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Technical University of Cluj-Napoca
North University Center in Baia Mare
Faculty of Engineering
Dr. V. Babes Street, No.62A,
RO-430083, Baia Mare, Romania
Phone: 00 - 40-362-401265/202
Fax: 0040-262-276153
e-mail: ungureanu.nicolae@gmail.com

COLLEGE OF NYIREGYHAZA

SIKOLYA László*, C.Sc.*
PÁY Gábor*, PhD.*
KOVÁCS Zoltán, *Ph.D.*

University of Nyiregyháza
Institute of Engineering and Agricultural Sciences
Kótaji Str. 9-11, P.O.Box.166
4400 Nyíregyháza, Hungary
Phone: 00-36 -42-599-434
e-mail: Pay.Gabor@nye.hu

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Effect of Drying Methods on the Physical and Mechanical Properties of Dried Sweet Corn

Tamás Antal[1,*] - Gábor Páy[2] - László Sikolya[3]

Abstract: The effect of the different drying processes of sweet corn on color, water activity, rehydration and texture were studied. In the present study, the lyophilization method as control was employed to dry sweet corn in comparison with infrared-freeze drying, hot-air-freeze drying, and vacuum pre- and freeze finish-drying methods. Research has highlighted the changes in physical and mechanical properties during drying. The drying methods were noted to have a statistically significant influence on the color, rehydration and firmness of the seeds. The Hunter color scale parameters redness, yellowness and lightness were used to estimate color changes during drying of sweet corn. Regarding texture, freeze dried samples showed lower firmness than the combined dried samples. The total color difference and rehydration of samples treated by the hybrid drying method were found to be more favorable compared to freeze-dried material. On the other hand, the dehydration had a statistically significant influence on the water activity of the sweet corn. Considering all the properties studied, combined vacuum and infrared freeze-drying is a suitable alternative to lyophilization.

Keywords: sweet corn, hybrid drying, color, texture, rehydration, water activity

1 INTRODUCTION

Zea mays L., also known as maize or sweet corn is a cereal that is one of the most important grains in all of the world. In recent years, an average of 30-34 thousand hectares of sweetcorn has been grown in Hungary, the largest in Europe. Sweet corn is one of the major primary products for human consumption, due to its nutritional value [6].

Drying of foodstuff is indispensable to control and maintain the quality of final products. Dehydration process is one of the thermal processes that are time and energy consuming in the industry. The hot-air drying, is one of the most widely used technique for the conservation of food on a global scale [19]. However, this drying method involves several disadvantages, such as its low energy efficiency and lengthy drying time during the falling rate period [12]. Moreover, unexpected quality degradations including browning and vitamin degradation are easily produced. The degradation of product quality is linked to high temperature and long drying time of hot-air drying [7]. Infrared radiation is able to penetrate into materials and directly transfer thermal energy to a certain depth of the products. The depth to which infrared radiation can penetrate is generally dependent on the absorbance of the products. Finally, it is helps to rapid evaporation of moisture from the samples due to high frequencies of waves [5]. The infrared drying method has many advantages such as high heat transfer coefficient and short drying time [13]. Higher quality products can be obtained using freeze-drying method. Freeze-drying involves crystallization of water in ice crystals, which subsequently sublimate, thus leaving a porous dried product [16]. Lyophilization typically creates a porous microstructure, which results in shorter rehydration process and higher rehydration capacities than in products dried using any other techniques [11]. During the freeze drying, the whole dehydrating process is accomplished in the state of high vacuum and low temperature, which almost retains the original color, shape and chemical components in raw materials [17]. Despite of its capability of providing a very high quality dried product, freeze drying is an expensive method and the high costs of process limit its using in industrial scale [16, 17].

That's why new methods so called hybrid drying are aimed to decrease working time and energy uptake without reduction in quality [9]. Hybrid drying techniques such as combining infrared radiation or convective drying with methods such as freeze drying or microwave drying can also be used [4, 21].

The color, rehydration and firmness of a food product is most important quality factors and plays a remarkable role in its appearance and consumer acceptability [10].

The different drying methods is a decisive impact for product quality such as physical, mechanical, chemical and nutritional changes that can affect color, rehydration, texture and nutritional value. However, there are few data about the effects of drying on physical and mechanical properties of sweet corn which is important for consumer.

Therefore, the aim of this work was to investigate the effect of hybrid and freeze drying on physical and mechanical properties in terms of color, rehydration, water activity, and firmness.

2 MATERIALS AND METHODS

2.1 Raw Material

Sweet corn (*Zea mays* L.) was purchased from a local supermarket and stored at 5°C until used. The average moisture content of sweet corn seed prior drying process is 75% (in wet basis) and 3.0 kg H_2O kg dry matter^{-1} (in dry basis). The moisture of corn grain was determined by drying it in an oven at 105 ± 1°C, for a 24 h period. Immediately after washing, the samples were placed in the dryers.

2.2 Drying processes

The corn grain samples had a total weight of 30.0 ±0.1 g for each of the seven samples. Details of each drying experiment are shown in Table 1.

