value was recorded in case of frozen green peas and frozen parsley leaves, and the maximum one in case of frozen broccoli)

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FORTIFYING BISCUITS WITH FLOUR MADE FROM TOMATO WASTE IN ORDER TO INCREASE THE NUTRITIONAL VALUE AND THE ANTIOXIDANT POTENTIAL
/
FORTIFIEREA BISCUIŢILOR CU FĂINĂ OBŢINUTĂ DIN DEŞEURI DE TOMATE, ÎN SCOPUL CREŞTERII VALORII NUTRIŢIONALE ŞI A POTENŢIALULUI ANTIOXIDANT

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Keywords: *tomato waste, fortification, biscuits, antioxidant capacity*

ABSTRACT
Valorisation of vegetable waste from food industry in order to achieve functional ingredients to be used for fortification of food products is of real interest. Waste obtained from tomato processing such as juice, paste, purée, ketchup, is an important source of protein, fibre, minerals, carotenoids and polyphenols. This paper presents the results of the research undertaken to fortify biscuits with tomato waste flour. Fortification levels were 5 and 7.5%. The biscuits obtained have proper sensory properties and high nutritional value, noting the bioactive compound content and antioxidant capacity.

REZUMAT
Valorificarea deșeurilor vegetale din industria alimentară, în scopul obținerii unor ingrediente funcționale care să fie utilizate pentru fortifierea produselor alimentare, este de un real interes. Deșeurile rezultate din procesarea tomatelor sub formă de suc, pastă, piure, ketchup, sunt o sursă importantă de proteine, fibre, elemente minerale, carotenoizi și polifenoli. Această lucrare prezintă rezultatele cercetărilor întreprinse pentru fortifierea biscuiților cu făină obținută din deșeuri de tomate. Nivelele de fortifiere au fost de 5 și 7,5%. Biscuiții obținuți au calități senzoriale corespunzătoare și valoare nutrițională ridicată, remarcându-se prin conținutul în compuși bioactivi și capacitatea antioxidantă.

INTRODUCTION
A major problem faced by the food industry is the accumulation, handling and disposal of waste resulting from the processing of raw materials. It is estimated that by 2020 the waste from food industry will reach about 126 Mt (*Mirabella et al., 2014).* Tomato (*Lycopersicon esculentum Mill.*) is a widely cultivated vegetable crop, with a world production of over 170 million tons in 2014 (*FAOSTAT, 2014*).

World Processing Tomato Council estimated that around 40 million tones of tomatoes were processed worldwide to produce tomato juice, paste, purée, ketchup, canned tomatoes and other food products (*WPTC, 2015*). By processing tomatoes in the form of juice, purée, paste, ketchup there obtains waste which contains skins, seeds and traces of tomato pulp. Tomato waste is an important source of lycopene and so many studies have been carried out to extract it from this type of waste (*Nobre et al., 2009).* Also, dried tomato waste contains 22.6 – 24.7% proteins, 14.5 – 15.7% lipids, and 20.8 – 23.5% fiber and also a source of vitamins B1, B2 and A.

In addition, tomato waste contains essential amino acids, and tomato seeds contain minerals in high concentrations (Fe, Mn, Zn and Cu) (*Aghajanzadeh et al., 2010*). Compared to pulp and seeds, tomato skins contain significantly higher concentrations of lycopene and β-carotene (*Papaioannou and Karabelas, 2012*). Total phenolic content of tomato skins was evaluated as 36.9±0.8 mg GAE/100g. Antioxidant capacity of tomato skins evaluated by two methods, registered the following values: FRAP (46.9 ± 0.9 µmol Fe^{+2}/g, $P < 0.05$) and DPPH (97.4 ± 0.2%, $P < 0.05$) (*Fuentes et al., 2013).*

Tomato seeds contain about 24.5% crude protein and have the highest content of glutamic acid and aspartic acid (*Persia et al., 2003*). Tomato seeds obtained from tomato processing are an important source of high quality vegetable proteins, along with intrinsic polyphenols, and also have antioxidant capacity *(Sarkar and Kaul, 2014*).

Valorisation of tomato waste by achieving of functional ingredients that will increase the nutritional quality and antioxidant potential of food products, is of real interest. Flour achieved from tomato waste is an important source of protein, lipid, minerals (K, Ca, Mg, Fe, Zn and Se), dietary fiber and bioactive compounds (lycopene, ß-carotene, and polyphenols). Also this flour has antioxidant potential being beneficial in a healthy diet for prevention of diseases caused by free radicals (*Catană et al., 2017).*

Isik and Topkaya (2016) studied effects of tomato pomace supplementation on chemical and nutritional properties of crackers. Levels of substitution of wheat flour with tomato waste powder were 4 %, 8 % and 12 %. Tomato pomace addition determined a significant ($p<0.05$) increase in protein, ash, dietary fiber (soluble, insoluble, total), minerals (Mg, Ca, K, P, Mn, Zn, Fe), total phenolics, antioxidant capacity, of crackers.

This paper presents the results of the research undertaken to fortify biscuits with tomato waste flour.

MATERIAL AND METHOD

Tomato waste resulted from tomato processing to juice within the Pilot Experiments Plant for Fruits and Vegetables Processing in IBA Bucharest. Tomato waste was subjected to dehydration process in a convection dryer at temperature 50 ºC to a moisture which allows its milling and conversion into flours and, at the same time, its stability in terms of quality. Milling of dried semi-finished product was performed by using Retsch mill. Tomato waste flour was used to fortify biscuits (Fig. 1).

Fig. 1 - Tomato waste flour

For the qualitative characterisation of the functional ingredient obtained from tomato waste and of biscuits fortfied with it, there were used standardized methods and developed and validated methods in IBA Bucharest. Sensory evaluation was performed by *"Comparison method with unitary score scales"* method. The moisture content was determined according to the AACC 44-15A method. Protein content was determined by the Kjeldahl method with a conversion factor of nitrogen to protein of 6.25 (AOAC Method 979.09, 2005). Fat content was determined according to AOAC Method 963.15, and ash content according to AOAC Method 923.03 (AOAC, 2005).

In order to determine minerals samples were mineralized by calcination, with the addition of hydrochloric acid and hydrogen peroxide. The minerals potassium (K), calcium (Ca), magnesium (Mg) and zinc (Zn) were determined by atomic absorption spectrophotometer (type *AAnalyst 400*, Perkin– Elmer). The mineral iron (Fe) was determined by Graphite Furnace Atomic Absorption Spectrophotometer (type *AAnalyst 600*, Perkin–Elmer). Total dietary fibre (TDF) was determined by enzymatic method using the assay kits: KTDFR ''Total dietary fibre'' (AOAC Method 991.43). Lycopene and β-carotene content were performed by high-performance liquid chromatography (HPLC-DAD).

Total phenolic content was determined by Folin-Ciocalteu procedure, and antioxidant capacity by DPPH method. The water activity (*A*w) was determined by an instrument Aquaspector AQS-2-TC, *Nagy*. Yeasts and molds were determined by the method SR ISO 21527-1:2009. *Enterobacteriaceae* were determined according to the SR EN ISO 21528-2:2017 method and *Escherichia coli* by SR ISO 16649-2:2007 method. *Salmonella* was determined by the method SR EN ISO 6579-1:2017.

RESULTS

Tomato waste flour has a complex biochemical composition, distinguished by its protein content (17.98%), lipids (10.85%), ash (4.39%), total fibre (54.55%), lycopene (61.50 mg/100 g), β-carotene (9.75 mg/100 g) and lutein (1.58 mg/100 g).

In order to achieve biscuits fortified with tomato waste flour, two series of experiments were made. In the first series of experiments, control biscuits (C1) and biscuits fortified with tomato waste flour (fortification levels: 5 and 7.5%) were achieved. The following raw materials and auxiliar materials were used in the composition of control biscuits (C1): sourdough, 650 white bread flour, 1250 black bread flour, telemea cheese, fresh Jerusalem artichoke tubers, butter, yoghurt, eggs, salt, dried rosemary, cumin seeds. In the case of fortified biscuits, tomato waste flour was additionally added according to the two levels of fortification (V1_5 and V1_7.5) (Fig. 2). In the second series of experiments, control biscuits (C2) and biscuits fortified with tomato waste flour were also made, using the same levels of fortification. The following raw materials and auxiliary materials: 650 white bread flour, oat flakes, telemea cheese, butter, cream, concentrated tomato juice (12 °Brix), eggs, Zatar spice, salt, cumin seeds, lemon juice, sodium bicarbonate, ammonium bicarbonate were used in the composition of control biscuits (C2). In the case of fortified biscuits, tomato waste flour was additionally added, according to those two level of fortification (V2_5 and V2_7.5) (Fig. 3).

C1 V1_5 V1_7.5

Fig. 2 - Control biscuits (C1) and biscuits fortified with tomato waste flour (V1)

C2 V2_5 V2_7.5

Fig. 3 - Control biscuits (C2) and biscuits fortified with tomato waste flour (V2)

Sensory analysis

Sensory analysis plays an important role in characterizing the quality of food products. Results of sensory analysis of biscuits fortified with tomato waste flour have shown that the addition of this functional ingredient in their composition has not a negative effect on sensory characteristics (Fig. 4). So, the analyzed products were tested by an expert panel receiving qualifying „very good", with scores in the range 19.60- 20.00, as follows: biscuits V1_5 – 19.60; biscuits V1_7.5 – 19.84; biscuits V2_5 – 19.84; biscuits V2_7.5 – 20.

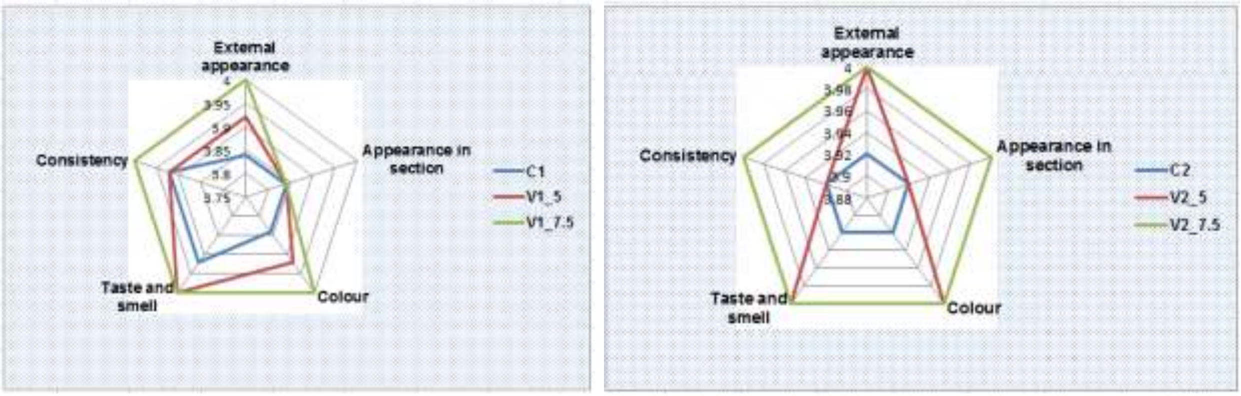

Fig. 4 - Sensory evaluation of Control biscuits and biscuits fortified with tomato waste flour

Physic-chemical analysis

Biscuits fortified with tomato waste flour have a complex biochemical composition, distinguished by their protein content, minerals (calcium, magnesium, potassium, iron, zinc), total dietary fiber and carotenoids (lycopene and β-carotene) (Table 1 and Fig. 5).

Table 1

Chemical composition of Control biscuits and biscuits fortified with tomato waste flour

Component	C1	V1_5	V1_7.5	C2	V2_5	V2_7.5
Moisture [%]	18.35	18.22	18.09	17.65	17.53	17.40
Protein [%]	12.34	12.90	13.18	13.29	14.12	14.53
Fat [%]	14.02	14.40	14.58	18.60	19.15	19.42
Ash [%]	1.82	1.96	2.02	2.51	2.72	2.84
Total dietary fiber [%]	1.85	3.58	4.45	2.92	5.48	6.85
Potassium [%]	264.55	282.33	291.25	360.17	386.52	399.70
Calcium [%]	103.93	127.74	139.65	161.70	196.98	214.57
Magnesium [%]	64.21	72.22	76.35	63.26	75.11	83.35
Iron [%]	2.59	2.90	3.04	2.91	3.53	3.60
Zinc [%]	1.45	1.48	1.54	1.71	1.75	1.80

It is noteworthy that these products have high protein content (12.90 - 14.53%), fibers (3.58 - 6.85%) and mineral elements, ash varying between 1.96 - 2.84%. Protein and ash contents of biscuits fortified with tomato waste flour are higher comparative to those of biscuits fortified with dried fruits of *Aronia melanocarpa.* Instead, the content of total dietary fiber of biscuits fortified with dried fruits of *Aronia melanocarpa* is higher than that of biscuits fortified with tomato waste flour (*Catană et al., 2018).* Also, biscuits made according to the experimental variants V2_5 and V2_7.5 have the total fiber content comparable to that reported by Isik and Topkaya (2016), in case of crackers supplemented with 4% and 8% of tomato pomace powder, respectively (5.30% and 6.68%).

Biscuits fortified with tomato waste flour have high mineral element content. The most abundant among investigated elements was potassium, its concentration varying in the range 282.33 - 399.70 mg/100 g (maximum concentration was recorded for V2_7.5). Also, biscuits achieved within this experimental study are distinguished by their content in calcium (127.74 - 214.57 mg/100 g), magnesium (72.22 - 83.35 mg/100 g), iron (2.90….3.60 mg/100 g) and zinc (1.48….1.80 mg/100 g). Content of K, Ca, Mg, Fe and Zn of these biscuits is higher compared to that reported by *Topkaya (2016),* in case of crackers supplemented with 4%, 8% and 12% of tomato pomace powder (K: 210.89 - 309.00 mg/100 g; Ca: 35.62 - 56.99 mg/100 g; Mg: 28.39 - 40.07 mg/100 g; Fe: 1.26 - 2.21 mg/100 g: Zn: 1.10 - 2.26 mg/100 g). These differences can be explained by the high content in mineral elements of the raw materials used in biscuits composition, together with tomato waste flour: telemea cheese, oat flakes, Jerusalem artichoke tubers, butter, yoghurt, eggs, concentrated tomato juice, cumin seeds etc.

Biscuits fortified with tomato waste flour are distinguished by their content in lycopene and β-carotene, which varied in the following ranges: 2.83 - 4.80 mg/100g in case of lycopene and 0.45 - 0.79 mg/100g in case of β-carotene (Fig. 5). Biscuits achieved according to the experimental variants V2_5 and V2_7.5 have content in lycopene and β-carotene higher than that of biscuits achieved in the first series of experiments

(V1_5 and V1_7.5) due to the use in composition, in addition to tomato waste flour and of concentrated tomato juice.

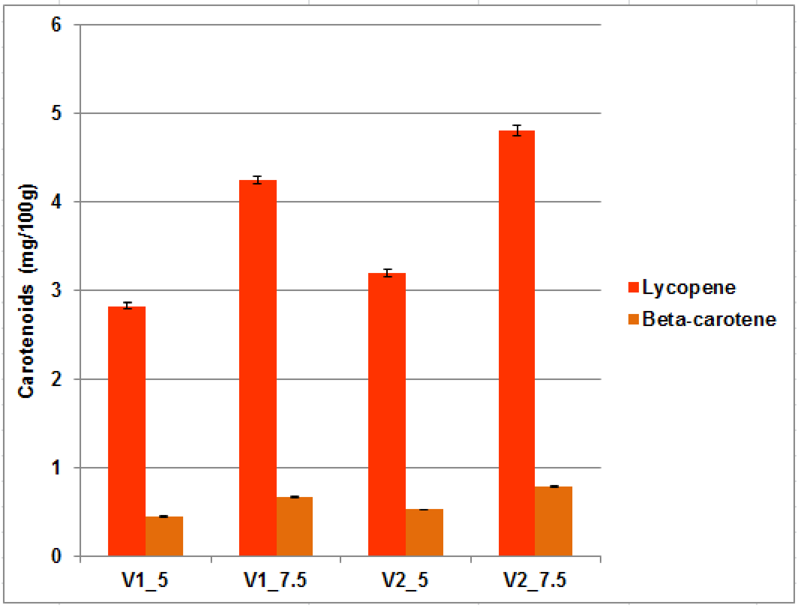

Fig. 5 - Carotenoids content of biscuits fortified with tomato waste flour

Total polyphenol content

Biscuits fortified with tomato waste flour have a high total polyphenol content, which varied in the range: 723.55 - 930.34 mg GAE/100g (minimum value was registered in case V1_5, and the maximum one in case of V2_7.5) (Fig. 6).

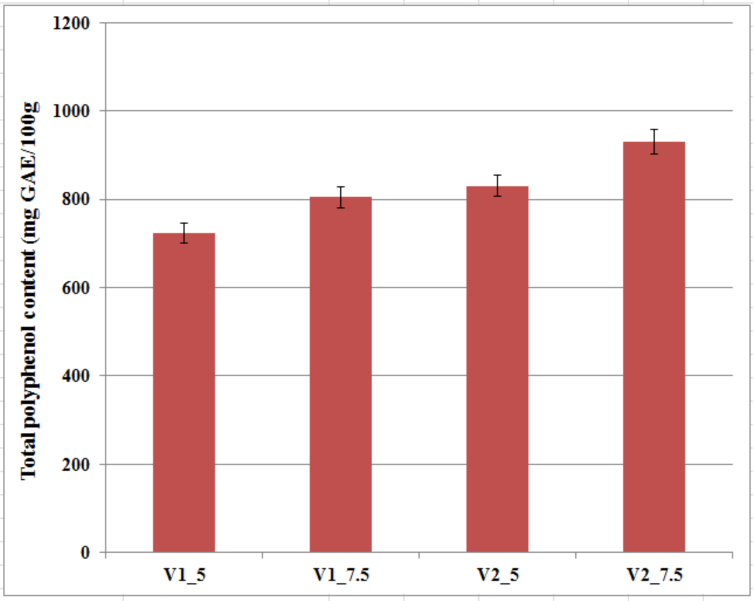

Fig. 6 - Carotenoids content of biscuits fortified with tomato waste flour

Total polyphenol content of biscuits fortified in this study is higher than that reported by Topkaya (2016) in case of crackers supplemented with 4% and 8% of tomato pomace powder, respectively (68.59 - 127.59 mg GAE/100 g), due to the ingredients rich in polyphenols (Jerusalem artichoke tubers, cumin seeds, Zatar spice, dried rosemary, concentrated tomato juice, etc.), used in their composition, together with tomato waste flour. Also, total polyphenol content is higher than those reported by Mildner-Szkudlarz *et al.* (2013), in case of biscuits made from wheat flour and addition of 10% white grape pomace (211 mg GAE/100 g). Also, total polyphenol content of biscuits with *Aronia* exceeds those of biscuits supplemented with 10% germinated fenugreek (*Trigonella Foenum Graecum*) seeds flour: 196.58 mg GAE/100g (*Mahmoud et al., 2012*).