Table 1. Summary of the drying program

Drying methods	*Pre-drying time [min]*	*Pre-drying temperature [°C]*
5min-MIR-FD	*5*	*40*
10min-MIR-FD	*10*	*40*
2h-VD-FD	*120*	*40*
3h-VD-FD	*180*	*40*
2h-HAD-FD	*120*	*40*
3h-HAD-FD	*180*	*40*
FD	-	-

Note: MIR-FD: infrared-freeze drying, VD-FD: vacuum pre- and freeze finish drying, HAD-FD: hot-air-freeze drying, FD: freeze drying

In the drying of sweet corn, it was found that at a drying temperature of 50°C, the surface of the samples was already browned, so only the pre-drying results at 40°C are reported in this study.

Hybrid drying: The drying air temperature (40 °C) and pre-drying time were set in the first stage (VD pre-drying, HAD pre-drying and MIR pre-drying) in the two-stage drying experiment. The first drying stage was followed by the second stage (so called post-drying: FD).

MIR pre-drying: The chamber wall was formed from aluminized steel, with a length of 15 cm, a breadth of 15 cm, and a height of 25 cm, equipped with a single door opening at the top, which allowed insertion and removal of the sample. The wavelength of radiation between 2.4-3.0 μm and the heating intensity were maintained 3 kW m^{-2} (Infrared intensity is usually expressed as radiation power per unit area). The quartz glass emitter (maximum power of per lamp 400 W) is located at a distance of 15 cm from the grain surface. The sample tray was supported on a balance (a precision of ± 0.1 g, model Precisa, Precisa Instruments AG, Dietikon, Switzerland).

VD pre-drying: A lab-scale vacuum dryer (model Kambic VS-50C, Kambic Lab. Eq., Semic, Slovenia) was operated at 4.9-5 kPa was used during the drying processing. For measuring the weight of the sample during experimentation, the tray with sample was taken out of the drying chamber, weighed on the digital balance.

HAD pre-drying: This drying technigue was carried out in a hot-air dryer (model LP306, LaborMIM, Hungary) at 40°C with an air flow rate of 1 m s^{-1}. During the drying process, the temperature (material and air) and air velocity were measured using a Testo 4510 type meter (Testo GmbH, Germany). The mass was measured on an analytical balance (model JKH-500, Jadever Co., Taiwan) with a precision of ±0.1 g.

FD drying: The laboratory freeze-dryer (model Armfield FT-33 freeze-dryer, Armfield Ltd., Ringwood, UK) is composed of a refrigeration system, heater, vacuum pump, working and condenser chamber and data collecting system (Emalog, Budapest, Hungary). The corn samples were frozen at -23°C in a freezing/heating chamber, with an absolute pressure of 80-90 Pa with a chamber temperature of 21°C and a condenser temperature of -49°C. In all experiments, temperature of the condenser and the chamber pressure were maintained at constant parameter.

The corn samples were dried by different drying methods until the final moisture content (3.6-5.8%, in wet basis). The drying process was continued until a constant moisture content was recorded. In all experiments, the sweet corn grain were spread uniformly in a single layer on a stainless steel tray.

2.3 Physical Properties

Color: Instrumental measurements of color characteristic were performed on fresh and dried material. The color of the samples was measured different place corn grain surface. The total color difference (ΔE) were measured with a ColorLite-sph900 spectrophotometer (ColorLite GmbH, Katlenburg-Lindau, Germany). The values were reported in the CIE color profile system as L^* − value (lightness), a^* − value (redness/greenness), and b^* − value (yellowness/blueness). was calculated according to the following equation (1):

$$\Delta E = \sqrt{(L_0 - L)^2 + (a_0 - a)^2 + (b_0 - b)^2} \qquad 1$$

Fresh sweet corn grain were used as the reference (0) and a larger ΔE denotes greater color change from the control material.

Rehydration: Randomly chosen 5 pieces of the dried samples with different methods were weighed (balance accuracy 0.1 g) and placed in a plastic dish with 80 ml distilled water (20°C) at room temperature (25°C), and allowed to rehydrate. The water immersion time was 60 minutes. After end of process the sample was removed from the bath, the excess water was drained with absorbent paper, then weighed. Rehydration ratio (RR) of dehydrated samples was estimated using the equation given below (2):

$$RR = \frac{W_r}{W_d} \qquad 2$$

where W_r is the drained weight of the rehydrated sample (g), and W_d is the weight of the dry sample used for rehydration (g).

Water activity (a_w): Before and after the drying process the water activity in the samples was measured using Novasina Labmaster (model CH-8853, Novasina AG, Switzerland) apparatus at 25±0.5°C with direct reading.

2.4 Mechanical Properties

The hardness of raw and dried samples, as an indicator of texture, was defined as the maximum force required to compress the corn grain tissue. The texture was measured using a Brookfiled CT3-4500 *texture*

*analyzer (*Brookfield Engineering Laboratories, Middleboro, USA*).* The parameters that have been used were the followings: 8 kg force load cell, 2 mm/s test speed, 20 mm travel distance and 2 mm diameter of cylindrical probe. The maximum depth of penetration was 2 mm and trigger force was 10 g. A 115 mm diameter plate (rotary base table) was used as a base while compressing the corn samples. The samples were kept in a room temperature at 25°C until analysis. The penetrometer measurements are reported in Newton's (N).