Main phenolic compounds in tomato pomace are: chlorogenic acid (75.6 mg/100 g), caffeic acid (51.2 mg/100 g), p-Coumaric acid (24.9 mg/100 g) and ferulic acid (2.3 mg/100 g). These phenolic compounds may inhibit platelet activation and, in addition, tomato pomace extract presents antithrombotic activity (*Fuentes et al., 2013).*

Antioxidant capacity

Due to their content in bioactive compounds (polyphenols, lycopene, β-carotene, etc.) biscuits fortified with tomato waste flour have high antioxidant capacity, which varied in the range: 348.92 - 478.2 µmol Trolox Equivalents/100g (the minimum value was registered in case of V1_5, and the maximum one in case of V2_7.5) (Fig. 7). Antioxidant capacity of these fortified biscuits is higher than that of crackers supplemented with 4% and 8% of tomato pomace powder, respectively (7.67 - 18.11 µmol Trolox Equivalents/100 g) *(Topkaya et al., 2016)* and of biscuits enriched with grape marc extract: 79 µmol Trolox Equivalents/100 g *(Pasqualone et al., 2014).*

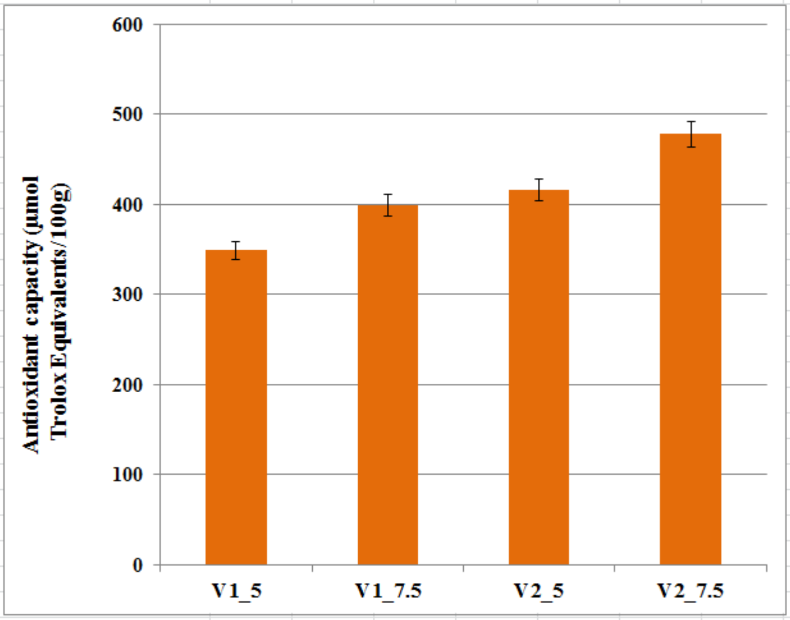

Fig. 7 - Antioxidant capacity of biscuits fortfied with tomato waste flour

Between total polyphenol content and antioxidant capacity there is a directly proportional relationship. In this study, the total polyphenol content of biscuits fortified with tomato waste flour, was strongly correlates with their antioxidant capacity (linear regression equation: y=1.5972x+166.63; regression coefficient: R^2: 0.9999). Results are in conformity with those of other authors which mentioned a direct correlation between total polyphenol content of fruits of *Aronia melanocarpa*, fresh and processed (frozen and dried fruits, juice, jam, compote) and their antioxidant capacity (linear regression equation: y= 47.761x – 14.327; regression coefficient: R^2: 0.9988) *(Catană et al., 2017).*

Microbiological analysis

Based on microbiological, sensory and peroxide index analyses it was established shelf-life of biscuits fortified with tomato waste flour (45 days). Microbiological analysis of these products at the end of shelf-life is presented in Table 2. Microbiological analysis shown that the biscuits fortified with tomato waste flour are in the frame of the provisions of the legislation into force. It is worth mentioning that in the shelf-life of the fortified biscuits, an important contribution has also tomato waste flour, which has antimicrobial activity**.** Gaafar *et al. (2015)* have shown that tomato pomace is a very promising source of bioactive compounds and can be used or its extracts as antiviral, antimicrobial and antioxidant agent.

Table 2

Microbiological analysis of biscuits fortified with tomato waste flour

Microbiological indicator	V1_5	V1_7.5	V2_5	V2_7.5
Yeasts and molds [CFU/g]	< 10	< 10	< 10	< 10
Enterobacteriaceae [CFU/g]	< 10	< 10	< 10	< 10
Escherichia coli [CFU/g]	< 10	< 10	< 10	< 10
Salmonella	absent/25g	absent/25g	absent/25g	absent/25g

During shelf-life water activity of these products varied in the following ranges: 0.672–0.855 for V1_5; 0.662-0.843 for V1_7.5; 0.643-0.823 for V2_5; 0.633-0.812 for V2_7.5.

CONCLUSIONS

Tomato waste flour is a valuable functional ingredient that can be used to fortify biscuits in order to increase nutritional value and antioxidant capacity. Biscuits fortified with tomato waste flour have proper sensory characteristics and are distinguished by content in proteins (12.90 - 14.53%), fibres (3.58 - 6.85%) and mineral elements (K = 282.33 - 399.70 mg/100 g; Ca = 72.22 - 83.35 mg/100 g; Mg = 72.22 - 83.35 mg/100 g; Fe = 2.90 - 3.60 mg/100 g; Zn = 1.48 - 1.80 mg/100 g). Adding of tomato waste flour in biscuits composition also ensures obtaining of relative high shelf-life, because this ingredient has **a**ntimicrobial activity**.**

Biscuits fortified with tomato waste flour are distinguished also by their content in bioactive compounds: total polyphenols (723.55 - 930.34 mg GAE/100 g), lycopene (2.83 - 4.80 mg/100 g) and β-carotene (0.45 - 0.79 mg/100 g). Also, due to their high content in bioactive compounds, these biscuits have high antioxidant capacity (348.92 - 478.2 µmol Trolox Equivalents/100 g).

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INTERACTIONS BETWEEN ANTIOXIDANTS FROM SOME FRUITS AND VEGETABLES
/
INTERACŢIILE DINTRE ATIOXIDANŢII PREZENŢI ÎN FRUCTE ŞI LEGUME

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Keywords: *total antioxidant capacity, photochemiluminscence, polyphenols, ascorbic acid*

ABSTRACT

Total antioxidant capacity is the result of the activity of all antioxidants present in the food. Interactions between components can be synergistic, additive or antagonistic. Naturally occuring antioxidants, when combined, can result in synergistic interactions with application in food systems. The synergistic effects provided by these antioxidants have implications in the biological systems, and also, can be applied to food quality and food shelf life. In this research work we tried to find out the effects of interactions among polyphenols, ascorbic acid on the total antioxidant capacity using photochemiluminscence methods in hydrophilic and lipophilic systems for some fruits and vegetables.

REZUMAT

Capacitatea antioxidantă totală a unui aliment este rezultatul activităţii antioxidanţilor prezenţi în produs.Interacţiile dintre compuşii antioxidanţi pot fi sinergice, aditive sau antagonice. Antioxidanţii naturali, prin combinare, pot avea efecte sinergice cu implicaţii în sistemele biologice, dar şi asupra calităţii şi termenului de valabilitate al produsului alimentar. În prezenta lucrare de cercetare ne-am propus să studiem efectele interacţiilor dintre polifenoli, acid ascorbic, prezenţi în fructe şi legume, asupra capacităţtii antioxidante totale utilizând metoda fotochemiluminescenţei în sisteme liofilice şi lipofilice.

INTRODUCTION

Many compounds can act as antioxidants, and they can be classified according to their source, function, mechanisms of action, and chemical structures. According to their mechanism, antioxidants can be classified as primary or secondary antioxidants. Primary antioxidants are chain-breaking antioxidants that inhibit lipid oxidation by interfering at the propagation or initiation phase or in β-scission reactions by accepting free radicals to form stable free radicals. Secondary antioxidants are considered preventative antioxidants that retard the rate of the chain initiation of oxidation by binding air oxygen or catalytic metal ions to delay the oxidation. The secondary antioxidants are different from the primary antioxidants in that they do not convert free radicals into more stable nonreactive products (*Chaiyasit et. al., 2007*; *Reishe et. al., 2002*). The antioxidants have mixed-function and may act as both primary and secondary antioxidants, such as the naturally occurring polyphenols (*Wanasundara and Shahidi, 2005*). Interactions among antioxidants in the food system are complex, not only because of the different types of antioxidants, but also due to the interactions with other food components.

The effect of the food matrix can be also significant, and the complexity is one of the main reasons for the lack of systematic approaches in dealing with the multifaceted interactions.Total antioxidant capacity of a food is the result of the activity of all antioxidants present in the food matrix. Interactions between components can be synergistic (the antioxidant effect of two or more antioxidants when applied together is greater than the sum of the individual antioxidant effects applied separately), additive (antioxidant effect of two or more antioxidants when applied together is equal to the sum of the individual antioxidant effects applied separately) or antagonistic (antioxidant effect of two or more antioxidants when applied together is less than the sum of the individual antioxidant effects applied separately). For example, phenolic extracts for different foods, when mixed, presents three of the effects. Synergistic interactions lead to synergistic activities in cellular models, and is not due to the synergism of change in composition (*Tsao R. 2010*). Polyphenols are amphiphilic compounds, being both soluble in aqueous and lipid phase. This unique property gives them the ability to be in contact with both vitamin C and vitamin E. The amphiphilic property and moderate redox potential predisposing polyphenolic compounds to an antioxidant synergism in the food and biological systems. For example, flavonoids with a catechol structure increase the α-tocopherol potential in the biological systems (rats) and protects the oxidation of vitamin *in vitro* (*Frank et. al., 2006*).

Experimental works have shown that vitamin C regenerates polyphenols which, in turn, regenerates vitamin E (*Dai et. al., 2005*).

MATERIALS AND METHODS

Materials

The fruits and vegetables (pomegranate, papaya, white cabbage, red cabbage, black grape, red bell pepper, green bell pepper, yellow bell pepper, lemon, kiwi, and broccoli) were purchased from Romanian local supermarkets. The fresh material was stored for no more than 3 days at 4 ^{0}C prior to analysis.

Determination of ascorbic acid

The dye-titration method was used, procedure AOAC, 2006. Metaphosphoric acid extracts of the fruits and vegetables were measured by titrating with 2, 6-dichlorophenolindophenol (DCIP). In this oxidation-reduction reaction, ascorbic acid in the extract was oxidized to dehydroascorbic acid and the indophenol dye reduced to a colourless compound. End point of the titration was detected when excess of the unreduced dye gave a rose pink colour in acid solution. The tests were carried out on some vegetables and fruits: pomegranate, papaya, white cabbage, red cabbage, black grape, red bell pepper, green bell pepper, yellow bell pepper, lemon, kiwi, broccoli. Dehydroascorbic acid was not analyzed in this study.

Determination of total phenolics

The phenol content was measured by the Folin-Ciocalteau reagent (*Aaby et al., 2005; Singleton and Rossi,1965*) using gallic acid as standard 1 mL of extract was mixed with 5 mL Folin-Ciocalteau reagent (previously diluted 10-fold with distilled water) and 4 mL sodium bicarbonate (7.5% w/v), and the mixture was diluted to 100 mL with distilled water. The solution was kept in the dark at room temperature for 1 h; the absorbance was then measured at 752 nm with a model Specord 210 spectrophotometer (Analytic Jena, Germany). Total phenolic content was expressed as gallic acid equivalents (the concentration of gallic acid was established from a calibration curve) in mg per 100 g fresh weight (mg GAE/100 g FW).

Determination of total antioxidant capacity using the photochemiluminescence (PCL) assay

The procedure was based on the methodology published by Popov and Lewin (1999). The principle of the PCL assay is based on the fact that the superoxide anion radicals ($O_2^{\bullet-}$) generated upon exposure to light and the presence of a photosensitizer are detected by their reaction with a photosensitizer, chemiluminogenous, compound-luminol (5-amino-2, 3-dihydro-1, 4-phthalazinedione). Analysis are conducted using a Photochem® apparatus (Analytik Jena, Germany). PCL evaluations allow for precise, reproducible and rapid analysis of antioxidant activity in both lipid-soluble (ACL) and water-soluble (ACW) extracts due to kits provided by the manufacturer (Analytik Jena, Germany). The presence of an antioxidant in the reaction solution results in a retardation of the luminescence. PCL assays were carried out in triplicate for each sample, using HPLC grade water for ACW and HPLC grade methanol for ACL measurements. Results were expressed as μmol Vitamin C equivalents per 1 g sample and as μmol Trolox equivalents per 1 g of tested sample.

RESULTS AND DISCUSSIONS

For a complete picture regarding the content of the two classes of bioactive compounds analysed in various fruits and vegetables, the following representation (Fig. 1) shows the values obtained for each type of product:

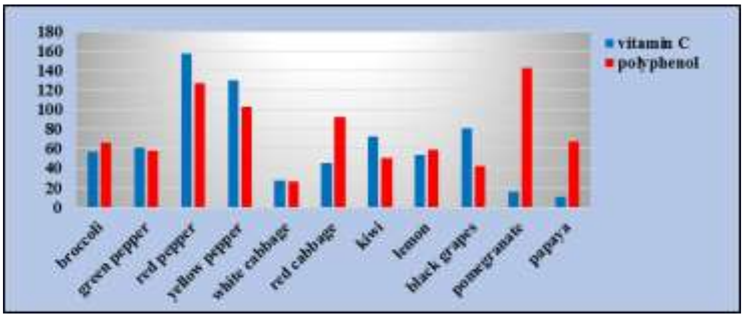

Fig. 1 -The content of vitamin C (mg/100 g fresh weight) and polyphenols (expressed as mg gallic acid/100 g fresh weight) in analysed products

As can be seen, high values of vitamin C (vitamin C expressed in mg/100 g fresh weight) presented red peppers, yellow peppers, grapes, kiwi and lowest values belong to the samples: white cabbage, pomegranate and papaya. As regards the content of polyphenols (expressed as mg gallic acid/100 g fresh weight), it presented higher values for pomegranate, red pepper, yellow pepper, red cabbage. Lower values were presented: black grapes and white cabbage. The same products (pomegranate, papaya, white cabbage, red cabbage, black grape, red bell pepper, green bell pepper, yellow bell pepper, lemon, kiwi, broccoli) have been investigated in terms of total antioxidant capacity in accordance with, phpthochemiluminescence method and protocols for aqueous system (ACW) and lipidic system (ACL).

ACW method

The measurements were carried out on the basis of a protocol, using ascorbic acid as a standard. For each series of measurements was needed at least three calibration points of standard concentration, with three repetitions for each concentration level.

The calibration with ascorbic acid consisted in the use of ascorbic acid concentrations of 0.5; 1.0; 1.5; 2.0 nmol/10µl, the measurement of parameter LagP -Lag0, followed by plotting the calibration curve in linear or quadratic system. It is important that the concentration of the measured samples to overcome the antioxidant concentrations of ascorbic acid standard used. The values obtained for the different samples may be expressed in nmol, µmol equivalent vitamin C /g product or equivalent ng , mg vitamin C /g product.

ACL method

The measurements were carried out on the basis of a protocol using Trolox (6-hydroxy-2, 5, 7, 8-tetrametilcroman-2-carboxylic acid) standard, a soluble analogue of vitamin E.

For each series of measurements was needed at least three calibration points of standard concentration, with three repetitions for each concentration level. The calibration with Trolox consisted in the use of 0.5; 1.0; 1.5; 2.0 nmol Trolox/10µl, the measurement of parameter Inhibition, followed by plotting the calibration curve in linear or quadratic system.The values obtained for the different samples may be expressed in nmol, µmol Trolox equivalent /g product or ng , mg Trolox equivalent /g product.

The results obtained for total hydrophylic and lipophilic antiox idant activity of some sample are presented in Figure 2.

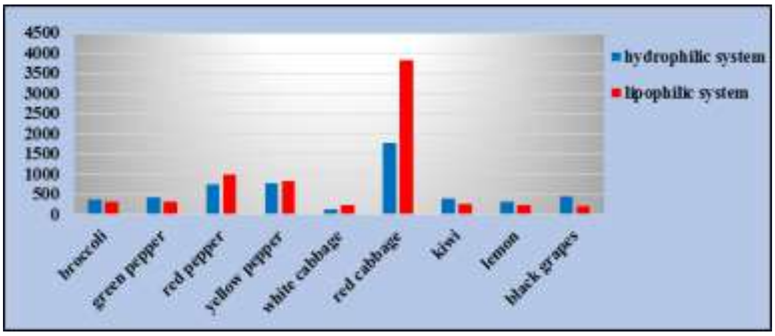

Fig. 2 - Antioxidant capacity of samples in lipophilic and hydrophilic systems (expressed in µmol Vitamin C equivalents /100g FW and µmol Trolox equivalents/100g FW)

Correlation between antioxidant capcity and the quantity of bioactive compounds in hydrophilic and lipophilic systems

It has established a good correlation between the antioxidant capacity of the analyzed samples in the hydrophilic system (expressed as mg vitamin C equivalent/g fresh weight) and the values of the content of vitamin C expressed as mg/g fresh weight. As shown in Figure 3, the linear correlation is established, y = 1.0474 x, where y is the antioxidant capacity, and x amount of ascorbic acid content (R^2 = 0.9665).

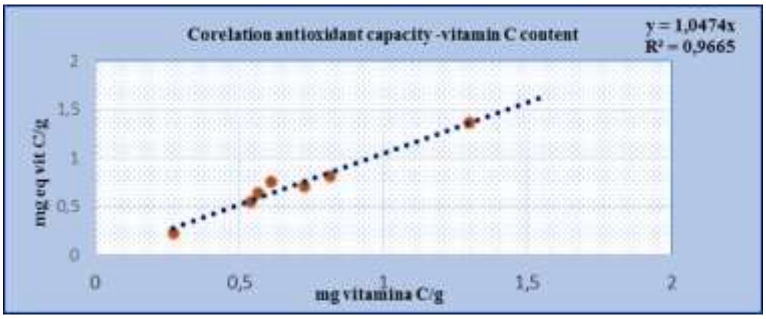

Fig. 3 - Correlation between antioxidant capacity and vitamin C

In the lipophilic system, the results had a weaker correlation between the antioxidant capacity expressed in mg Trolox /g fresh weight and the content of polyphenols (gallic acid expressed in mg/g fresh weight) (Fig. 4).