2.5 Data Analysis

Each experiment included three replications. Excel software (Microsoft Office, 2013) was used for drawing graphs. Data were subjected to analysis of variance (ANOVA). Comparison of means was carried out by Duncan's multiple range test. Statistical analysis was performed using the Statistical Package for Social Science (SPSS 20.0 for windows, SPSS Inc., Chicago, IL, USA).

3 RESULTS AND DISCUSSIONS

3.1 Drying time

The influence of hybrid drying and freeze drying on drying time of sweet corn is shown in Fig. 1. It was found that all combined drying methods significantly reduced (p<0.05) the drying time of lyophilization. The results agree with what was reported by Zhang et al for freeze drying combined with air drying of kiwifruits [22]. *As pre-drying time increased at combined drying, moisture removal also increased and ultimately resulted in the reduction in total drying time. In terms of MIR-FD, HAD-FD and VD-FD, the drying time significantly decreased (p<0.05) with the increase in pre-drying time from 5 to 10 min and from 2 h to 3 h as expected.*

The freeze drying operation time is the highest of all drying solutions (p<0.05). While the freeze-drying process took 19 hours, the drying time after the 10 min-MIR-FD treatment was 12 hours, reducing the drying time by about 37%. A previous study showed that the FD-MIR dehydration method reduced the lyophilization operational time by about 48% with similar product quality [20].

There is no significant difference (p>0.05) between 3h-VD-FD and 2h-HAD-FD hybrid drying methods.

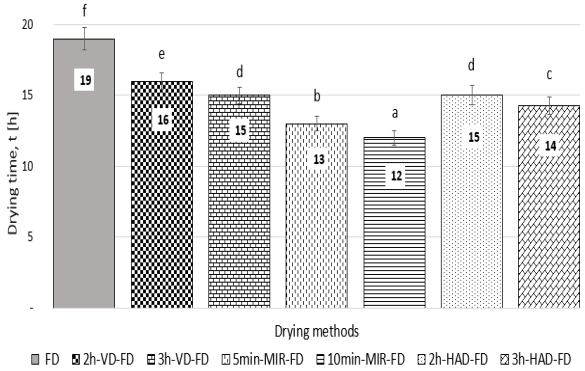

Fig. 1. Process time for different drying conditions

3.2 Physical and mechanical properties

Fig. 2 shows sweet corn grain samples of dried by one-stage and two-stage drying processes. There is no apparent difference between FD, VD-FD and 5min-MIR-FD maize seeds.

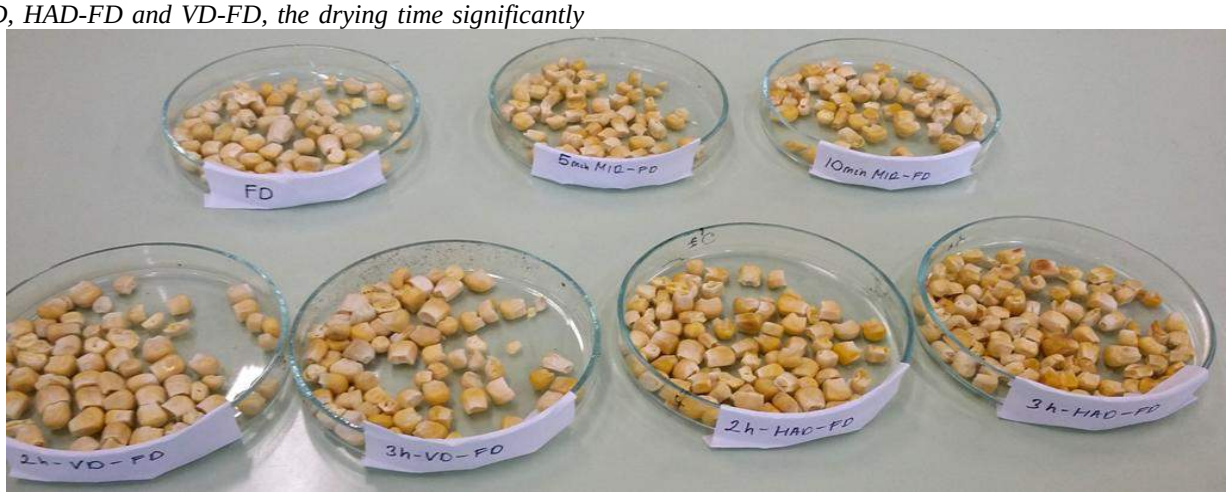

Fig. 2. Hybrid- (MIR-FD, VD-FD and HAD-FD) and freeze-dried (FD) sweet corn samples

While the freeze-dried (FD) samples faded slightly, the 10min-MIR-FD and HAD-FD materials were slightly darker compared to the raw material. In addition, brown spots on the surface of the 3h-HAD-FD samples are visible, which are the result of the Maillard reaction [2]. No shrinkage is observed in sweet corn products.