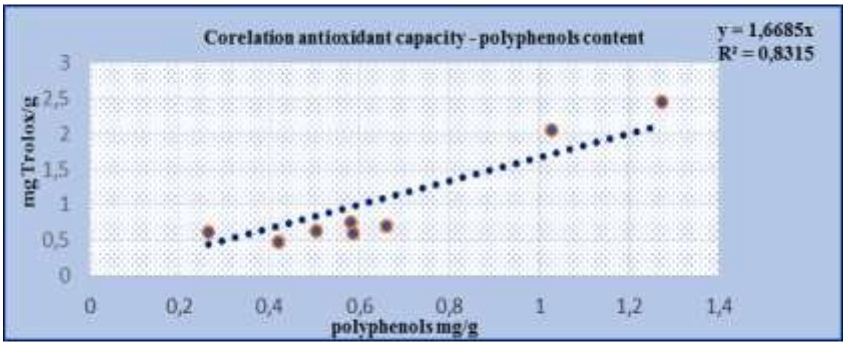

Fig. 4 - Correlation between antioxidant capacity and polyphenols

The values obtained from the red cabbage sample were different, meaning that the antioxidant capacity in boath hydrophilic and lipophilic systems were six to ten time more than the content of acid ascorbic or polyphenols (synergistic interactions).

CONCLUSIONS

The synergistic effects provided by these phytochemical antioxidants not only have implications in biological systems as an integrated defense mechanism against oxidative stresses, but can be applied to food quality and food shelf life.

Excluding the values obtained from the red cabbage, it has established a good correlation between the antioxidant capacity of the analyzed samples in the hydrophilic system (expressed as mg vitamin C equivalent/g fresh weight) and the values of the content of vitamin C expressed as mg/g fresh weight.

In the lipophilic system, the results had a weaker correlation, the antioxidant capacity expressed in mg Trolox /g fresh weight in relation to the content of polyphenols expressed in mg gallic acid /g fresh weight) was poor. The sample- red cabbage showed more antioxidant capacity and thus can be used as more effective radical scavenger against detrimental damages caused by the free radicals, but the key points of the synergistic mechanism needs further research.

ACKNOWLEDGMENTS

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STUDY ON THE INFLUENCE OF MINERAL FERTILIZATION ON THE YIELD OF GRAIN SORGHUM CULTIVATED IN THE CARACAL PLAIN
/
STUDIU PRIVIND INFLUENTA FERTILIZARII MINERALE ASUPRA PRODUCTIEI LA SORGUL DE BOABE CULTIVAT ÎN CÂMPIA CARACALULUI

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Keywords: *grain sorghum, density, fertilization level, yields, protein content.*

ABSTRACT

The main objective of the paper is to optimize some technological sequences - crop density and fertilization level - to the grain sorghum crop in Oltenia Plain in ARDS Caracal climatic conditions. The production data obtained from the experiment in 2018 show that the level of recorded in crops increased with the density of the plants and the increase of the nutrient doses, the production having values of over 9400 kg/ha in the variant with a density of 30 seeds/square meter on the level of fertilization with $N_{150}P_{80}$ *+ Aminosol.*

REZUMAT

Obiectivul principal al lucrării îl reprezintă optimizarea unor secvențe tehnologice – desimea culturii și nivelul de fertilizare - la cultura de sorg de boabe în condițiile climatice din Câmpia Caracalului de la SCDA Caracal. Datele de producție obținute în urma experimentării din anul 2018 arată că nivelul producțiilor înregistrate a crescut odată cu densitatea plantelor și creșterea dozelor de nutrienți, producțiile înregistrând valori de peste 9400 kg/ha la varianta cu densitatea de 30 boabe germinabile/metru pătrat și nivelul de fertilizare cu $N_{150}P_{80}$ *+ Aminosol.*

INTRODUCTION

Sorghum is one of the crops with a high adaptability to poor environmental conditions (poor soils, arid climate) due to its high capacity to efficiently harness natural resources and increased drought tolerance. The importance of sorghum culture is given by its role as an alternative to corn crops, amid multiple uses: feeding animals, food, food and light industry for starch production, ethyl alcohol, beer and so on.

Having a good capacity to efficiently harvest natural resources, sorghum has produced high yields under less environmentally friendly conditions for other cereals (*Antohe et al., 1981, Draghici I., 1999, 2014*). Researches have shown that the elements of technology: crop rotation and fertilization (*Varvel, 2000; Espinoza, 2005; Kaye, 2007*), culture density (*Schatz, 1990*) and distance between rows (*Fernandez, 2012*) had a very significant influences on yield on grain sorghum (Sorghum bicolor (L.) Moench var. eusorghum).

Sorghum has a minimum requirements related soil due his root system with high development and performance for extracting water and nutrients, even in case of soils with large variance of pH, from 4,5 to 8,5. However, the best results were registered on the soils with medium texture, and with good level of organic matter.

Sorghum has also low nutritional requirements because it has the well-developed radicular system that allows it to extract all the nutrients it needs from the soil. He needs small amounts of phosphorus and potassium, requiring: 20-60 kg a.s/ha. Related to nitrogen, the requirements are higher, but in any case less than the corn crop, around 60 to 80 Kg a.s./ha (*Pochiscanu S., 2015*).

MATERIAL AND METHOD

The research was carried out at ARDS Caracal, during the 2018 year in the conditions of a chermozem soil, medium rich in nutrient and with a humus content which varied between 3% to 4%. The soil in the arable layer (0-20 cm) has a lutearic texture with a clay content (particles below 0.002 mm) of 36.2%, an apparent density of 1.42 g/cm^3, a total porosity of 47% and one medium penetration rate (penetration resistance of 42 kg/cm^2).

From the point of view of the hydric features in the superficial layer, the wilting coefficient records the value of 12.3%, the field capacity 24.5% and the hydraulic conductivity is 9.2 mm/h.

The main aim of the research was to establish the most valuable variant of fertilization on the best density on grain sorghum. As experimented genotype we use grain sorghum hybrid ES Alize from Euralis Company, a semi early hybrid, with high tolerance on drought, high tolerance to shatter and shake.

As a previous plant we use colza. The crop was sowing on 3rd of May 2018. The cultural hygiene was ensured by the treatment with Casper herbicide applied in the first stage of plant development.

The experiment had two factors:

- **A factor** – ***crop density*** - with three graduations:
  - *a1 – 200 seeds/square meter;*
  - *a2 – 250 seeds/square meter;*
  - *a3 – 300 seeds/square meter.*
- **B factor - *fertilization* -** with five graduations:
  - *b1 – unfertilized variant;*
  - *b2 - $N_{75}P_{80}$;*
  - *b3 - $N_{75}P_{80}$ + Aminosol;*
  - *b4 – $N_{150}P_{80}$;*
  - *b5 – $N_{150}P_{80}$ + Aminosol;*

The collected data in the field were analyzed using statistical program of ANOVA.

RESULTS

Climatic conditions *(figure 1)* – during the experiment, the climatic conditions had an important influence on the evolution of grain sorghum crop.

The data shown in Figure 1 certify that the 2018 agricultural year was ***an excessively warm year***. Compared to the normal area, an average temperature of 12.6°C was achieved, with 2.0°C, higher than the multiannual average of 10.6°C. Regarding the months of the warm period of the year (April - September), we find that in no month were recorded temperatures lower than the multiannual average. The deviations were positive, ranging from 0 - 5.2°C.

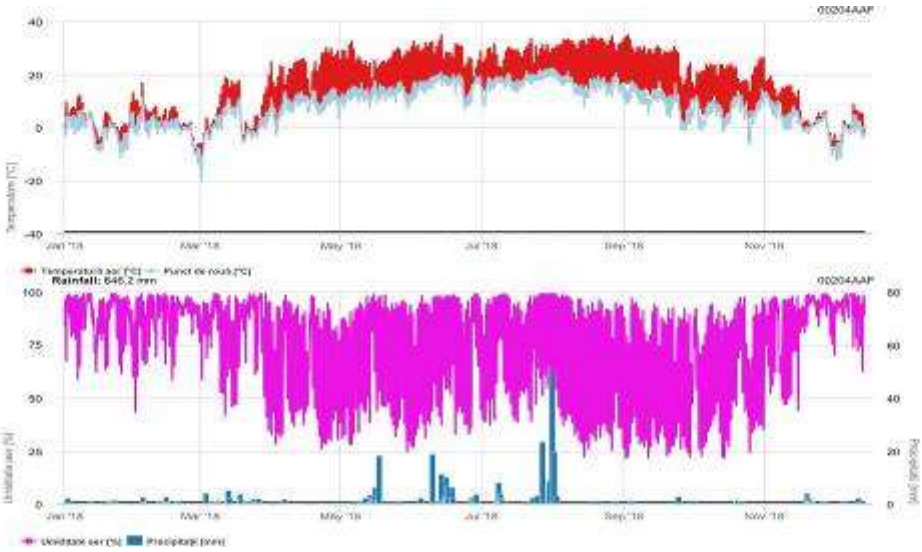


Fig. 1 – Climatic condition on 2018 year registered at ARDS Caracal

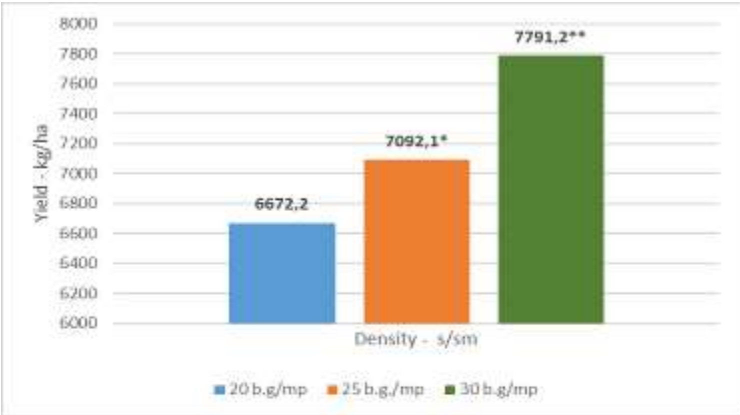
April is remarkably hot, recording a thermal surge of 5.2°C, the highest temperature ever recorded in April from this area. Daily average temperatures exceeded 32°C in the middle of the month. Also in May were exceptional temperatures, with monthly deviation of + 3°C, all of which led to a record: the warmest spring since there were meteorological records in the area. It is remarkably hot and August and September, with a thermal surplus of 2.4°C and respectively 2.0°C.

From the point of view of precipitations, the 2018 year was on with a high level of rainfall, especially in the second part. The precipitation in this agricultural year totals 843.6 mm, with 306.2 mm higher than the multiannual average of 537.4 mm.

The results recorded this spring crop was influenced, in the first phase, negatively by extreme temperatures in April, temperatures that led to cumbersome processing and rapid drying of the germinative bed, with negative effects on the growth of the culture. In the second phase, the excessive precipitations recorded in June and July, of 134.2 mm and respectively 147.8 mm, led to good results in the cultivation of grain sorghum. The yield of the sorghum grown under such conditions depends largely on rainfall during the vegetation season and the soil water stored in the previous rains (Xin et al., 2008).

The results obtained at SCDA Caracal show that in the year 2018, which had a high rainfall regime during the second part of the sorghum vegetation period, the production potential of these tested hybrids was well expressed by the yields obtained.

Related to the influence of the A factor – plant's density on the level of yields – it's obviously observed that the production increase in the same time with the density of plants, from 6672.2 kg/ha at the level of 20 seeds /square meter – used as Control – to over 7791 kg/ha on the level with the highest density of 30 seeds/square meter. Both levels with higher density than Control realized increases in production, of 6.3% for 25 seeds/square meter and respectively 16.8% for 30 seeds/square meter variant.



DL 5% - 326 kg/ha; DL 1% - 875 kg/ha; DL 0.1% - 1492 kg/ha.

Fig. 2 – Influence of the A factor – plant's density - on the yields at grain sorghum

If we look at the trends of these increases, we can establish a positive correlation between plant's density and levels of the yields (Fig. 3), in the sense that production increases with plant density,

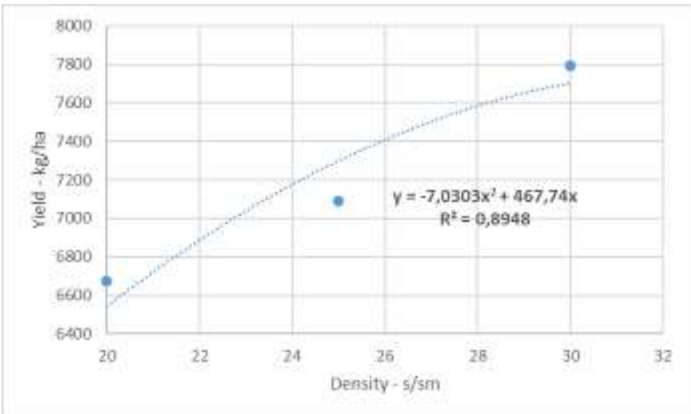
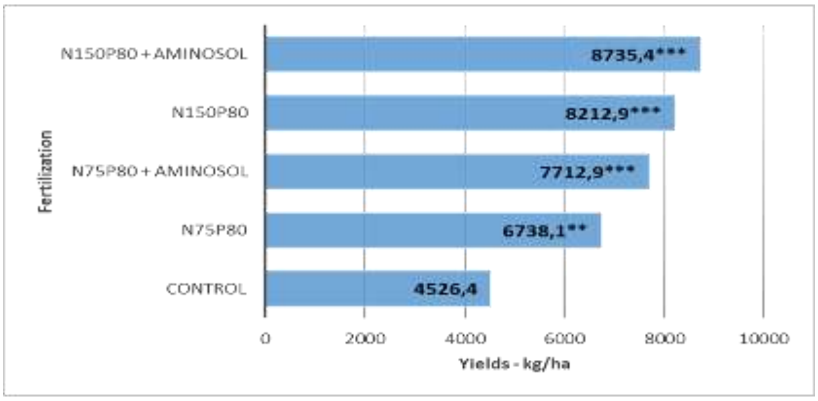


Fig. 3 – Correlation between plant's density and yields on grain sorghum

Taking in account the evolution of the evolution of the yields from the second factor – B – levels of fertilization – we can observe the continuous increase of the productions, starting to the unfertilized variant to the highest level of $N_{150}P_{80}$ + Aminosol. That situations reveal the great potential that sorghum has to harness applied fertilizers, even in the conditions of the argic chernozem from the ARDS Caracal (Fig. 4).



DL 5% - 743 kg/ha; DL 1% -1368 kg/ha; DL 0.1% - 3024 kg/ha.

Fig. 4 – Influence of the B factor – fertilization - on the yields at grain sorghum

In comparison with the Control, we register very significant increase in production on the $N_{75}P_{80}$ variant of over 48%. Adding a biostimulator (Aminosol) at the same level of the mineral fertilization we registered a very significant increase in production, of 3186,5 kg/ha, that means a yields with 70,4% higher that the Control.

Almost the same situation has been observed on the last two variants of fertilization the $N_{150}P_{80}$ and $N_{150}P_{80}$ + Aminosol. When we applied only the mineral fertilizers, the increase was of 81,4% that means 3686,5 kg/ha. The biostimulator has a significant influence on the grain sorghum capacity to give very good productions and the increase observed on the variant with combined fertilizers of $N_{150}P_{80}$ + Aminosol was over 4200 kg/ha and that was a production with 93% higher that the unfertilized variant used as Control.

Analyzing the data from table 1 – ***about the influence interaction of the two tested factors – plant's density and fertilizers levels*** - where the yields varied between 4031.7 kg/ha in the unfertilized variant at the lowest density and 9484.1 kg/ha in the variant with the highest fertilization level within the lowest density, we can conclude that for the climatic conditions in the Caracal Plain, the most valuable sowing rate prove to be 30 seeds/square meter with values between 5019.8 kg/ha in the unfertilized variant and 9484.1 kg/ha in the $N_{150}P_{80}$ + Aminosol.

From fertilizer factor point of view, although sorghum has found good production factors that even under non-fertilizer conditions have reached levels between 4031.7 kg/ha and 5019.8 kg/ha, the application of simple mineral fertilizers or in combination with the treatment with Aminosol resulted in significant production increases, especially at the density of 30 seeds/square meter, with very significant positive differences in the $N_{150}P_{80}$ and $N_{150}P_{80}$ + Aminosol, where the increases were 26.1% and respectively 32% compared with the control.

It is noteworthy that all non-fertilized variants (used as a control on the tested density level) realized productions with very significant negative differences related the control.

Table 1

Results obtained related the influence of interaction of density (A) and fertilization (B) on yield at grain sorghum cultivated at ARDS Caracal, 2018

A Factor Sowing density (seeds/sq.m)	B Factor Fertilization (kg a.s./ha)	Grain yields			Signification
		Kg/ha	(%)	Differences kg/ha	
20	Unfertilized	4031.7	56.1	-3153,4	OOO
	$N_{75}P_{80}$	6511.9	90.6	-673,3	
	$N_{75}P_{80}$ + Aminosol	7190.5	100.1	5,3	
	$N_{150}P_{80}$	7575.4	105.4	390,2	
	$N_{150}P_{80}$ + Aminosol	8051.6	112.1	866,4	*
25	Unfertilized	4527.8	63.0	-2657,4	OOO
	$N_{75}P_{80}$	6674.6	92.9	-510,6	
	$N_{75}P_{80}$ + Aminosol	7583.3	105.5	398,1	
	$N_{150}P_{80}$	8004.0	111.4	818,8	*
	$N_{150}P_{80}$ + Aminosol	8670.6	120.7	1485,4	**
30	Unfertilized	5019.8	69.9	-2165,3	OOO
	$N_{75}P_{80}$	7027.8	97.8	-157,4	
	$N_{75}P_{80}$ + Aminosol	8365.1	116.4	1179,9	**
	$N_{150}P_{80}$	9059.5	126.1	1874,3	***

	$N_{150}P_{80}$ + Aminosol	9484.1	132.0	2298,9	***
Average/experience (Control)		**7185,2**	**100.0**	**CONTROL**	**CONTROL**
DL 5% (kg/ha)		804			
DL 1% (kg/ha)		1158			
DL 0,1 % (kg/ha)		1749			

Regarding the quality of the grain sorghum production obtained (Table 2), the accumulations of protein and crude starch (determined using a rapid seed analyzer PERTEN-TA 7200) were analyzed at the level of the tested variants. The recorded data shows that both factors - density and fertilization level - had influenced the chemical composition of sorghum grains, in terms of quality.