Table 2 summarizes the results of physical and mechanical properties of raw and dried sweet corn.

Water activity (a_w) was determined for each experiment before and after dehydration. According to Lewicki et al., the growth of most fungi, molds and bacteria is inhibited when a_w value is less than 0.7 [11]. It was found, that the dried products within the range of

0.19–0.36 water activity. The dried samples are in microbiologically stable condition. The water activity values of FD, HAD-FD, MIR-FD and VD-FD dried corn samples were found to be statistically different.

Table 2. Effect of drying methods on physical and mechanical properties

Drying methods	Water activity a_w [-]	L^* parameter [-]	Color difference ΔE [-]	Rehydration RR [-]	Firmness [N]
Fresh corn grain	0.795	87.71	-	-	1.012
5min-MIR-FD	0.211^{ab}	84.82^{c}	13.56^{d}	3.35^{ab}	0.172^{b}
10min-MIR-FD	0.275^{d}	81.33^{e}	16.21^{f}	2.19^{de}	0.262^{d}
2h-VD-FD	0.315^{e}	88.11^{a}	9.62^{a}	2.31^{d}	0.181^{b}
3h-VD-FD	0.306^{e}	86.15^{b}	11.94^{b}	2.61^{c}	0.194^{c}
2h-HAD-FD	0.361^{f}	84.25^{cd}	14.55^{e}	2.25^{d}	0.314^{e}
3h-HAD-FD	0.198^{a}	79.23^{f}	18.68^{g}	2.04^{f}	0.331^{ef}
FD	0.244^{c}	91.40^{d}	12.33^{bc}	3.48^{a}	0.153^{a}

The color parameters of the fresh and dried sweet corn grain are given in Table 2. Drying had an important effect on the color of samples. The Hunter value L^* is influenced by the drying temperature and pre-drying time. Our results indicated that values of L^* (91.40) for corn grain of FD were significantly higher *($p<0.05$)* than for those of hybrid dried and fresh materials (control). This is due to the fading of the maize grains during lyophilization, a finding consistent with a previous publication [3]. Among the combined drying methods, the samples treated with the VD-FD method had the highest L parameter values *($p<0.05$)*. The values of L^* were 84.82 and 81.33 respectively for MIR-FD and 84.25 and 79.23 for HAD-VD sweet corn. As a result, the color of corn grains in MIR-FD was lighter than HAD-FD. The low L^* color parameters of the 10min-MIR-FD and 3h-HAD-FD maize samples (81.33 and 79.23) indicate that a Maillard (so called non-enzymatic browning) reaction has occurred [1]. It is clear that samples dried with longer pre-drying time (for example increasing from 5 min to 10 min) had lower brightness (L) at hybrid drying.

Analyzing the ΔE values, the highest value was observed in 3h-HAD-FD samples (Table 2), as compared with the rest of the treatments ($p<0.05$). As the pre-drying time from 5 to 10 min and from 2h to 3h increased, the ΔE values of dried samples significantly increased ($p<0.05$). We found from the results that VD-FD maize seeds have lower total color difference (ΔE) than FD samples. There was a significant difference ($p<0.05$) between 2h-VD-FD and single-stage of FD dried maize. The relatively low color difference is probably due to the vacuum in the VD and FD dryers [8]. *The significantly largest ($p<0.05$) ΔE is observed for the HAD-FD and 10min-MIR-FD samples.*

The rehydration ratio (RR) values obtained in this work varied from 2.04 to 3.48 (Table 2). A maximum rehydration ratio (RR=3.48) was obtained for the freeze dried of corn grains. It should be noted that there is no significant difference ($p>0.05$) between the 5min-MIR-FD and FD samples. Previous publications attributed the low rehydration ratio to a prolonged drying time [15]. This is consistent with the data obtained in this study when the pre-drying time is taken into account. The 10min-MIR-FD and 2h- and 3h-HAD-FD samples have the lowest rehydration values. This is because the infrared and hot-air pre-drying causes the surface of the maize grain to harden, which prevents the product from absorbing water [18]. This is confirmed by the textural results.

If comparing the fresh samples with the dried corn grain, the hardness decreased from 1.012 N to 0.153-0.331 N (Table 2). Moreover, the increase in pre-drying time for the combined drying of the sweet corn, also produced a significantly effect ($p<0.05$) on hardness, i. e. increased. FD maize has the most favorable hardness value *(0.153 N)*. This is because lyophilised products have a porous, loose structure [14]. The hardness value of the FD samples approached the textural value of the 5min-MIR-FD and 2h-VD-FD maize seeds, although there was a significant difference ($p<0.05$) between them. Samples dried with hot-air have firmness values twice that of FD maize.

4 CONCLUSIONS

The effect of hybrid drying and freeze drying on operational time, physical and mechanical properties of sweet corn seed, i.e. water activity, rehydration, color and texture was studied.