The protein accumulation – Khalil J.K., et al., 1984 shows that in the sorghum hybrids cultivated under conditions in Saudi Arabia the protein content varied between 15.3% and 15.9%. Also, M. Mabelebele et al., 2015 South African sorghum varieties have protein content of 8.1 to 9.5%.

In our experiment, the protein content varied between 11.68% at the density of 30 seeds/square meter in the unfertilized variant and 13.02% at the density of 20 seeds/square meter in the $N_{150}P_{80}$ + Aminosol variant. Compared to the control, very significant positive differences recorded only the above-mentioned variant, namely $N_{150}P_{80}$ + Aminosol.

Applying the Aminosol biostimulator conduct to increases in protein content and in all variants where it was applied, unconcerned of the density used, in comparison with the values of $N_{75}P_{80}$ and $N_{150}P_{80}$ variants.

Research by Kaufman RC et al., 2013, showed that protein content in sorghum grains increased with increasing nitrogen rate. Looking at the results that we present we can see the same evolutions of the protein content, starting to lowest level on the unfertilized variant and increasing to the highest level of the fertilizers on all three densities tested.

Analyzing the crude starch level determined by the rapid method, we notice that there is an inverse correlation with the protein level, increasing as the protein decreases. Gross starch values ranged between 78.10% for the $N_{150}P_{80}$ + Aminosol variant and 80.50% for the unfertilized variant from the 20 seeds/ m^2 density which recorded significantly different positive differences compared to the control - the average of the experiment, of 79.32 %.

Significant positive differences are also present in the N75P80 variants at the density of 25 seeds/square meter and unfertilized variant at the density of 30 seeds/m^2.

Table 2

Results obtained related the influence of interaction of density (A) and fertilization (B) on quality yield of grain sorghum cultivated at ARDS Caracal, 2018

A Factor Sowing density (seeds/ m^2)	B Factor Fertilization (kg s.a./ha)	Protein content		Brut starch	
		%	Signification	%	Signification
20	Unfertilized	12.06	O	79,20	
	$N_{75}P_{80}$	12.35		78,90	OOO
	$N_{75}P_{80}$ + Aminosol	12.47		78,80	OOO
	$N_{150}P_{80}$	12.84	**	78,20	OO
	$N_{150}P_{80}$ + Aminosol	13.02	***	78,10	OO
25	Unfertilized	11.93	OO	80,50	**
	$N_{75}P_{80}$	12.24		80,20	*
	$N_{75}P_{80}$ + Aminosol	12.37		79,90	
	$N_{150}P_{80}$	12.56		79,40	
	$N_{150}P_{80}$ + Aminosol	12.85	**	79,20	
30	Unfertilized	11.68	OOO	80,30	*
	$N_{75}P_{80}$	12.00	O	79,90	
	$N_{75}P_{80}$ + Aminosol	12.23		79,70	
	$N_{150}P_{80}$	12.37		78,90	
	$N_{150}P_{80}$ + Aminosol	12.68	*	78,60	O
Average/experience (Control)		**12.38**	**CONTROL**	**79.32**	**CONTROL**
DL 5%		0.22		0.64	
DL 1%		0.38		1.08	
DL 0,1 %		0.63		1.37	

CONCLUSIONS

Summarizing the data from the paper, we can highlight, as most important conclusions, the follows:

- grain sorghum found very good climatic conditions at ARDS Caracal during the year 2018 and give good productions which varied between 4031.7 kg/ha to 9484.1 kg/ha;
- both tested factors, sowing density and nutritional regime had very powerful influence on the level of yields, ensuring very significant increase in productions related the Control used;
- for grain sorghum cultivated on argic chernozem, the best variant of plant's density prove to be 30 seeds/square meter, variant where the production registered was over 7700 kg/ha;
- the level of fertilization had also a very strong influence to the yields, grain sorghum having the ability to harness very well the nutrients applied. From this point of view, the best results were registered on the level of $N_{150}P_{80}$ + Aminosol whatever the density tested;
- the increases in production of the variants treated with Aminosol in comparison with those without treatment, at the same level of fertilizers, shown us that the grain sorghum has a very good capacity to use the minerals applied on extra radicular way;
- in terms of quality of productions, we can observe that there is a correlation between protein content and starch content, in sense that on the variant where we observe the highest content of protein, the starch level decrease – on the same density variant;
- a large nutritional space on 20 seeds/square meter conduct to a higher accumulation of protein, of 13.02% at the highest level of fertilizers of $N_{150}P_{80}$ + Aminosol;

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OBTAINING NUTRITIONALLY IMPROVED CONFECTIONERY AND PASTRY PRODUCTS
/
OBŢINEREA PRODUSELOR DE COFETĂRIE ŞI PATISERIE CU CALITĂŢI NUTRIŢIOANLE ÎMBUNĂTĂŢITE

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ABSTRACT

The main purpose of this paper is to obtain safe and nutritionally improved confectionery and pastries products such as cheesecake, cake with pudding and fruit, fiber cookies and cranberries, nut cookies and dietary biscuits. A specific recipe has been established and some ingredients were used to increase the nutritional value of products. Laboratory experiments have been carried out to establish the final recipe, each product having several experimental variants or several changes to the recipe and the final recipe has been used to produce the pilot experiments. Each product was then subjected to laboratory analyzes:physico-chemical, sensorial, microbiological and packaging analysis.

REZUMAT

Scopul principal al acestei lucrări este obținerea produselor de cofetărie și produse de patiserie sigure și îmbunătățite din punct de vedere nutrițional, cum ar fi cheesecake, prăjituri cu budincă și fructe, biscuiți din fibre și merișoare, cookie-uri de nuci și biscuiți dietetici. Sa stabilit o rețetă specifică și s-au utilizat câteva ingrediente pentru a crește valoarea nutritivă a produselor. Au fost efectuate experimente de laborator pentru a stabili rețeta finală, fiecare produs având mai multe variante experimentale sau mai multe modificări ale rețetei și rețeta finală a fost utilizată pentru a produce experimentele pilot. Fiecare produs a fost apoi supus unor analize de laborator: analize fizico-chimice, senzoriale, microbiologice și de ambalare.

INTRODUCTION

Confectionery (cheesecake and cake with pudding and fruit) and pastry (cookies with fibers and cranberries, cookies with walnuts, dietary biscuits with oil seeds) were obtained. Cheesecake is a baked or not dessert whose main and thickest layer consists of a mixture of fresh cheese or cream cheese, together with other ingredients. The baking technique is one of the oldest techniques in the field of food processing *(Kulkarni et al., 2010)*. Among the raw materials of interest are walnuts that have many nutritional benefits such as high level of polyunsaturated fatty acids, fibers and proteins.

The cake with pudding and fruits is a confectionery made up of three layers: the leaf cake, the pudding, which is formed by heating starch transforming it into a gel and the glaze, resulting from an orange syrup covering the cake and offering it a more pleasant taste and look. The ingredients used are carob powder, walnuts, orange pulp and raisins. Carob powder is rich in vitamins, minerals and dietary fiber and is a powerful antioxidant with lower lipid content and higher carbohydrate content. It can be used as cocoa replacer. Nuts and orange pulp are important sources of vitamins A and C, iron, calcium and potassium and raisins are a natural source of sugar, containing 70% pure fructose, vitamins A and C and minerals as potassium, iron and magnesium.

Cookies are small bakery products *(Manley, 1998*) characterized by high sugar and fat levels and low moisture levels *(Cauvin and Young, 2006)*. Due to their low moisture content and thickness, cookies are crisp, properties that are greatly appreciated when eating *(Cauvin and Young, 2006).* These products are widely consumed as snacks and can thus be used as a matrix for the addition of functional ingredients. Therefore, bioactive compounds intake could be improved by incorporating into cookies *(Mounjouenpou et al., 2018)*. The ingredients used are oat flour, rye flour, cranberries, for the first type of cookie and oat flour, nuts, wheat bran and honey for the second type of cookie. The increasing of dietary fiber content and reducing the amount of white flour, taking into account the benefits of all ingredients was followed.

Biscuits are the most popular bakery products because of their high nutritional value, their availability in various shapes and sizes at an affordable cost. Biscuits are rich in sugar (mainly sucrose) and fats and are usually avoided because of high energetic value *(Parvinder et al., 2017)*.

The functional properties of biscuits can be increased by improving or modifying the main ingredients, namely flour, sugar and fat, along with supplementing health-promoting ingredients such as milk, dietary fiber, etc. replacement of all or part of white flour with other types of flour, use of no-caloric sweeteners and fat replacers. The ingredients used are oat flour, rye flour, wheat bran, skimmed yoghurt, pumpkin seeds, sunflower seeds, sesame seeds, carob powder, coconut flakes and raisins.

MATERIAL AND METHOD

The following ingredients were used as ingredients with functional potential: walnuts, carob powder, raisins, orange juice, oat flour, rye flour, cranberries, wheat bran, pumpkin seeds, sunflower seeds and sesame seeds.

Phisico-chemical analysis

Moisture content was determined at 103°C (±2°C) (2 g test samples) until constant weight was attained (ICC Standard No. 110/1). The ash content was determined by incineration at 525 ± 25˚C (ICC No. 104/1). Total fat content was determined by extracting 10 g of sample with petroleum ether at 40-65˚C, using a semi-automatic Soxhlet Foss Extraction System 2055 (Foss, Sweden). Total nitrogen (N) and crude protein content (N·6.25, conversion factor) was determined by the Macro Kjeldahl Method (Kjeltec System, FOSS, Sweden). The carbohydrate content was calculated by difference: 100 - (ash content + protein content + fat content + moisture content). All experiments were performed in triplicate.

Sensorial analysis

The sensory analysis method used to test the products obtained was scoring scale method. The Scoring Scale Method consists in using requirements to assess the intensity of a sensorial attribute. This method is widely applied and is used for the quantitative evaluation of a set of organoleptic properties (appearance, odor, taste, color, etc.) of food products (Lawless and Heymann, 2010). The first step in the sensory approach is to establish a panel of evaluators by selecting them on the basis of a questionnaire, followed by panel training for the sensorial evaluation of food products under test.

The second step is to develop the sensorial analysis sheet. After the individual assessment, the sensorial analysis sheets are centralized and a calculation method is used to evaluate the results. If the evaluation panel consists of N evaluators and n is the number of sensorial attributes set for evaluation, it results that each product sample will receive a total of (Nxn) scores, so, each evaluator gives one score to each evaluation criterion (attribute) for each of the analyzed and tasted samples.

The total score $(P_{tot})_i$ which is received by each sensorial attribute „i" from all „N" evaluators is given by formula 1:

$$(Ptot)\,i = \Sigma Nj = 1\;(Pindi)j = Pind1 + Pind2 \;+ \ldots + Pind\;N \tag{1}$$

where:

$(Pind_i)_j$ is the individual score given by the evaluator „j" for the attribute „i";

N – total number of evaluators from panel.

The average score for the attibute „i" is given by formula 2.

$$(P_{med})i = \frac{\Sigma NJ=1\,(Pindi)j)}{N} = \frac{(\mathrm{Pind1} + \mathrm{Pind2} + \ldots + \mathrm{Pind\ N})}{N} \tag{2}$$

Several scoring systems are used to analyze the sensorial attributes from the evaluation sheet. In this case 5 points appraisal system was used.

Microbiological analysis

The following methods were used for microbiological analysis:

Method for determining the total number of mesophilic aerobic germs (NTG)

The determination of the total number of germs was carried out according to the method specified in SR ISO 4833: 2003 - Microbiology of food and fodder. Horizontal method for enumeration of microorganisms, colonization technique at 30°C. The N number of microorganisms present in the product is calculated as a weighted average starting from two successive dilutions.

Determination of the number of yeasts and molds

The determination of the number of yeasts and molds was carried out according to the method specified in SR ISO 21527-1: 2009 - Microbiology of food and animal feeding stuffs. Horizontal method for enumeration of yeasts and molds. Part 1: Colony counting technique in products with water activity greater than 0.95. This part of ISO:21527 specifies a horizontal method for enumerating viable yeasts and molds present in products intended for human or animal nutrition where the water activity is higher than 0.95 [egg, meat, dairy products (except milk powder), fruit, vegetables, dough, bread, etc.] by the colony counting techniques at 25°C.

RESULTS

For cheesecake, four experimental variants were developed: cheesecake with jelly fruit from berries, cheesecake with chocolate and caramel cheesecake. As ingredients with potential benefits for proper nutrition were walnuts and berries and oranges pulp squeezed. For these products, all basic ingredients were kept and minor changes were depending on the variant. For the leaf were used: biscuits, butter and walnuts. For the cream (pudding) cheese cows, vegetable cream, flour, sugar, yolks and eggs and, frozen forest fruits (when the case). For the berries jelly, water, sugar, gelatin and frozen berries were used. For the chocolate cheesecake was added chocolate in cream, and the chocolate glaze was made of cream and chocolate.

For caramel cheesecake, caramel is made from sugar, cream and butter. From the point of view of the technological process, the method used was the baking process, where the leaf is prepared by melting butter, homogenizing it with biscuits and nuts, molding and pressing and placing it in the refrigerator for 30 minutes. To prepare the cream, cow cheese and cream is mixed adding sugar, gradually adding eggs and, finally, the flour and the berries, when the case. The cream was added over the leaf and this cake is baked for 1.5 hours at 150°C, after that cooled and refrigerated for 4-6 hours. Jelly is obtained by mixing gelatin with water, swelling it for 10 minutes, then melting on the water bath or in the microwave oven for about 30 seconds.

At the same time, the sugar and the berries are boiled for about 15 minutes, then crushed until paste, then passed through the strainer and let to cool at room temperature. Adding the melted gelatin, then pour the mixture over the cake which is re-introduced for 3 hours in the refrigerator. The chocolate glaze is obtained by melting the chocolate which is made by mixing with the tempered cream, then the composition is poured over the cake, which is introduced into the refrigerator for 3 hours. Caramel is obtained by melting the sugar, adding cream, mixing continuously until the viscosity of the composition increases and the vegetable fat is added, then the mixture is cooled and added over the cake to be frozen in the refrigerator for 3 hours.

For the cake with pudding and fruits, carob powder, nuts and berries were added to the basic recipe as potential functional ingredients. For preparing the tops eggs, sugar, salt, flour, breadcrumbs, carob powder, nuts and baking powder were used. For pudding milk, sugar, yolk, salt, pulp from squeezed oranges, raisins and starch were used.

For the ornamental glaze orange, sugar and gelatin has been used. From the point of view of the technological process, the eggs are separated, whites are foamed, then the ingredients are gradually added and the mixture is baked on the oven for 30-35 minutes at 150°C, then cooled. For the pudding, the yolks are mixed separately, the sugar and salt are added. Starch dissolves in milk, then the whole composition is added to the rest of the milk and mixed. The milk is warmed, then added a little to the yolks to slowly raise their temperature. Squeeze the oranges, keep the juice for the glaze, and add the orange pulp to the pudding. Add the composition to the milk that is heated and stir continuously until it thickens. Add the raisins. Allow to cool to room temperature.

The cake is frozen for 4-6 hours. To prepare the glaze, the orange juice is warmed up, adding the sugar, then cool. Gelatin, which has been left to swollen and melted, is added to the orange juice. The syrup is poured over the cooled cake, which is reintroduced into the refrigerator for 3 hours.

For the cookie with fibers and fruits the following raw materials were used: white wheat flour, oat flour, rye flour, eggs, sugar, salt, butter, baking powder and cranberries. For the cookie with nuts, three experimental variants were done: cookies with nuts and chocolate, cookies with nuts and jam and cookies with nuts and honey. For these products, the basic ingredients were used: white wheat flour, oatmeal, nuts, butter, sugar, wheat bran, baking powder, salt, eggs and addition of specific ingredients such as: chocolate, jam and honey. From the point of view of the technological process, the cookies are made by foaming the sugar with butter and adding the other ingredients, kneading the dough, resting it for 20-30 minutes at the refrigeration temperature, shaping the dough, baking at 180-190°C, 15-20 minutes, cooling, weighing and packaging of the product.

Dietary biscuits with oilseeds have been processed in three experimental variants: dietetic biscuits with oilseeds, dietary biscuits with coconuts and dietary biscuits with raspberries and raisins. The main ingredients are: oat flour, rye flour, wheat bran, eggs, skimmed yoghurt, butter, baking powder, sugar, salt and, depending on the assortment, there were added: for variant 1, pumpkin seeds and sesame seeds; for variant 2: carob powder, coconut flakes, sunflower seeds, pumpkin seeds; for variant 3: cinnamon, raisins, sunflower seeds, pumpkin seeds.

From the point of view of the technological process, the products are obtained by sifting the flours, dissolving the salt with water, melting butter, mixing of sourdough, sourdough fermentation, mixing the dough, portioning, final proofing, shaping, baking at a temperature of 180 -190°C and for 15-25 minutes, cooling, weighing and packing.

Fig. 1 - Cheesecake with berries and jelly from berries juice

Fig. 2 - Cheesecake with berries jelly

Fig. 3 - Cheesecake with chocolate glaze

Fig. 4 - Cheesecake with caramel glaze

The samples were physico-chemical analyzed and the energetic value was established. The nutritional values of the four products are shown in Table 1.

Table 1

Cheesecakes nutritional values

	Cheesecake with jelly fruits	**Cheesecake with berries and jelly from berries juice**	**Cheesecake with chocolate glaze**	**Cheesecake with caramel glaze**
Energetic value (kcal/100 g product)	336	277	383	412
Energetic value (kj/100 g product)	1402	1158	1596	1714
Proteins, g	4.92	5.4	6.34	5.84
Lipids, g	22.12	16.6	24.55	29.21
Carbohydrates, g	29.43	26.6	34.08	31.42
- Sugars, g	12.8	15.6	17.55	15.0
Natrium, g	88.0	15.6	17.55	78.0

From the sensorial point of view, the cheesecake with berries glaze sample has received the highest score for exterior appearance, outside and inside color. The most appreciated product for smell, texture, flavor, sweetness and after taste, was the cheesecake with chocolate glaze. Total acceptability has decreased in order: Cheesecake with chocolate> Cheesecake with berries glaze > Cheesecake with berries in glaze and pudding> Cheesecake with caramel.

From a microbiological point of view, the development of microorganisms such as *Enterobacteriaceae*, yeasts and molds were observed at 30 days after the date of processing. The shelf life is 30 days. Packaging can be done in an aluminum tray, paper tray or stretch film.

a) b) c)

Fig. 5 - a), b), c) - Cheesecake with berries in glaze and pudding

From a physic-chemical point of view, the nutritional value of the Cheesecake with berries in glaze and pudding was determined, as follows: energetic value 751 kJ /178 kcal; proteins 4.57g; total lipids: 4.02 g; saturated fatty acids: 0.88 g; total carbohydrates: 30.85 g; sugars: 24.2 g; salt: 0.1 g. From a sensory point of view, the acceptability of the product was established. The shelf life was established at 17 days. Packaging can be done in aluminum tray, paper tray or stretch film.

Fig. 6 - Cookies with fibers and fruits

Fig. 7 - Cookies with walnuts

The nutritional value of Cookies with fibers and fruits was set: energetic value 1942 kJ/463 kcal; proteins 7.2 g; total lipids: 21.78 g, saturated fatty acids 14.15 g; total carbohydrates 59.62 g; sugars 23.04 g; salt 0.31 g. From a sensorial point of view, consumer acceptability has been demonstrated. The product shelf life is 45 days. Packaging can be done in a cardboard box with a window, PET cassette or BOPP container.

Table 2

Nutritional values of 3 variants for cookies with walnuts

	Cookies with walnuts and jam	**Cookies with walnuts and chocolate**	**Cookies with walnuts and honey**
Energetic values (kcal/100 g product)	443	488	467
Energetic value (kj/100 g product)	1861	2049	1961
Proteins, g	10.9	12.1	11.52
Lipids, g	16.87	21.58	18.07
Saturated fatty acids	5.41	7.08	4.0
Carbohydrates	61.83	61.45	64.5
Sugars	22.35	24.2	24.1
Sodium	0.25	0.28	0.23

From a sensorial analysis point of view, it is noticed that: this product has a more intense color, the texture of surface is rough, it can feel a hardness of the bite, slightly sweeter than other products, unctuous and more intense after taste; cookies with nuts and honey and cookies with nuts and jams have a slightly more intense flavor and aroma. From a microbiological point of view, the shelf life is 35 days. From the packaging point of view, packing is done in a cardboard box with a window, a PET cassette, a BOPP container.

For the biscuits with oil seeds 3 experimental variants were obtained:

Fig. 8 - Biscuits with seeds

Fig. 9 - Biscuits with oilseeds and cocos flakes

Fig. 10 - Biscuits with oilseeds and raisins

Table 3

Nutritional values of dietary biscuits with seeds

	Biscuits with seeds	Biscuits with oilseeds and cocos flakes	Biscuits with oilseeds and raisins
Energetic value (kcal/100 g product)	455	455	420
Energetic value (kj/100 g product)	1906	1907	1763
Proteins, g	10.81	12.1	10.95
Lipids, g	22.12	21.58	18.08
Saturated fatty acids, g	9.51	11.15	9.94
Carbohydrates, g	53.18	55.27	53.39
Sugars, g	13.06	14.32	12.97
Sodium, g	0.33	0.35	0.38

From a sensorial point of view, it can be noticed that: the sunflower and pumpkin seeds biscuits have a more intense color and slightly higher fermity; biscuits with seeds and coconut have a slightly higher firmness, have the most unctuosity and intense sweet taste and the most aromatic and intense palatable taste and color. From a microbiological point of view, the shelf life is set to 20 days. From the packing point of view, packing is done in a cardboard box with a window, a PET cassette, a BOPP container.

CONCLUSIONS

Total acceptability of all products decreased in the following order: Cheesecake with chocolate > cheesecake with berries glaze > Cheesecake with berries in the glaze and in the cream > Cheesecake with caramel. Cheesecake with caramel has the highest energetic value. Chocolate cheesecake has higher protein and carbohydrate content.

Cheesecake with berries was rated as having a highest pleasant taste.

Cookies with nuts and chocolate have high energetic value and higher protein and lipid content. Cookies with nuts and honey have higher carbohydrate content.

Biscuits with seeds and Biscuits with seeds and coconut flakes have the highest energetic value. Biscuits with seeds and coconuts have higher protein and carbohydrate content. Biscuits with only seeds have higher lipid content.

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THE INFLUENCE OF INGREDIENTS ON CONFECTIONERY AND PASTRY PRODUCTS QUALITY THROUGH COMPARISON BETWEEN DIFFERENT EXPERIMENTAL VARIANTS
/
INFLUENŢA INGREDIENTELOR ASUPRA PRODUSELOR DE COFETĂRIE ŞI PATISSERIE PRIN COMPARAREA ÎNTRE DIFERITE VARIANTE EXPERIMENTALE

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Keywords: *confectionery products, bakery products, ingredients, influence, composition*

ABSTRACT

The main purpose of this paper is to highlight the impact of food ingredients on confectionery and pastry products (cheesecake, cake with pudding and fruits, cookies with fibers and cranberries, cookies with nuts and biscuits with oil seeds). There were several experimental variants and laboratory tests in order to identify the compatibility between ingredients. Synthetical food additives were avoided using in small quantities ingredients (starch, gelatin) for their technological effect. Based on microbiological analyzes, the impact of ingredients on the products shelf-life was demonstrated and during by sensorial analysis, the product attributes are described by the panel of experts.

REZUMAT

Scopul principal al acestei lucrări este evidențierea impactului ingredientelor alimentare asupra produselor de cofetărie și produse de patiserie (cheesecake, prăjituri cu budincă și fructe, biscuiți cu fibre și merișoare, biscuiți cu nuci și biscuiți cu semințe de ulei). Au existat mai multe variante experimentale și teste de laborator pentru a identifica compatibilitatea dintre ingrediente. Aditivii alimentari sintetici au fost evitați prin utilizarea în cantități mici de ingrediente (amidon, gelatină) pentru efectul lor tehnologic. Pe baza analizelor microbiologice, a fost demonstrat impactul ingredientelor asupra duratei de conservare a produselor și în timpul analizei senzoriale, atributele produsului sunt descrise de grupul de experți.

INTRODUCTION

It has been found that the three meals consumed per day may not be sufficient to provide the nutrients necessary for growth, and thus eating regular meals is necessary to supplement the body requirements *(Lobstein et al., 2004)*. Biscuits and cookies have different compositions ranging from high fat/sugar to low fat/sugar with many different ingredients. Snacks, including cookies, are widely consumed throughout the world *(Okpala et al., 2013)*. They are an important part of the human diet, especially as a source of energy and can be eaten between daily important meals.

Cookies are the most popular among consumers as a better source of carbohydrates, proteins, dietary fiber, having a medium storage period and also serve as ready-to-eat products *(Bala et al., 2015)*. Biscuits are bakery products of high commercial interest due to their production, marketing and consumption characteristics, high demand, relatively long storage life and good acceptability, especially by children. These products are developed to implement formulations from a nutritional point of view, especially related to fiber and protein content.

Starch is the main structural element in biscuits, fat or sugar plays the role of structuring the product. Overall quality of biscuits is largely determined by the type of fat used.

In commercial samples of biscuits, significant texture differences were found depending on the location of the scoring, as well as differences of baking *(Narsing et al., 2017)*.

The texture depends on the formulation and the cooking regimes used *(Maache-Rezzoug et al., 1998)*. In biscuits porosity increased with moisture content, expansion zone, and color was influenced to a small extent by relative humidity *(Mandala et al., 2006)*. Biscuits are made from flour, sugar, milk, fats, flavorings and other chemical additives.

They are produced by mixing flour and/or starch with other ingredients by a mixing process, fermented, and may contain different toppings, fillings, shapes and textures. Their shelf life allows wide-scale production and widespread distribution. Flour is the main ingredient in biscuit formulations, providing a matrix in which the other ingredients are mixed to form the dough *(Gutkoski, Bonamigo, Teixeira, & Pedó, 2007)*. Sometimes bakery products are used as vehicles for the incorporation of nutritive ingredients *(Sudha et al., 2007)*. Supplementing other minor ingredients to improve nutritional benefits has been practiced around the world *(Narsing et al., 2017)*.

It is known that the cereal mix can provide a good balance of nutrients and good protein quality. Therefore, the possibility of diversifying their application in the food industry can expand and can redress their consumption potential *(Rosangela et al., 2011)*.

MATERIAL AND METHOD

For the cheesecake new product four experimental variants were obtained: cheesecake with berries jelly, cheesecake with berries and berries jelly, chocolate cheesecake and caramel cheesecake. These products were made by establishing a basic recipe and adding other ingredients, depending on the assortment. For the leaf biscuits, butter, nuts were used and cheese, vegetable cream, wheat flour, sugar, eggs and yolks and frozen berries (for one with fruits) were used for the cream. The berries jelly was obtained from: water, sugar, gelatin and frozen berries.

For the chocolate cheesecake, chocolate has been added to the cream, and the chocolate glaze was made of cream and chocolate. For caramel cheesecake, caramel was obtained from sugar, cream and butter. From the point of view of the technological process, the method used was the baking process, and the baking took place at 150°C for 1.5 h.

For the cake with pudding and fruit, the leaf was obtained from eggs, sugar, salt, flour, breadcrumbs, carob powder, nuts and baking powder. Milk, sugar, yolks, salt, orange pulp, raisins and starch were used for pudding obtaining and orange juice, sugar and gelatin were used for orange juice glaze. From the point of view of the technological process, the important step is baking, the leaf being obtained by baking 30-35 minutes at 150°C.

White wheat flour, oatmeal, rye flour, eggs, sugar, salt, butter, baking powder and cranberries were used for the cookies with fibers and fruits. For the cookies with walnut three experimental variants were obtained using walnuts and chocolate, walnuts and jam and walnuts and honey. The basis ingredients for making these cookies are: white wheat flour, oatmeal, nuts, butter, sugar, snack, baking powder, salt and eggs. Depending on the assortment, the ingredients describing the end product were chocolate, jam and honey. From the point of view of the technological process, baking takes place at 180-190°C for 15-20 minutes.

Biscuits with oilseeds have been designed in three experimental variants: only with oilseeds, with oilseeds and coconut, with oilseeds and raisins. The common ingredients underlying the products are: oatmeal, rye flour, bran, eggs, skimmed yoghurt, butter, baking powder, sugar and salt. Depending on the assortment, there were added: for variant 1, pumpkin seeds, sunflower seeds and sesame seeds; for variant 2: carob powder, coconut flakes, sunflower seeds, pumpkin seeds; for variant 3: cinnamon, raisins, sunflower seeds and pumpkin seeds. From the point of view of the technological process, baking takes place at a temperature between 180-190°C for 15-25 minutes.

RESULTS

For cheesecake, four experimental variants were obtained: cheesecake with jellyfruit, cheesecake with berries and jellyfruit, chocolate cheesecake and caramel cheesecake. The four experimental variants have been established since the beginning of the experiments.

The first experiment was done by adding butter, nuts and bread crumbs to the leaf. Although the fat content was quite large, the breadcrumbs could not be sufficiently hydrated, requiring a much larger amount of fat, and the leaf, at the end of the technological process, was very breakable and had an unsatisfactory taste. From a technical point of view, in the first experiments, the leaf was placed in the oven at 180°C for 15 minutes. The introduction to the oven was then replaced by placing it in the refrigerator for 20-30 minutes, observing a better compaction of the leaf.

Chocolate tablet was used in chocolate cheesecake, which caused the consistency changing by strengthening the cream. In the cream, innitially, cow cheese and vegetable cream were added in a 2:3 ratio. Finally, the addition of 1:1 cheese and cream was established to give a more creamy consistency.

Fig. 1 - Cheesecake with bread crumbs

Mixing with the mixer of the entire composition caused surface cracking due to the accumulation of air. Another experiment was done by automatic mixing of cheese, sugar, yolks, eggs and flour and the cream was mixed separately. In this way the cream was incorporated manually in the paste composition and the surface remained firm, without any cracks.

Fig. 2 - Cheesecake experiments

For the cake with pudding and fruit, three laboratory experiments were performed. Starting from the initial recipe, changes in the amount of ingredients were required. Thus, on the first experiment, due to the higher content of whites and the addition of sunflower oil, the composition for the leaf has a hard consistency. The second experiment was carried out by reducing the amounts of ingredients, and in the third experiment, 2 eggs were added to improve the coagulation process.

Fig. 3 - Cake with pudding and fruits

In the pudding, in the third experiment, starch was added which, by gelatinization, formed a homogeneous and bound mixture. Only yolks have been added to the pudding to coagulate. Replacement of starch can be made with flour that is rich in starch, and behaves the same as heat treatment. In the glaze, being only orange juice and sugar, the addition of gelatin was necessary.

In cookies with fruits and fibers, the amount of fiber was increased by the addition of oatmeal and rye flour, which formed a matrix together with white flour, thereby making the gluten network. For baking products, baking powder helps to form a porous product. The kneading process helps to have air in the dough. The ingredients with allergenic potential are: eggs, wheat flour and butter. The amounts of added raw materials have been balanced so that the product is unctuous. With higher amounts of flour and lower fat, the product results in very rough and hard chewing. The presence of cranberries influences the taste of sweetness.

Fig. 4 - Cookies with fibres and fruits

In cokies with walnuts, walnuts have helped to form the texture of the product. The types of flour used provide higher fiber content but also hardness. The cookies with walnuts and chocolate have a more intense color due to chocolate pieces, more textured surface, hardness and more intense taste.

Fig. 5 - Cookies with walnuts

In biscuits with oilseeds, due to the combination of oatmeal, rye flour, bran and seed types, the fiber content is increased, but they form a product of high hardness. In order to no longer add lipids, degreased yogurt was used. Grinding the pumpkin seeds helps make the biscuit more unctuous.

Fig. 6 - Biscuits with oilseeds

CONCLUSIONS

The biscuit leaf was better than the breadcrumb and tasted better. Crumb crust did not give cheesecakes the expected taste, and the texture was very sandy. The creams have gained an appropriate consistency due to coagulation of egg proteins and starch gelatinization. In chocolate cheesecake it was found that chocolate used must have an increased percentage of cocoa because chocolate tablet makes the cream hardeness, changing its consistency. Cheesecake with berries has a surface of jelly that has more emphasized the idea of dessert product.

In the cake with pudding and fruit, the leaf is risen, porous, tasty, with a brown color due to the carob powder. Walnuts also offer a plus of sensorial and nutritional quality. Puddings have increased viscosity due to starch that has gelatinized at temperature above 60°C. The orange taste is felt as the orange pulp squeezed was used to increase taste perception and nutritional quality, by an additional source of vitamins. The glaze is dense, gelatinized due to the addition of gelatin for textural purposes. It completely covers the surface of the cake. The taste is pronounced by oranges, and the color is orange. The overall taste is fresh due to raw materials that allow the cake to be perceived to be easy to eat.

In cookies with fibers and fruits it has been found that the product does not oppose chewing hardness. The presence of cranberries influences the taste of sweetness. The cookies with walnuts and chocolate has been rated with a slightly sweet and fluffy taste. Cookies with walnuts and honey and walnuts and jam have a slightly more intense flavor, which also correlates with taste. Biscuits with sunflower and pumpkin seeds have a more intense color and slightly higher fermity. Also, biscuits with coconut and oilseeds have a slightly higher firmness, have the most sweet and intense taste of sweetness, have the most aromatic and intense palatable taste and a pleasant color. From a microbiological point of view, due to the lack of addition of food additives, especially preservatives and stabilizers, the products have a lower shelf-life compared to the commercial products.

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VARIABILITY OF SOME MORPHOLOGICAL CHARACTERS TO THE JERUSALEM ARTICHOKE CROP UNDER THE CONDITIONS OF THE ARDS CARACAL
/
VARIABILITATEA UNOR CARACTERE MORFOLOGICE LA CULTURA DE TOPINAMBUR IN CONDITIILE DE LA SCDA CARACAL

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ABSTRACT
Through the study, we aimed to identify and recommend for the Caracal Plain area the best genotypes of Jerusalem artichoke, which will use the climatic and soil conditions with high efficiency. Among the three genotypes tested, the best behavior was registered at Rareş variety, a Romanian genotype obtained at SCDA Buzău, which recorded the best productivity indices - plant height, leaf size - and a total biomass production of 44.3 tons /ha.

REZUMAT
Prin studiul realizat am urmărit să identificăm și recomandăm pentru zona Câmpiei Caracalului cele mai bune genotipuri de topinambur care să valorifice cu un înalt randament condițiile de climă și sol. Dintre cele trei genotipuri testate, cel mai bun comportament l-a avut soiul Rareș, genotip românesc obținut la SCDA Buzău, care a înregistrat cei mai buni indici de productivitate – înălțimea plantelor, dimensiunile frunzelor – dar și o producție de biomasă totală de 44,3 tone/ha.

INTRODUCTION
Jerusalem artichokes is appreciated for its characteristic, sweet taste, for the rich in minerals (Ca, Mg, K, P), vitamins (β-carotene, thiamine, lactoflavine, niacin, biotin, ascorbic acid) (lysine, arginine, histidine, cystine, tryptophan, aspartic acid), specific agents (choline, betaine, saponin, quercimetry) and enzymes (inulinase, proteinase, invertase, phosphorylase and phenolase). The biochemical composition of tubers depends mainly on the genetic structure, the environmental factors and variety used (*Soare et al., 2017, 2018*).

Over time, Jerusalem artichokes has been successfully used to treat a wide range of conditions, from diabetes, colds, atherosclerosis, colorectal cancer, cholesterol, to digestive candidiasis, constipation, lack of calcium or obesity. Jerusalem artichokes is also recommended in asthenia, as tonic, antiseptic, gout, dyspepsia, rheumatism. Tubers are used as a raw material in the spirit industry, but also in the manufacture of sweets. From 100 kg of Jerusalem artichokes tubers could be obtain 7 to 10 liter of alcohol and about 60 kg of marc. The alcohol fermented from the tubers is said to be of better quality than that from sugar beets.

From the agronomic point of view, the Jerusalem artichokes is considered drought-resistant and can be cultivated at low cost without irrigation by harnessing poor soils (*Monti et al., 2005*), exhibits very high adaptability at the extremes of the unfavorable factors - drought resistance at extremely high temperatures (35-45°C plants and – 30 - 45°C in case of tubers), resistance to high concentrations of salts, heavy metals, nitrates, however many studies have shown that irrigation is necessary when water is insufficient and drought is increasing.

Also, the Jerusalem artichokes is a very valuable crop for green energy. Biomass obtained from Jerusalem artichokes is considered as a rich source of ethanol (*Denoroy P., 1996*). The production of biogas from Jerusalem artichokes is much higher compared to other energy crops (*Emmerling C., 2007*).

In China, a study was conducted to evaluate the potential of existing genotypes of *Helianthus tuberosus L.* as a biomass raw material for ethanol production (*Zu Xin Liu, 2012*). The authors determined the biomass productivity and chemical composition of the twenty and six Jerusalem artichokes clones grown in a semi-arid region of China and demonstrated that the biomass obtained could be a promising starting material for cellulosic ethanol The yield of the ethanol potential of cellulose and hemicellulose in the biomass was 1821 to 5930 l/ha, contributing 29.8-66.4% of total ethanol yield, which could be as high as those from the sorghum strain. Large variations between the genotypes investigated for carbohydrates make it possible to select the appropriate clones for to be used in the production of bioethanol in the semiarid regions.