Drying reduced the water activity (a_w) of the maize grain to <0.4. Generally, the vacuum and infrared application decrease the water activity, improve the product color, rehydration and reduce the hardness. The results indicate that lower drying temperature and pre-drying time in case of hybrid drying are more adequate to preserve these properties.

The results showed that the combination of MIR (pre-drying time: 5 min) followed by FD and VD (pre-drying time: 3 h) followed by FD saves 31.6% and 21% times compared to FD while keeping the product physical and mechanical properties at an acceptable level.

Among the four drying methods, FD led to the best quality properties, including rehydration and firmness.

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Authors addresses

[1]Tamás, Antal, PhD. habil., University of Nyíregyháza, Sóstói str., 31/b., +36 42 599400, antal.tamas@nye.hu

[2]Gábor, Páy, PhD., University of Nyíregyháza, Sóstói str., 31/b., +36 42 599400, pay.gabor@nye.hu

[3]László, Sikolya, PhD., University of Nyíregyháza, Sóstói str., 31/b., +36 42 599400, sikolya.laszlo@nye.hu

Contact person

[*]Tamás, Antal, Dr. habil., University of Nyíregyháza, Sóstói str., 31/b., +36 42 599400, antal.tamas@nye.hu

Effect of different organic fertilizers on soil and rye parameters in long-term experiments

[1]Tibor Aranyos, [2*]Ágnes Hadházy, [3]István Henzsel, [4]Marianna Makádi

Abstract:

The intensive land use and the effects of climate change have resulted in the decline of organic matter content of soils in Europe and Hungary as well. For ensuring the suitable crop safety and maintaining the soil fertility it is necessary the organic matter supply of the soils. Our research work was carried out in 2020 in the Westsik crop rotation long-term experiment and in the sewage sludge compost long-term experiment at the Research Institute of Nyíregyhaza, IAREF, University of Debrecen. The soil type of the experiments was Lamellic Arenosol, Dystric. The objective of our study was to determine of the effects of different nutrient management practices on soil parameters and rye test plant. The results of soil pH and SOM analysis confirmed the positive effect of sewage sludge compost on soil. The rye plant parameters showed mainly the beneficial effect of farmyard manure and sewage sludge compost. The straw manure treatment had the least effect on the soil and on the parameters of rye. This research demonstrated the importance of the organic matter supply of the soils and the results confirmed that the composted sewage sludge and farmyard manure could be used efficiently in crop production concerning soil quality and plant yield.

Keywords: sandy soil, rye, farmyard manure, straw manure, sewage sludge compost

1 INTRODUCTION

The rye (*Secale cereale L.*) is important cereal crops of sandy soil which used for both human consumption and animal feed (Bushuk, 2001). The total production area of rye in Hungary reached about 25767 hectares with total production of 84.116 tonnes (FAO, 2020). The rye botanical parameters, like plant weight, spike number, seed weight determine the yield of rye, consequently they have strong correlation with rye yield (Kilic and Yağbasanlar, 2010).

In the region of Nyírség, there are more than 400 thousand hectares of sandy soils. The fertility of these soils is limited by their low mineral and organic colloids content (Várallyay, 2005). In addition the intensive land use and the effects of climate change have resulted in the decline of organic matter content of soils (Wiesmeier et al., 2016). For ensuring stable crop production the improvement and the organic matter supply of sandy soils is required. The organic manure application significantly increases the organic carbon content of soil and soil fertility which is realized in yield components as compared to chemical fertilizer (Dersch and Bohm, 2001). Moreover, the organic manure application has several benefits, like to balance the nutrient supply, increase the soil nutrient capacity and the soil microbial activity, improve the soil structure consequently improve the soil water availability (Han et al. 2016). The organic matter affects not only the yield by supplying the nutrients but indirectly affects soil physical and chemical properties, too (Darvish et al. 1995). The organic material content of soil is a very important factor of soil fertility (Rahman and Parkinson, 2007).

There are several well-known organic manure forms, like straw manure, composts and farmyard manure. Several research results indicated positive effects of farmyard manure especially on soil organic carbon contents and soil biological properties in many field experiments (Mäder et al., 2002; Marinari et al., 2006 and Heinze et al., 2010). The addition of substances with high organic matter content into the soil, like farmyard manure, straw manure, resulted in the increase of organic matter content of soil (Bradley, 2008), the improvement of soil physical and chemical properties and affected the soil pH, too (Eghball, 2002). Soil pH is very important factor affecting nutrient solubility, and influencing the sorption capacity of soil (Citak and Sonmez, 2011).

In the past, farmyard manure was used in the largest amount for organic matter supply of soils, but the livestock production has decreased in Hungary and the technology has also changed, so the amount of usable manure is not enough for regular nutrient supply of arable lands. In current agriculture, natural materials, industrial wastes and by-products can be used more and more often as supplements of organic matter of soils, thereby improving the physical, chemical properties, fertility and biological activity of soils (Angin et al., 2013; Liu et al., 2014; Sánchez De Cima et al., 2015). The range of potentially suitable materials may expand further with using composted sewage sludge to increase fertility of sandy soils (Adani et al., 2009; Mylavarapu and Zinati, 2009).