MATERIAL AND METHOD

The research was carried out at ARDS Caracal, during the 2018 year in the conditions of a chermozem soil, medium rich in nutrient and with a humus content which varied between 3% to 4%. The soil in the arable layer (0-20 cm) has a lutearic texture with a clay content (particles below 0.002 mm) of 36.2%, an apparent density of 1.42 g/cm^3, a total porosity of 47% and one medium penetration rate (penetration resistance of 42 kg/cm^2).

From the point of view of the hydric features in the superficial layer, the wilting coefficient records the value of 12.3%, the field capacity 24.5% and the hydraulic conductivity is 9.2 mm/h.

The main aim of the research was to test three genotypes of Jerusalem artichoke in order to establish the most valuable genotype for the area of ARDS Caracal.

The experience was a monofactorial one, based on the randomized block method in three rehearsals. The variants had four rows of 5 meters spaced 70 cm between the rows. The harvested area was 2.8 square meter from the middle rows. Biological material used was Dacic variety (low port of plants) and Rareş variety with provenance of ARDS Buzău and Dăbuleni local population, originated from CCDCPN Dăbuleni.

The preparation of the land for planting was done by plowing at 25 cm in autumn, followed by a 20: 20: 0 complex fertilizer application on a dose of 200 kg/ha applied in the spring during the preparation of the germinating bed and incorporated with two soil mobilization.

Planting was done manually at the end of April at a distance of 45 cm between tubers per row.

During the vegetation period, determinations were made regarding the morphological characters: plant height, average leaf size/plant, average leaf number and average branch/plant. The production of biomass and tubers was done using plots of the middle ranges of the variant.

The calculation and interpretation of the results was performed in comparison with the average/experience, using the variance analysis method ANOVA.

RESULTS

Climatic conditions (Fig. 1) – the climatic conditions registered in 2018 on the areal of the ARDS Caracal were strongly influence the main evolutions of the rhythm of plant's development and their capacity for production.

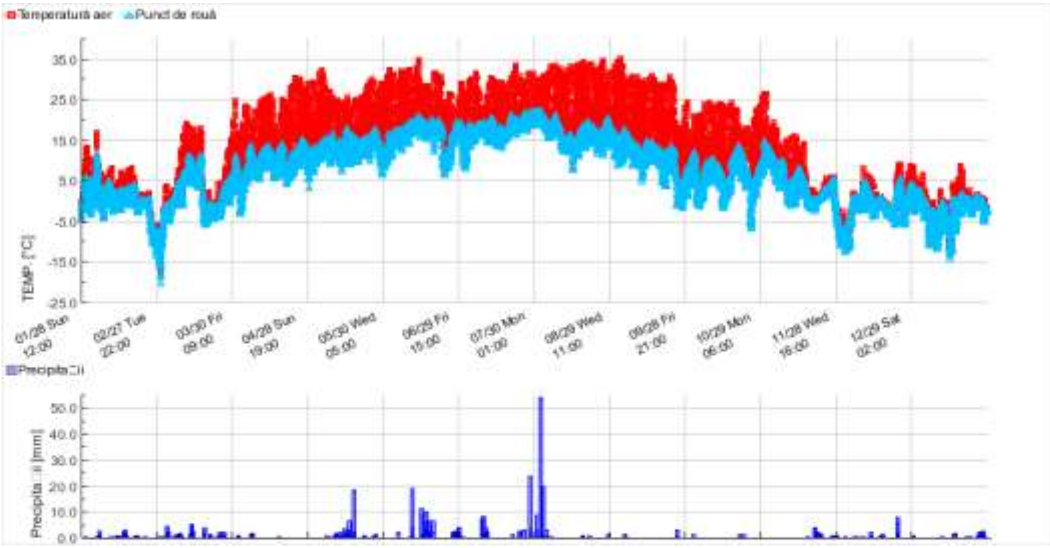

Fig. 1 – Climatic condition on 2018 year registered at ARDS Caracal

In Figure 1 can be observed that the 2018 agricultural year was ***an excessively warm year***. Compared to the multiannual registrations, an average temperature of 12.6°C was achieved, with 2.0°C, higher than the multiannual average of 10.6°C. Regarding the months of the warm period of the year

(April - September), we find that in no month were recorded temperatures lower than the multiannual average. The deviations were positive, ranging from 0 - 5.2°C.

April was remarkably hot, recording a thermal surge of 5.2°C, the highest temperature ever recorded in April from this area. Daily average temperatures exceeded 32°C in the middle of the month. Also in May were exceptional temperatures, with monthly deviation of + 3°C, all of which led to a record: the warmest spring since there were meteorological records in the area. It is remarkably hot and August and September, with a thermal surplus of 2.4°C and respectively 2.0°C.

From the point of view of precipitations, the 2018 year was on with a high level of rainfall, especially in the second part of plant's vegetation. The precipitation in this agricultural year totals 843.6 mm, with 306.2 mm higher than the multiannual average of 537.4 mm.

The lack of precipitations at the beginning of stage vegetation of plants had negatively influenced the emergence of plants, which made the period with high temperatures in the summer overlap with the period when the requirements of the plants for water were maximum, that fact going to a decrease of the potential of plants to ensure large amount of biomass. Another particular problem was registered after some fast rains which conduct to crust on the soil surface (Fig. 2) and in that conditions we have to intervene to break it.

Fig. 2 – Crust on the soil surface in spring of 2018 at ARDS Caracal

The average height of Jerusalem artichoke plants varied in the conditions of year 2018 between 58 cm and 321 cm. The average of plants height reach in these conditions a value of 225.6 cm. Related to this value, the dwarf variety, Dacic, had an average height of 58 cm, followed by the Dăbuleni population, which produced plants with an average height of 298 cm. The highest plants were recorded in the Rareş variety, with plants with an average height of 321 cm (Fig. 3 and 4).

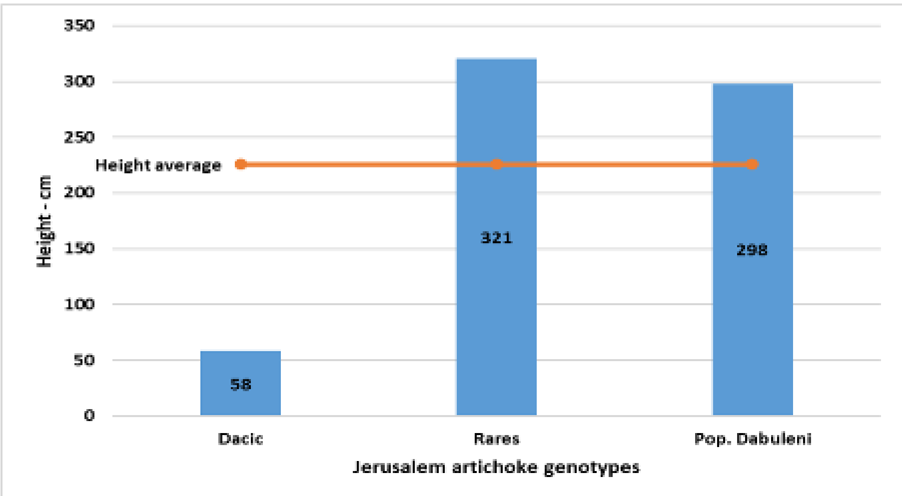

Fig. 3 – Plants height in 2018 in the conditions of ARDS Caracal

Fig. 4 – Aspect from the experimental field – Rareș variety (tall plants) and Dacic variety (dwarf plants)

An important component of the biomass is represented by the leaves. In our experiment, ***the average number of leaves per plant*** ranged from very large interval (Fig. 5) – due the morphological characteristic features of the genotypes - from 479, 3 registered on Rareș variety to 927.3 observed at dwarf variety, Dacic. The latter, although having a small port with dwarf stems, almost creeping, showed a very large number of leaves, in the variant there were individuals whose leaf number exceeded 1200 leaves/plant.

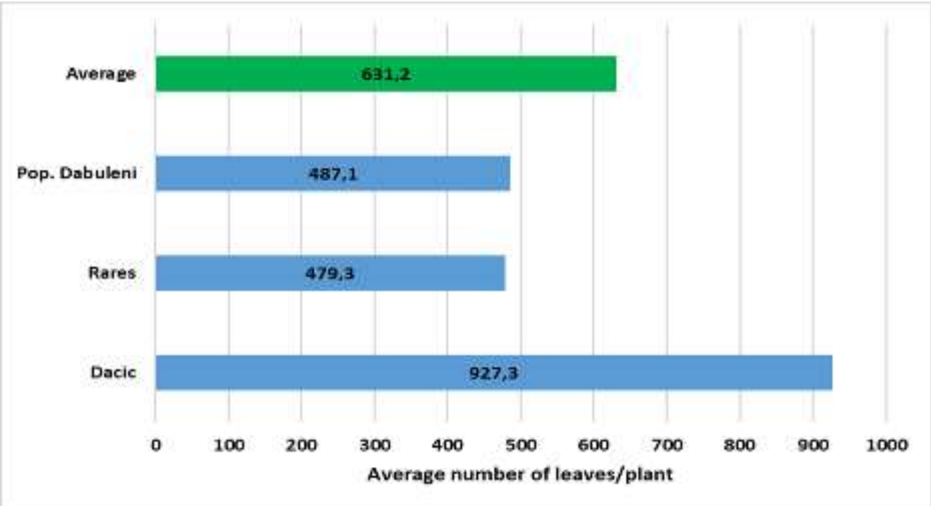

Fig. 5 – Varieties average number of leaves/plant in comparison with the average/experiment

Although Jerusalem artichoke develops under moisture stress conditions, a better understanding of real water needs is essential to maximize productivity, it is necessary to know at what level of stress the plant can withstand and when the higher requirement is for water. The stress caused by water deficiency has a much more pronounced effect on the above parts of the plants than on the tubers (*Mecella et al., 1996*). Jerusalem artichoke seems to adapt to water deficiency conditions, as indicated by the intermediate level of reduced yield with moderate stress throughout the growing season (*Conde et al., 1991*). Acute water stress in the first stage of development may even have a beneficial effect on yield in some cases, Jerusalem artichoke plants decreasing leaf index and increasing leaf weight as a water stress acclimatization strategy (*Conde et al. 1988*).

Also, related to the plants leaves we registered the dimensions of those, in order to determine the foliar surface for each tested variety (Table 1). The registered values were determined on the blooming stage of plants and had large variations of the length and wide of the leaves, due the morphological characteristics of the genotypes and climatic conditions. Leaves length ranged between 9.4 cm on the Dacic variety and 18.2 cm on Rareș variety, with a minimum value of 8.5 cm and a maximum values of 26 cm. In this case the average for the experimented assortment was 14.9 cm.

Table 1

Some morphological characters registered on the assortment of Jerusalem artichoke cultivated at ARDS Caracal, 2018

Variety	Leaves dimensions - cm -		Average branch/plant
	Length	Wide	
Dacic	9.4	5.3	24.8
Rares	18.2	9.5	45.3
Pop. Dabuleni	17.1	9.3	46.4
Average/experiment	**14.9**	**8**	**38.8**
Minim	*8.5*	*4.8*	
Maxim	*26.0*	*16.0*	

The average dimensions of the wide of leaves in the experiment was 8 cm. Related to this value we observed wider leaves on the varieties of Rareș and Dabuleni Population with 9.5 cm and respectively 9.3 cm. During the measurements made we found leaves with a high value of the wide of 16 cm and also with small value of 4.8 cm.

The total biomass yield is influenced by many factors, as follow: plant's density, height of plants, number and dimensions of the leaves and also the number of branch of the plant stem. Related to this last factor we registered the average number of the branch/plant – which in our case had values ranging between 24.8 branch/plant on Dacic variety and 46.4 branch/plant at Dabuleni Population. Closer values of the average brach/plant were observed on the Rareș variety, of 45.3.

The biomass yield of the tested genotypes has values which rage between 31.4 t/ha at Dacic variety and 44.3 t/ha at Rares variety. In the conditions of the 2018 year Dabuleni population gave a good production of biomass of 38.5 t/ha (Table 2).

Table 2

Biomass productions registered on the assortment of Jerusalem artichoke cultivated at ARDS Caracal, 2018

Variety	Biomass yield t/ha	Difference		Signification
		%	t/ha	
Dacic	31.4	82.4	-6.7	OOO
Rareș	44.3	116.3	6.2	***
Pop. Dabuleni	38.5	101.0	0.4	-
Average/experiment	**38.1**	**100.0**	**CONTROL**	**CONTROL**

DL 5% =1.9 t/ha; DL 1% = 2.2 t/ha; DL0.1% = 2.9 t/ha.

Related the Control, which had a value of 38.1 t/ha, we observed very significant increase in productions on the Rareș variety of 16% - hat means over 6 t/ha. In case of Dabuleni Population the increase of 0.4 t/ha was considered as insignificant from the statistically point of view.

Dwarf variety Dacic had a production of biomass considered with very significant difference related to the average/experiment of 6,7 t/ha less that the Control and realizing only 82.4% from their production.

CONCLUSIONS

After the results obtained at the Jerusalem artichoke in the 2018 year and in the climatic condition from the ARDS Caracal, we can conclude as follow:

- the Caracal plain offers a very good conditions for growing and developing of the Jerusalem artichoke plants;
- climatic conditions from the 2018 spring had negatively influenced the emerge of the plants, with further repercussions on the main production's components;
- the high rain regime registered in the second part of plant's vegetation bring a positive influence on the level of the biomass yield;

- the best adaptability and capacity of productions, from all the genotypes from assortment, prove to have Rareș variety which realized the highest values on the majority of the morphological characters: plant's height, dimensions of leaves and biomass yields;
- the average biomass yield of 38.1 t/ha is one considered good in the conditions of the experimented year on the assortment, with a very good prediction if we consider the fact that the Jerusalem artichoke is a perennial plant and increases its production capacity starting with the second year;
- it is worth mentioning the Dacic variety that he has a very good ability to emit shoots and a very good vivacity.

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REDUCING MICROBIAL FOOD LOAD USING UV PULSES
/
REDUCEREA ÎNCĂRCĂTURII MICROBIENE A PRODUSELOR ALIMENTARE FOLOSIND PULSURI DE RADIAȚIE UV

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Keywords: *UV decontamination, ultraviolet rays, germicidal lamps, decontamination tunnel, UV pulses;*

ABSTRACT

UV-C disinfection systems inactivate all known food spoilage such as microorganisms including bacteria, mould spores, yeasts and food pathogens like viruses. In 1878, scientists Downes and Blunt discovered that microorganisms do not reproduce when exposed to direct sunlight. Eventually, the correlation between a specific wavelength and the maximum micro-organism reaction was recognised at precise nanometer (nm) wave-lengths of light. As a result, UV decontamination Technology was born, radiation having a wavelength less than visible light.

REZUMAT

Sistemele de dezinfecție cu UV-C inactivează toate sursele de degradare a alimentelor precum: microorganisme inclusiv bacterii, sporii de mucegai, drojdii si virusuri. În 1878, oamenii de știință Downes și Blunt au descoperit că microorganismele nu se reproduc atunci când sunt expuse la lumina directă a soarelui. În cele din urmă, corelația dintre o lungime de undă specifică și reacția maximă a microorganismului a fost cercetată pentru lungimi de undă precise nanometrice (nm). Ca rezultat, s-a născut Tehnologia de decontaminare cu UV, radiații ce au o lungime de undă mai mica decât lumina vizibilă.

INTRODUCTION

The spectrum of electromagnetic radiation, classified as descending from the wavelength λ, extends from high wavelength radiation such as radio waves, followed by microwaves, infrared rays, visible light, then ultraviolet radiation to short wavelength respectively X and gamma rays (Fig. 1).

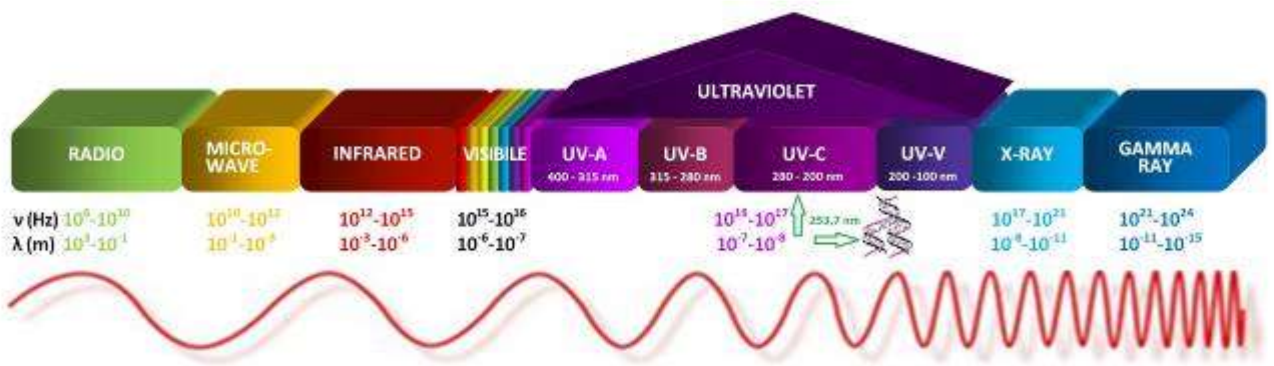

Fig.1 - The Electromagnetic Spectrum

Regarding microwave, a series of sterilizing experiments have been made to determine the effect of microwave energy on several typical indicator bacteria such as Bacillus subtilis var. nigar, Bacillus stearothermophilus, Bacillus pumilus E/sub 601/, Staphylococcus aureas, Bacillus cereus. Under the conditions of different sterilization duration and unequal intensity of microwave power irradiation onto the bacteria, a useful result of killing bacteria has been observed, i.e., the Bacillus subtilis can be considered as an optimum indicator bacterium for microwave sterilization (*Wu Q*.).

Infrared (IR) heating is the application of electromagnetic radiation (in the wavelength range of 0.78–1000 μm) to generate heat in the exposed materials. This generated heat energy can be used to achieve many desirable effects, including decontamination in foods. The technology shows great potential in various applications because of its inherent advantages, such as controlled, rapid heating and precise targeted application (Ramaswamy and Krishnamurthy, 2012). Ultraviolet rays are most used to decontaminate food and water.

MATERIAL AND METHOD

Inactivation of bacteria with UVA-LED was determined by colony-forming assay. Vibrio parahaemolyticus, enteropathogenic Escherichia coli, Staphylococcus aureus and Escherichia coli DH5alpha were reduced by greater than 5-log(10) stages within 75 min at 315 J cm(-2) of UVA. Salmonella enteritidis was reduced greater than 4-log(10) stages within 160 min at 672 J cm(-2) of UVA [3]. The formation of 8-hydroxy-2'-deoxyguanosine in UVA-LED irradiated bacteria was 2.6-fold higher than that of UVC-irradiated bacteria at the same inactivation level. Figure 2 shows a UVA bulb and its wavelength graph.

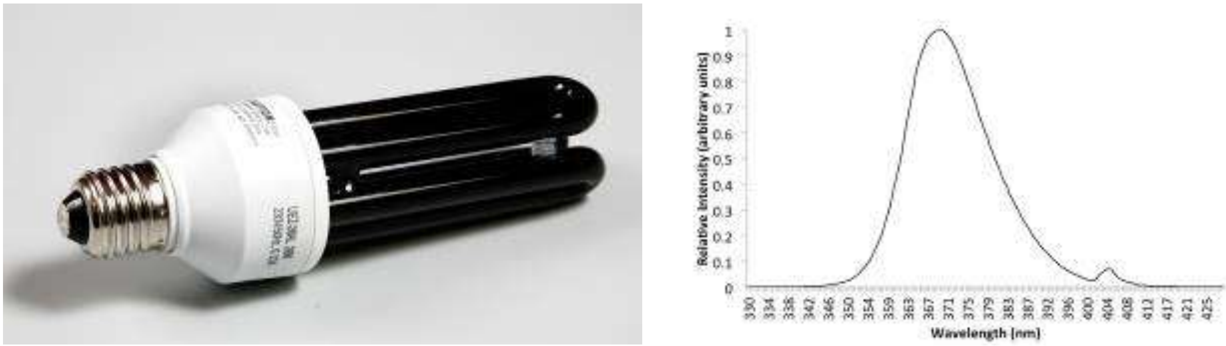

Fig. 2 - UVA bulb and its wavelength graph [4]

Overexposure to UVB radiation not only can cause sunburn but also some forms of skin cancer. However, the degree of redness and eye irritation (which are largely not caused by UVA) do not predict the long-term effects of UV, although they do mirror the direct damage of DNA by ultraviolet. All bands of UV radiation damage collagen fibers and accelerate aging of the skin. Both UVA and UVB destroy vitamin A in skin, which may cause further damage.

UVB radiation can cause direct DNA damage. This cancer connection is one reason for concern about ozone depletion and the ozone hole. The most deadly form of skin cancer, malignant melanoma, is mostly caused by DNA damage independent from UVA radiation (*https://www.cancer.org*).

Although it is dangerous for humans, UVB radiation is used with precautions for germicidal benefits, an example of a UVB lamp operating in mid-band UVB and having Peak 306 +/- 6 nm is shown in Figure 3.

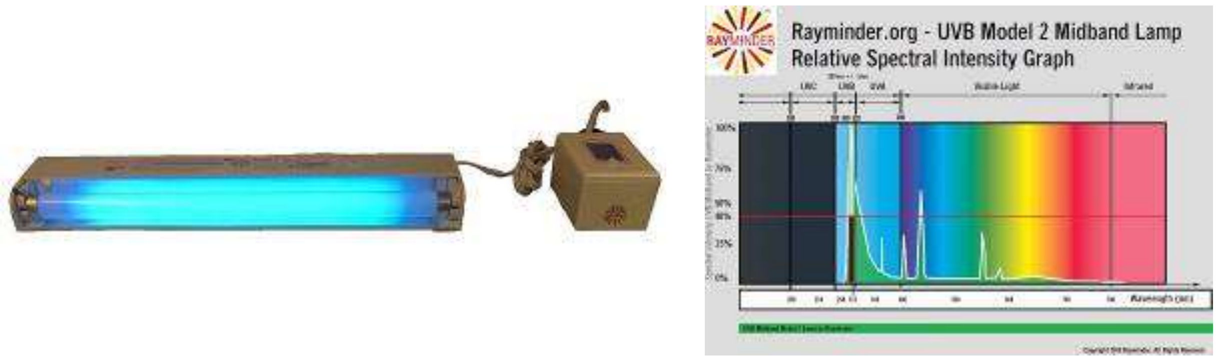

Fig. 3 - UVB lamp and its relative spectral intensity graph *(https://rayminder.org)*

Model 2d UVB Midband lamp with timer it's the premium UVB Midband lamp with programmable memory and active digital countdown displayed on a blue touchscreen *(https://rayminder.org).*

UV-C light in the form of germicidal lamps has been used since the late 1800s to kill the types of microorganisms that typically cause indoor air quality (IAQ) problems - bacteria, mould, yeast and viruses.

Niels Ryberg Finsen (1860-1904) was the first to employ UV rays in treating disease. He was awarded the Nobel Prize for Medicine in 1903. He invented the Finsen curative lamp, which was used successfully through the 1950s.

UV-C was used to disinfect the municipal water supply of Marseille, France, in 1908. Westinghouse developed the first commercial UV-C germicidal lamps during the 1930s. They were used primarily in hospitals. After World War II, UV-C was used for sterilizing air in hospitals, kitchens, meat storage and processing plants, bakeries, breweries, dairies, beverage production, pharmaceutical plants and animal labs - anywhere microbiological contamination is a concern. During the 1950s UV-C was incorporated into air handling equipment. It became a major component in the control and eradication of tuberculosis (TB).

During the 1960s, concern about microbes decreased with the introduction and increasing availability of new drugs and sterilizing cleaners. The energy crisis of the 1970s sparks enthusiasm for conservation. To save energy, heating, ventilating, and air-conditioning (HVAC) systems were shut down when not in use. Condensation that had previously been evaporated by the constantly moving air collected on coils and in the drain pan. Mould and other microorganisms multiplied in this dark, wet environment. When the systems were re-started, microbial contaminants were circulated throughout the building.

Recent technological advancements have made it possible for UV-C disinfection technology to deployed in an ever expanding field of applications *(https://www.uvtechnology.co).*

UVC is a more powerful weapon than even our model 2 accomplishes with UVB. The Germinator TM is our Model "C" Germicidal UVC that uses 254 nm, UVC light. Precisely the best at inactivating DNA/RNA of germs in the air and on surfaces without polluting the air with ozone.

UVC produces the most effective germicidal light you can get while remaining ozone-free. The USEPA (United States Environmental Protection Agency) recommends keeping ozone levels below 0.05 ppm. Light below 253.6 nm produces ozone, while spectra from 254 nm to 320 nm (including full UVB range) provide germicidal benefits of varying degrees (*https://rayminder.org*).

A research team from the U.S. Department of Agriculture's (USDA) Food Components and Health Laboratory in Beltsville, Md., and Sensor Electronic Technology, Inc. (SETi) in Columbia, S.C., has demonstrated that low irradiance ultra-violet (UV) light directed at strawberries over long exposure periods at low temperature and very high humidity-typical home refrigerator conditions-delays spoilage. The team used a novel device incorporating light-emitting diodes (LEDs) that emit UV at wavelengths found in sunlight transmitted through Earth's atmosphere.

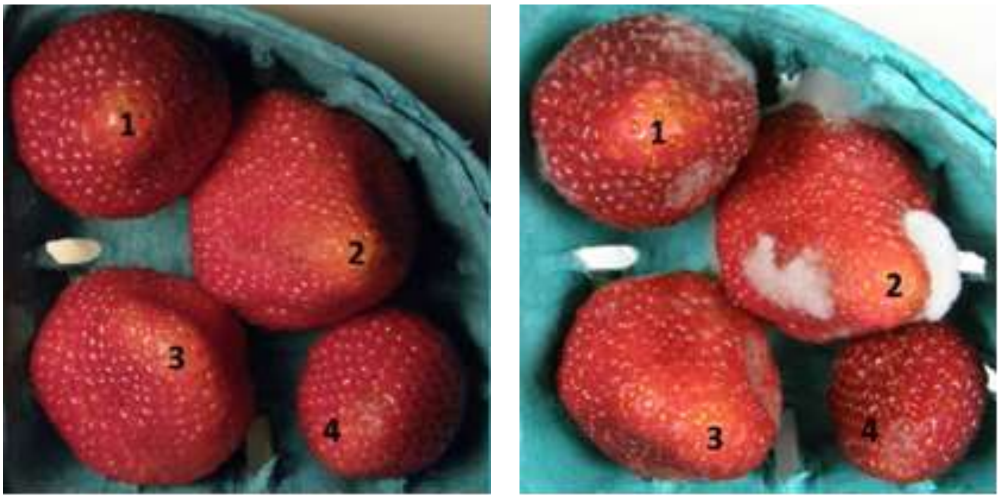

Fig. 4 – Dark control: before test (left) at end of test (right)

Ultraviolet C (UVC) light can be used to prohibit foodborne pathogens from contaminating fresh fruits, according to a new study. Scientists at Washington State University said that the findings will be welcomed by organic fruit processors who seek alternatives to chemical sanitizers and must also comply with the U.S. Food Safety Modernization Act to help prevent foodborne illnesses.

The research, published in the International Journal of Food Microbiology, reveals that UVC light is effective against foodborne pathogens on the surface of certain fruits.

"UVC radiation is present in sunlight; however, it is completely absorbed by the ozone layer and Earth's atmosphere," explained Washington State University food safety specialist Shyam Sablani. It has germicidal properties and can be effective against bacteria, mold and viruses. UVC light has been used for several years to sanitize food contact surfaces as well as drinking water and contaminated air. Although it cannot penetrate opaque, solid objects, it can be effective in sanitizing surfaces.

Sablani and colleagues investigated the effectiveness of UVC light for inactivating strains of E. coli and listeria on the surface of organic apples, pears, strawberries, red raspberries and cantaloupes. They found that the light can kill up to 99.9 percent of pathogens on apples and pears. Listeria was more UVC resistant than E. coli, and the technology worked best on fruit with smooth surfaces. That's because the rough surfaces of fruits like strawberries, raspberries and cantaloupes offer places where pathogens can hide, reducing the effects of the UVC light (*https://www.processingmagazine.com*).

UVC is an invisible spectrum of light that will eliminate viruses, bacteria, moulds and odour on surfaces, by penetrating their membranes, attacking their DNA, preventing them from replicating and killing them instantly. Due to the growing demand from international and local retailers and their consumers for environmentally friendly and chlorine-free products, the use of UV-C technology in the disinfection of fruit, vegetables, nuts, meats and bread has increased substantially of late.

Fig. 5 – UV-C decontamination tunnels for fruits and vegetables (*https://rayminder.org/uvc.html; https://www.campdenbri.co.uk; https://www.sciencedaily.com; https://www.youtube.com***)**

On fruit with rougher skin, UVC light inactivated 90 percent of pathogens present. Research is already underway to increase the effectiveness of UVC light on fruits with rough surfaces, Sablani said. The technology could be implemented on a fruit packing line by installing UVC lamps enclosed behind protective barriers in a tunnel that exposes fruit to the light as it passes on a conveyor belt.

UV light penetrates and permanently alters the DNA of the microorganisms in a process called thymine dimerization. The microorganisms are "inactivated" and rendered unable to reproduce or infect. The log inactivation (log I) determines the magnitude reduction in concentration using the following equation:

$$\log I = \log I_0 \cdot (N_0/N) \tag{1}$$

where:

I - *UV* intensity at a wavelength of 253.7 nm;

N_0 - challenge microorganism concentration in influent sample, in *PFU*/ml or *CF*U/ml;

N - challenge microorganism concentration in corresponding effluent sample, in *PFU*/ml or *CF*U/ml.

The level of inactivation of typical bacterial indicator organisms can be demonstrated using the equation below:

$$N = N_0 \cdot e^{-It} \qquad (2)$$

where:

N - organism concentration following UV exposure;

N_0 - initial organism concentration;

I - *UV* intensity at a wavelength of 253.7 nm;

t - exposure time.

The degree of inactivation by ultraviolet radiation is directly related to the UV dose applied to the water. The relationship between the UV dose and destruction achieved of a target microorganism is shown in Table 1.

Table 1

The relationship between the UV dose and destruction achieved of a target microorganism

Dose [mJ/cm2]	Reduction in number of live microorganisms
5.4	90.0%
10.8	99.0%
16.2	99.9%
21.6	99.99%
27.0	99.999%

Significant research has been done in the past years to determine the log inactivation of various pathogens. The UV dose requirement to reach the percent removal of various pathogens is shown in Table 2 (*Florea et. al., 2012*).

Table 2

The UV dose requirement to reach the percent removal of various pathogens

Target Pathogens	Log inactivation							
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Cryptosporidium	1.6	2.5	3.9	5.8	8.5	12	15	22
Giardia	1.5	2.1	3.0	5.2	7.7	11	15	22
Virus	39	58	79	100	121	143	163	186

UV germicidal lamps are becoming more and more popular in the fight against cross-contamination and the spread of foodborne diseases.

UVC decontamination offers a quick and easy method to reduce contamination in air and on surfaces, leading to *(https://www.uv-light.co.uk/):*

- Improved product quality and freshness
- Increased shelf life and customer confidence
- Reduced waste, spoilage and cross-contamination
- Reduced customer complaints and associated reputational damage

UVC can be used to disinfect:

- Bread and baked goods
- Meat and fish
- Fruit and vegetables
- Cheese and dairy produce.

In many UV sterilization studies, buffer solutions are used for investigating the inactivation mechanisms and evaluating the antimicrobial effect of UV light such as *phosphate-buffered saline* (PBS) or *peptone water* (PW). The bactericidal effects of all UV radiations were lower in peptone water (PW) than those in phosphate-buffered saline (PBS) (*Min-Jin and Jae-Won, 2018*).

Light pulse processing is a viable alternative to heat treatment for the destruction of pathogenic microorganisms and molds. Light pulses are effective for reducing the microbial population on the food surface, packaging materials and medical devices. In the USA, since 1996, the use of flash lamps for decontamination using xenon lamps with wavelengths between 200-1000 nm has been approved, the treatment time being between 2 ms and the fluency up to 12 J/cm^2.

In principle, treatment consists in the serial application of pulses of light emitted by the lamp. Thus, the voltage applied to the lamp terminals is transmitted to the internal gas and there are collisions between the electrons and the gas molecules, resulting in the emission of intense light but shortening the duration. There is no variable number of pulses, each having between 1 μs and 0.1 s.

For xenon lamps, the light emitted is variable from the UV field near-infrared UV range.

In the case of flash lamps, the importance is the *dead* (unused) lamp volume, defined as the inactive lamp internal surface (the inner volume from the electrode to the terminal). High values of this parameter result in lower pressure during operation, while low values result in higher pressures and hence high efficiency. Thus, it is recommended to use high power lamps and low unused volume.

The evaluation on UV light is achieved by determining the fluence rate and the fluence (*Păunescu and Brătucu, 2015*).

The **fluence rate** is the total radiant power from all the directions in the infinitesimal sphere and is expressed in W/m^2 or W/cm^2.

The **fluence** is the total quantity of radiant energy in all the incident directions of an infinitesimal sphere and is expressed in J/cm^2 or J/m^2. The determination of these two sizes needs to be correlated with the exposure.

The capacity of the light pulse to reduce the microbial load of liquids is dependent on:

- the distance from the lamp to the sample;
- the duration and fluence of the treatment;
- liquid turbidity;
- liquid height.

RESULTS

The germicidal effect of the UV-C light emitted by the microwave powered lamp was assessed on 4 different microorganisms. Figure 6 shows the reduction in the numbers for the microorganisms tested.

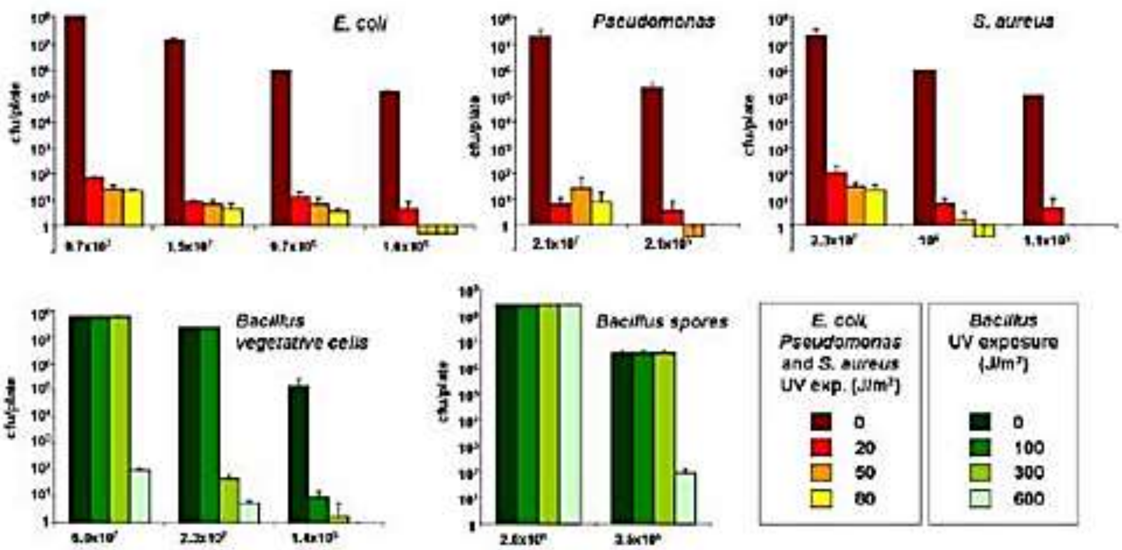

Fig. 6 – Reduction in the numbers for the 4 different microorganisms tested (*Păunescu and Brătucu, 2015*)

The results obtained from light pulses treatment:

- at 0.25 J/cm^2 and 2 pulses was reduced by 7.4 log CFU/ml for *Klebsiella terrigena* using a PureBRIGHT treatment unit;
- Saccharomyces cerevisiae cells were reduced to 5.8 log CFU/ml by treating them in buffer potassium phosphate disposed in plates of 110 mm diameter and treated at 3.5 J / cm^2 and with a reflector positioned beneath the lamp;
- *Escherichia coli* inoculated into apple juice and apple cider was reduced to 5.5 log CFU / ml after light pulse treatment at 50 mm from the lamp, under stirring and at a fluency of 12 J / cm^2;
- Milk samples treated at 25.1 J / cm^2 exhibited with 2 log CFU / ml had fewer *Serratia marcescens* cells;

Studies on the effects of light on vitamins were conducted at lengths between 290 and 700 nm, including UV and visible fields. Using a CIDERSURE 1500 system to treat apple juice at a flow rate of 57 ml / s (the lowest flow allowed by the installation) between 50-60% of the initial vitamin C concentration remained in the analyzed samples (*Teslariu M.).*

But the efficiency of UV light is decreasing against spores and protozoa (*Cryptosporidium* and *Giardia* > bacteria > spores > viruses) Thus, at 253.7 nm the doses required for the inactivation of some groups of microorganisms are:

- Bacteria 2 – 8 mJ/cm^2
- cocci and micrococci 1,5 – 20 mJ/cm^2
- spores 4 – 30 mJ/cm^2
- viruses 5 – 30 mJ/cm^2
- yeasts 2.3 – 8 mJ/cm^2
- fungi 30 – 300 mJ/cm^2
- algae 300 – 600 mJ/cm^2

CONCLUSIONS

UVC is an invisible spectrum of light that will eliminate viruses, bacteria, moulds and odour on surfaces, by penetrating their membranes, attacking their DNA, preventing them from replicating and killing them instantly. Due to the growing demand from international and local retailers and their consumers for environmentally friendly and chlorine-free products, the use of UV-C technology in the disinfection of fruit, vegetables, nuts, meats and bread has increased substantially of late.