The aim of our study was the examination of the effects of different organic manuring practices on soil parameters and rye test plant. For studying the effects of different fertilization methods, the long-term experiments provide excellent opportunities.

2 MATERIAL AND METHODS

Our research work was carried out in 2020 in the Westsik crop rotation long-term experiment (91 years old) and in the sewage sludge compost long-term experiment (17 years old) at the Research Institute of

Nyíregyhaza, IAREF, University of Debrecen. The soil type was Lamellic Arenosol, Dystric.
The soil samples were collected from the 0-30 cm soil layer.
The pH of the soils was measured in 1 N KCl solution. The rate of soil: KCl solution was 1:2.5.
The organic matter content of soil (SOM) was determined by Tyurin method (Buzás, 1998).
26 t ha^{-1} of straw manure (SM) and farmyard manure (FYM) were sawn into the soil before sowing the rye. The sewage sludge compost (SSC) was applied at the rate of 27 t ha^{-1} and it contained sewage sludge 40 (% m/m), straw 25 (% m/m), bentonite 5 (% m/m) and rhyolite 30 (% m/m). Sewage sludge compost is applied in every 3rd year, the last time in 2018.
Plant samples were collected in four replications/plots from 1 m^{-2}, on 13/07/2020. Plant biomass (g m^{-2}), rye crop (g m^{-2}) and spike number (pc m^{-2}) were determined by counting and measuring the plant and all spikes and measuring all grains per m^2.
Collected data were analyzed by the IBM SPSS Statistical Software Package 21.0 version. One-way ANOVA followed by Tukey's test were used at 0.05 significance level to determine the treatment effect and compare the means. In addition, Pearson's correlation analysis was done to find relationships between the soil properties and plant parameters.

3 RESULTS

3.1 The soil parameters:

Soil $pH_{(KCL)}$ was between 4.59 and 6.38. The lowest $pH_{(KCL)}$ was resulted by the SM application (4.59). The $pH_{(KCL)}$ of the FYM and control was the same (4.62). The highest $pH_{(KCL)}$ was reached by the SSC application (6.38). The $pH_{(KCL)}$ data of SSC was significantly different from all of other applied organic manure data (*Figure 1.*). There were no significant differences between the data of control, SM and FYM.

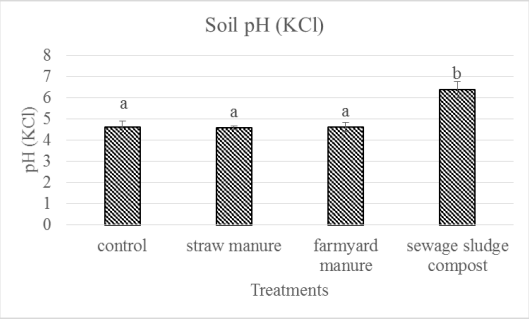

Fig. 1. Changes in soil pH of 0-30 cm soil layer in different organic matter treatments

a-b indexes mean different groups of means according to the Tukey's test at the significance level of p<0.05, mean ± Standard Deviation (SD)

Soil Organic Matter content (SOM) was between 0.496 and 0.775%. The lowest value was found at the SM plot (0.496%) while the highest one at the SSC plot (0.775%) and the difference between them was significant. The control and FYM resulted in 0.591% and 0.646% SOM values and the difference between these data was not significant (*Figure 2.*).

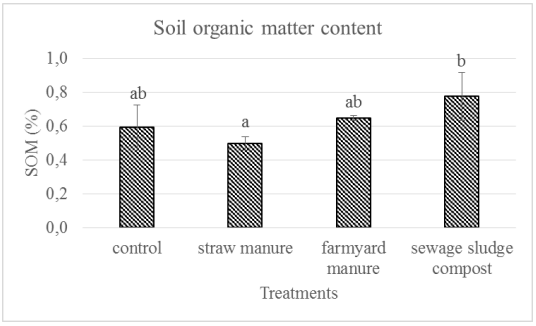

Fig. 2. Changes in SOM of 0-30 cm soil layer in different organic matter treatments

a-b indexes mean different groups of means according to the Tukey's test at the significance level of p<0.05, mean ± Standard Deviation (SD)

3.2 The rye plant parameters:

The data of rye biomass was between 530.5 g m^{-2} (SM) and 1283.5 g m^{-2} (FYM). The result was 799.3 g m^{-2} in the control and 1034.8 g m^{-2} in the SSC plots. The FYM and SSC resulted in significantly higher rye biomass than SM application (*Figure 3.*).

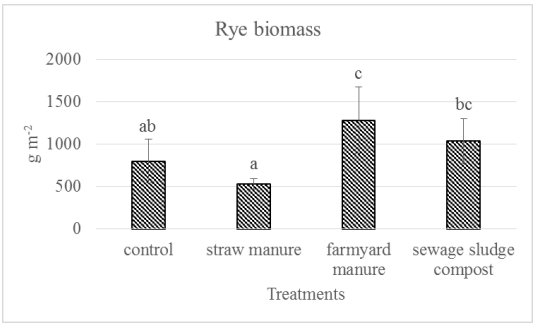

Fig. 3. Changes in rye biomass in different organic matter treatments

a-c indexes mean different groups of means according to the Tukey's test at the significance level of p<0.05, mean ± Standard Deviation (SD)

The data of rye spike number was between 296 ps/m^2 (control) and 472/m^2 ps (SM). The data of control (296 ps/m^2) was significantly different from the FYM (469 ps/m^2) and SM (472 ps/m^2) data (*Figure 4.*).

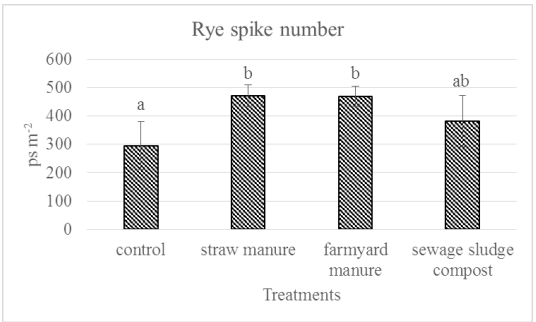

Fig. 4. Changes in rye spike number in different organic matter treatments

a-b indexes mean different groups of means according to the Tukey's test at the significance level of p<0.05, mean ± Standard Deviation (SD)

The rye crop data varied between 170.2 g m^{-2} (SM) and 589.5 g m^{-2} (FYM). The data of control (309.4 g m^{-2}) the compost (383.6 g m^{-2}) and the SM were not significantly different (*Figure 5.*).

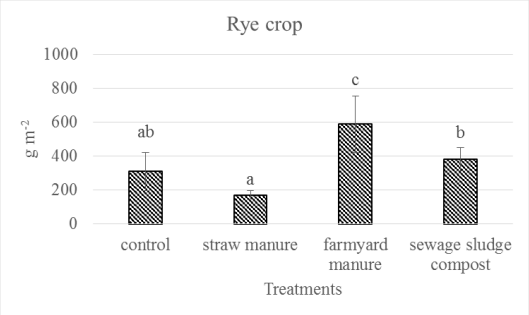

Fig. 5. Changes in rye crop in different organic matter treatments

a-c indexes mean different groups of means according to the Tukey's test at the significance level of p<0.05, mean ± Standard Deviation (SD)

*The correlation analysis indicated positive and medium correlation between the SOM and soil pH (0.588**). The higher soil organic matter content resulted in more favourable soil pH. There was significant positive and close correlation between the plant biomass and rye crop (0.846**). The correlation was significantly positive and medium between the spike number and plant biomass (0.545**).*

4. DISCUSSION

The pH and the organic matter content of soil increased the mainly in the SSC treatment. It can be explained by the high organic matter content of applied SSC. The application of organic amendments is recommended as an effective tool to ameliorate soil properties. Organic substances can increase the pH of acidic soils through their acid/base buffering effect. *Sewage sludge composts are good sources of organic matter, because they average organic matter content – depending on the initial materials – are about 20-30 (% m/m). The enhancement of soil organic matter content was reported previously as a result of the addition of SSC to sandy soil (Mylavarapu and Zinati, 2009). In the soil stable structural elements are created by the effect of organic matter input (Arthur et al., 2011).* However, the measurements were carried out two years after SSC application and the *improvement of soil properties observed during the experiment was limited only to a short period of time, and was connected with rapid mineralization processes (Celik et al., 2004).*

The FYM is commonly used as a potential source of organic matter in acidic soils to raise soil pH (Citak and Sonmez, 2011; Ozlu and Kumar, 2018). In our case the SM and the FYM treatment had no effect on soil pH and SOM. Mineralization processes are quick in acidic soils, therefore the manure application can increase the soil pH only within the short time (Whalen et al., 2000).

The rye plant parameters showed mainly the beneficial effect of FYM and SSC. The SM treatment had the least effect on the parameters of rye and also on the soil. This can be explained that the organic matters applied into the soil by FYM and SSC treatments are more stable and more resistant to mineralization processes, than by SM treatment. The stable soil organic matters promote the crop growth and plant productivity by providing nutrients for plants and modifying the soil quality. They play an important role in the formation of soil aggregates. Organic substances are a good nutrient source for soil bacteria and fungi, which help in the improvement of soil structure by binding soil particles into aggregates. *The organic matters also help decrease the soil compaction, stabilize the soil structure, reduce the soil erosion and improve the water holding capacity of soil (Ding et al., 2012).* The SSC treatment had a greater effect on the soil, because in addition to organic matter, bentonite and rhyolite were also applied to the soil with sewage sludge compost. Bentonite has a high content of montmorillonite with a high water capacity, thereby it has a positive effect on soil water management. SSC application had a positive effect on soil structure, nutrient and water management of sandy soil, which positively influenced the plant development and yields (Adani et al., 2009; Mylavarapu & Zinati, 2009; Wu et al., 2017). SSC treatment has generally a positive effect on the amount and the quality of the yield (Eriksen et al., 1999; Lillywhite et al., 2009; Weber et al. 2014). Researchers reported that organic matter addition into the soil by compost application has a positive effect on seed germination vigor, growth and development of plant roots and shoots (Van Noordwijket al., 1993). This may be explained by the fact that higher amounts of organic carbon also contribute to improved soil fertility (Adani et al., 2009; Barral et al., 2009; Zhong et al. 2010).