No other technology has the capability, the adaptability and the favourable cost economics to control bacteria in the food chain. Bacteria is airborne and difficult to control. The use of UV-C technology provides the added boost of safety and disinfection over a spectrum of all food to food processors and customers alike. This is done at the most important points of the production process, thereby providing added protection and confidence.

Light pulse processing is a viable alternative to heat treatment for the destruction of pathogenic microorganisms and molds. Light pulses are effective for reducing the microbial population on the food surface, packaging materials and medical devices.

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TECHNOLOGIES AND EQUIPMENT USED FOR CAPITALIZATION OF BY-PRODUCTS RESULTING FROM ENERGY CROPS IN THE FORM OF COMPOST
/
TEHNOLOGII ŞI ECHIPAMENTE UTILIZATE PENTRU VALORIFICAREA SUBPRODUSELOR REZULTATE DIN CULTURILE ENERGETICE SUB FORMĂ DE COMPOST

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Keywords: *sweet sorghum, artichoke, compost, capitalization, by-products*

ABSTRACT
The paper presents synthetically various existing equipment in the technologies that exploit the by-products resulted from sweet sorghum crops (the stems and leaves remaining after the juice extraction) and the artichoke crops (stalks and leaves, respectively other debris left after the processing of the tubers, husks etc.), in the form of compost, so that there is an integral capitalization of the two crops.

REZUMAT
Lucrarea de faţă prezintă sintetic câteva echipamente existente în cadrul unor tehnologii care valorifică subprodusele rezultate din culturile de sorg zaharat (tulpinile şi frunzele rămase după extragerea sucului) şi din culturile de topinambur (tulpinile şi frunzele, respectiv alte resturi rămase după prelucrarea tuberculilor: coji, etc.), sub formă de compost, astfel încât să existe o valorificare integrală a celor două culturi.

INTRODUCTION
Sweet sorghum and topinambur are two crops with high energy potential because they can be used to obtain primary products: seeds and / or juice, respectively tubers, and the resulting by-products: the sweet sorghum stalks (with leaves), artichoke and / or residues resulting from the processing of artichoke (husks, etc.) can then be processed in order to obtain high value "other products", in this case - compost.

Sweet sorghum, a multipurpose crop, producing protein from grain and sugars from the stalk, has been considered as a potential raw material for biofuels production (*Rooney et al., 2007*). The effect of inorganic nitrogen fertilization on the productivity of sweet sorghum biomass has been thoroughly studied. Optimum fertilization seems to be in the range of 90 a 110 kg of N / ha and 15 – 20 kg of P / ha (*Erickson et al., 2012*). Above these values, there is a slight or no effect at all on biomass and sugar productivities, although soil type and organic matter content could influence the results (*Almodares et al., 2008; Wortmann et al. 2010; Serrao et al., 2012*).

Jerusalem artichoke (*Helianthus tuberosus L.*) is classified in the Asteraceae family and was first cultivated in Egypt in the 18th century (1805 - 1875), Its tubers are a good source of inulin, protein, with high mineral content, especially rich in iron, calcium, potassium, sodium, phosphorus, vitamins B, C and β-carotene (*Abdel Maksoud et al., 2009*). *Bernacki et al. (1972)* reported that operational speed of potato planter at manual filling of buckets is very low (should not exceed 1.5 - 1.6 km/h), but in automatic feeding of potato planter, the operational speed is ranged from 3 to 8 km /h. *Kosaric et al. (1984*) mentioned that tuber seeds are planted in leveled rows, in individual small hills or in ridges; the proper planting distance is 50 to 60 cm between seed tubers (plants) within rows, and 70 to 130 cm between rows, these being usually recommended, for giving a planting density for maximum yield per area that does not depress average tuber size through crowding.

Composting is an aerobic process (oxygen needs to be present) carried out by bacteria and other micro-organisms that break down any type of organic waste into soil. To work properly, the right quantities and proportions of nitrogen, carbon and oxygen need to be provided in the composting process. Thus is obtained a rich, safe and fully mature soil that can be used without any further mix for potting, agriculture and gardening (*www.kcsengineering.com*).

The most important change triggered by composting is the transformation of Nitrogen into different molecules:

- Ammonium (NH_4^+);
- Nitrites (NO_2^-);
- Nitrates (NO_3^-) which are absorbed by plants and animals.

Mature compost is chemically stable and is recognized as an exceptional soil fertilizer and conditioner, of great use to improve soil water retention and to prevent the desertification (Fig. 1).

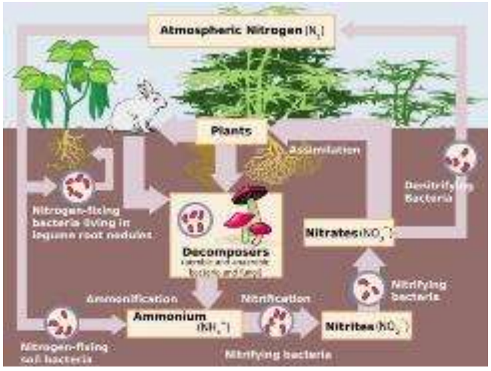

Fig. 1 - Composting and the Nitrogen Cycle (*www.kcsengineering.com*)

Regarding the obtaining of compost from different waste, *Madusanka et. al (2017*) conducted a study to evaluate the composting processes and to identify essential improvements where the main shortcomings identified by this study were: no source separation at origin, no monitoring of temperature, moisture, stability, or maturity during composting. These problems hinder the smooth operation of the composting processes and lead to low demand for compost. Based on their findings, the recommendations for increasing the demand for compost are performing source separation during waste collections, process improvement by monitoring the temperature and moisture, and the marketing of compost to improve its popularity among farmers.

Other research was conducted to integrate the anaerobic digestion with composting (*Kraemer and Gamble, 2014*), because this integrated systems have many advantages: reduction and in some case even the removal of digester effluent treatment; thermophilic composting treats effluent from mesophilic digestion, resulting in pathogen destruction and higher value for the digestate; direct onsite use of biogas energy in operating the composting system (avoiding grid electricity costs); conservation of digestate effluent nutrients; increases the overall plant capacity with minimal footprint increase - one site, one permit, one receiving building; minimizes the odor from food waste processing as food waste receiving and digestion is completely enclosed and relatively small amounts of food waste can be handled in the same plant designed for greater quantities of leaves and yard trimmings.

The study of the effect of sweet sorghum bagasse compost on sweet sorghum productivity in pots, conducted by *Negro et al. (1996*) has showed that the addition of compost to soil produced significant increases on sorghum productivity with regard to the control. Best results have been achieved with the composts obtained from a mixture of sweet sorghum bagasse and pig manure (30t/ha), where the aerial dry biomass increments with regard to the mineral fertilizer treatment was 37%, where the irrigation was 2/3 of the available water.

The addition effects upon sweet sorghum biomass productivity and sugar content (*Cifuentes et al., 2016*) has showed that the compost has relatively low nitrogen content, between 0.5 - 2.0 %, that is slowly mineralized in the soil (*Sikora and Szmidt, 2001; Amlinger et al., 2003*). Compost additions improve the stability of soil particles, moisture retention, greater aeration and microbial diversity, cause porosity increase and a lower density, preserves and restores soil organic carbon and its positive effect on crop yields persists for several years (*Diacono and Montemurro, 2010; Martinez-Blanco et al., 2013*); it also exhibits suppression properties of soil borne plant disease (*Bonanomi et al., 2010*) and contributes to carbon fixation and the reduction of greenhouse gases emissions associated with agriculture (*Favoino and Hogg, 2008; Martinez-Blanco et al., 2013*). Organic nitrogen is more readily available to the plant when inorganic fertilizers and compost mixtures are employed, due to a faster nitrogen mineralization from compost (*Sikora and Szmidt, 2001; Diacono and Montemurro, 2010*).

MATERIAL AND METHOD

The by-products obtained from energy crops have a high value if they are processed in the form of new "products" that can be capitalized on the market, the by-products of sweet sorghum and artichoke being very valuable from the point of view of their contained nutrients and also due to their economic value on the market.

Both crops have high yields per hectare and hence, the amount of by-products produced is high, which ultimately leads to important benefits for the farmers.

For this reason, the composting of the by-products of sweet sorghum and artichoke is important and requires specialized equipment for: grinding, transport, mixing, aeration, etc.

RESULTS

KCS Engineering company has developed a simple and efficient composting technology that allows the compost to be harvested in compact equipment (Fig. 2). Thus, the ideal conditions for composting bacteria to thrive and develop, are created and maintained. With a rotating composting drum and efficient ventilation and mixing systems, waste such as food, garden waste, chopped sorghum and Jerusalem artichoke strains, are composted fast and efficiently under any environmental conditions. The composter works on a continuous composting cycle, which allows to quickly reduce the volume of waste to aprox. 10-15% of the original volume loaded into the machine with integrated crushers and shredders, handling of untreated waste (when recycling food waste such as bones, fish and meat) is minimized, avoiding the occurence of smells and insects, while fully contained and insulated composting barrels and performant aeration systems, give no access to rodents or insects into the composting digester, and ensures that the whole composting process can take place regardless weather conditions, in an odourless way.

Fig. 2 – Composting equipment (*www.kcsengineering.com*)

MAYÇELİK company (Tukey) has developed an fully automated equipment for the production of compost (Fig. 3). The machine contains a component with through, making the transfer between the fermentation compost bunkers; a homogeneous mixture is obtained, floor and side pools and launcher borders completely stainless steel consists of hair. The equipment is complete hydraulic drive system and is composed of: compost filling hopper and, compost filling the tape.

Fig. 3 – Fully automated equipment for compost production (*www.maysera.com*)

ADARCO INVEST Petroşani made a specific equipment for household waste sorting and recycling activities (sorting installation, transfer plants, technological equipment, etc.). The facilities for sorting, composting and mechanical-biological treatment are complex installations that are placed, where possible, in the material recovery sector with the purpose of recycling these materials, or on the metropolitan ecological pits platforms and serve annual capacities between 30000 - 60000 tons of waste consisting of fractions:

paper / cardboard, PET, plastic, textiles, glass, aluminum, etc. The waste obtained in the process of sorting enters into the recycling stream or is collected by the recycling specialized companies. The refused materials are compacted and transported to special ecological pits.

Fig. 4 – Rotating sieve (*adarco.ro*)

Fig. 5 – Rotative drum (*adarco.ro*)

The company XACT System has developed a Composter Rotating Drum Technology (Fig. 6), which provides an effective emergency response solution to disasters with bio-security risks. Situations involving mortalities (animals of any size can be handled; larger animals are ground prior to loading), litter, manure, and other sorts of raw solid organic waste can be converted quickly in order to mitigate potential damage that could result. Compost stacked below the discharge conveyor of the BioReactor and tremendous challenge of handling huge volumes of solid organic waste in municipalities (biosolids, household waste, yard and leaf waste etc), on farms (cow manure, horse manure, mink manure, poultry litter and mortalities), and in industry (processing wastes, grease trap waste, renderings and sludge etc). In addition, legislative demands placed upon communities to reduce dependency on landfills, divert organics from landfills, treat biosolids before they are land applied, and dispose of mortalities, rendering, manure etc in a more environmentally responsible way has increased the need for better solid organic waste management strategies.

Fig. 6 – Compact BioReactor system (*xactsystemscomposting.com*)

Joraform AB made a Biocontainer for Compost Mixing (Fig. 7) and the waste is inserted into the first chamber, where it is aerated and mixed with the incoming fresh waste by the JORAFORM proven mixing technique. After 10 - 14 days, the mixing arms passes the material into the second chamber to isolate it from fresh waste in order to complete the ripening process. The ripening chamber is equipped with an independent mixing system which is also used for smooth emptying of the ripening chamber after additional 14 days. After 28 days cycle, the waste is fully converted to compost and no further composting is needed. The new JORAFORM BIOCONTAINER is designed with two well isolated parallel rows of a composting room and a ripening room, this given this equipment a superior capacity in relation to its compact design, the loading can be done from the side or from the top whichever is the most suitable for the user. It contains new developed control system which monitors the temperature and filling levels in the chambers in order to as efficient as possible turn your waste into well balanced compost. The programming is easily done in any language and the parameters can be set to optimize the composing process in relation to the waste stream.

Fig. 7 – Biocontainer for Compost Mixing (*xprt.com*)

An important company form China (*compost-turner.net*) manufactures equipment and composting machines for biodegradable organic solid waste, especially manufacturing compost turner machinery of various specification and yield, including wheeled, tracked, self-propelled machine, double-tank fermentation and manure fermentation turning machine, mushroom, compost turning machines and organic fertilizer production equipment (Fig. 8 and 9).

Fig. 8 – Full Hydraulic Crawler Compost Turner (*compost-turner.net*)

Fig. 9 – Tow Behind Compost Turner (*compost-turner.net*)

HENAN TONGDA produces fertilizer equipment and composting lines including (*fertilizergranulatormanufacturer.com*): small compost turner (Fig. 10), bio compost machine (Fig. 11), compost turner, crawler type compost turner machine (Fig. 12), groove type compost turner (Fig. 13) and wheel type compost turner making machine (Fig. 14).

Fig. 10 – Small Compost Turner

Fig. 11 – Bio Compost Machine

Fig. 12 – Crawler Type Compost Turner Machine

Fig. 13 – Groove Type Compost Turner

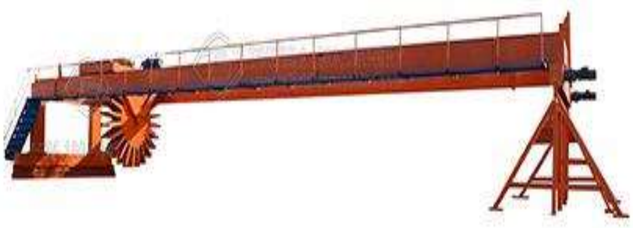

Fig. 14 – Wheel Type Compost Turner Making Machine (*fertilizergranulatormanufacturer.com*)

The company FRONTIER INDUSTRIAL CORPORATION (USA) produces for over 20 years, composting equipments: Mighty Mike Windrow Compost Turner (Figure 15), Tow Behind Turners, Self-Propelled, Power Assist, Track Drive, Selv-Trailering, Watering Systems, which can be used in farms or composting stations in different phases of the composting process.

Fig. 15 – Mighty Mike Windrow Compost Turner (*www.frontierturners.com*)

King Feeders UK is a company specializes in the supply of green waste composting machinery, and has wide ranging experience in this area of equipment with a proven track record of supply to a range of different sectors: county councils, local authorities, landscape/gardening companies, waste processing companies, universities, leisure parks, charities and recycling consortiums.

Fig. 16 – Compost Shredders Complete With Discharge Elevator / Crane (www.ecogreencomposting.co.uk)

Fig. 17 – Eco Green Screener Machine *(www.ecogreencomposting.co.uk)*

Fig. 18 – Rotary Separator *(www.ecogreencomposting.co.uk)*

CONCLUSIONS

Over the past 10 years, technologies and equipment for the capitalization of the various by-products resulting from the processing of energy crops (and not only) as compost have seen a very rapid development, which has led to the emergence of new industries, respectively of new equipment.

The development was supported by strong investments from companies and investors who realized that from the use of some by-products / residues that were previously thrown or left to degrade themselves on land, now, with the help of modern technologies, after more or less processing (as the case), products with high added value are obtained, by eliminating some by-products that, in certain situations, were an ecological problem.

Today's technologies and equipment allow the processing of the by-products resulting from any industry, so that ultimately is obtained a valuable compost that can be capitalized in agriculture.

ACKNOLEDGEMENT

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[24] http://compost-turner.net/

[25] http://fertilizergranulatormanufacturer.com/

[26] https://www.frontierturners.com/about-us/

[27] https://www.ecogreencomposting.co.uk/index.php

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ACKNOWLEDGMENTS (***Arial 10 pt.***) of people, grants, funds etc should be brief (*if necessarily*).

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[1] Vlădut V., (2009), *Study of threshing process in axial flow apparatus (Studiul procesului de treier la aparatele cu flux axial),* vol.1, ISSN/ISBN …………., "Terra Nostra" Publishing House, Iaşi/Romania;

Journal Article: Names and initials of authors, year (between brackets), full title of the paper, full name of the journal (Italic), volume number, publisher, place, ISSN, page numbers:

[1] Lizhi Wu, Yan Di., (2005), Demonstrational study on the land consolidation and rehabilitation (LCR) project of saline-alkali soil in arid areas: a case study of Lubotan LCR project in Pucheng County, Shaanxi Province (干旱区盐碱化土地整理工程实证研究-以陕西蒲城县卤泊滩土地整理项目为例), *Transactions of the Chinese Society of Agricultural Engineering*, vol.21, no.1, ISSN ………, pp.179-182, Madison/Wisconsin;

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Conference or Symposium: Names and initials of authors, year (between brackets), full title of the paper (Regular), full name of the conference/symposium (Italic), volume number, publisher, place, ISSN, page numbers

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Dissertation / Thesis: Names and initials of authors, year (between brackets), full name of the thesis (Italic), specification (PhD Thesis, MSc Thesis), institution, place;

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Patents: Names and initials of authors, year (between brackets), patent title (Italic), patent number, country:

[1] Grant P., (1989), *Device for Elementary Analyses*. Patent, No.123456, USA.

Legal regulations and laws, organizations: Abbreviated name, year (between brackets), full name of the referred text, document title/type (Italic), author, place:

[1] *** EC Directive, (2000), Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000, on the incineration of waste, Annex V, *Official Journal of the European Communities*, L332/91, 28.12.2000, Brussels.

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Summaries, reviews and perspectives covering topics of current interest in the field, are encouraged and accepted for publication. Reviews should be concise (max. 8 pages). All the other conditions are similar with regular articles.

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