5. CONCLUSION

Organic matter addition to acidic sandy soil could improve its pH and organic matter content. The changes of soil properties after long-term application of SM and FYM and SSC depend on the quality of organic matter added to the soil. The effects of organic manures depend on their initial materials, treatments (composting or not), stability and application regime. More complex the added organic manure, more effective as a soil improving material. The nutrient supplying capacity depends on the application regime: however, the SSC had positive effects on soil pH and organic matter content, it was less effective as available nutrient source for rye in the 2nd year after the application.

We concluded that SSC and FM could be used efficiently in crop production concerning soil quality and plant yield.

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Authors addresses

[1]Tibor Aranyos, PhD, University of Debrecen, IAREF, Research Institute of Nyíregyháza, Nyíregyháza Westsik V. út 4-6, Hungary
Phone: +36 42 594 308
E-mail: aranyostibi@gmail.com

[3]István Henzsel, University of Debrecen, IAREF, Research Institute of Nyíregyháza, Nyíregyháza Westsik V. út 4-6, Hungary
Phone: +36 42 594 305
E-mail: henzsel@agr.unideb.hu

[4]Marianna Makádi, PhD, University of Debrecen, IAREF, Research Institute of Nyíregyháza, Nyíregyháza Westsik V. út 4-6, Hungary
Phone: +36 42 594 306
E-mail: makadim@gmail.com

Contact person
[2]Ágnes Hadházy, PhD, University of Debrecen, IAREF, Research Institute of Nyíregyháza, Nyíregyháza Westsik V. út 4-6, Hungary*
Phone: +36 42 594 304
E-mail: hadhazy@agr.unideb.hu

A measurement of physics school leaving exam in the wine cellar

I. Beszeda[1,*] - T. Stonawski[2] - Á. Béni[3]

Abstract: Concepts of electrical conduction of liquids, electrolyte, anode, cathode, and electrolysis appear as early as 8th grade in primary school. Students carry out an experiment on water conductivity according to which distilled water does not conduct but can be made a conductor by adding some salt. A simple circuit in the experiment requires a battery, wires, a small bulb or an LED lamp. In high school, at grade 10, students encounter the above experiment again. Students' interest can also be attracted by examining tap water or different mineral waters, how much their conductivity differs and whether there is a correlation between the amount of minerals and the electrical conduction. We can study the conductivity of other soft drinks, and even spirits, too, so we inevitably meet wine, which produces considerable electrical conduction due to the anions, metal ions, metal compounds, and acids it contains. According to the literature, measurement of the specific electrical conductivity is also used to test the stability of wines. In this paper, we deal with the electrical properties of wines using simple measurement method that is used in high school as well.

Keywords: wine, electrical conductivity, measurement, electrolyte, water, school

1 INTRODUCTION

Concepts of electrical conduction of liquids, electrolyte, anode, cathode, and electrolysis appear as early as 8th grade in primary school. Students carry out an experiment on water conductivity according to which distilled water does not conduct but can be made a conductor by adding some salt. A simple circuit in the experiment requires a battery, wires, a small bulb or an LED lamp [1].

The electrical conductivity can be attributed to the charge carriers, Na + and Cl- ions, which are able to move after the dissolution of the salt crystals. When sugar is dissolved, no electrical conduction is observed because sugar molecules does not dissociate. We get the same experience with solutions of alcohol. Examining tap water, a slight conduction can be measured, which can be explained by the dissolved salts contained [2].

In high school, at grade 10, students encounter the above experiment again, but of course, expanded and detailed according to their more extensive knowledge.

Carrying out the above experiment to tap water can make the "standard" distilled water example much more practical. Students' interest can also be attracted by examining different mineral waters, how much their electrical conductivity differs and whether there is a correlation between the amount of minerals and the electrical conduction. We can study the conductivity of other soft drinks, and even spirits, too.

When we start dealing with solutions, we inevitably meet the drink called wine, the king of solutions (and in addition, the formula for alcoholic fermentation is also derived from Gay-Lussac, who is known for the Gay-Lussac's law). Wine is an aqueous-alcoholic solution of about 2,500 (organic and inorganic) components resulting from numerous processes [3]. Although an alcoholic solution is a very poor conductor, the anions, metal ions, metal compounds and acids in the wine produce acceptable electrical conductivity.

According to the literature, measurement of the specific electrical conductivity is also used to test the stability of wines. "Conductivity is a parameter that depends on the ion concentration of the medium, so the precipitation of ions in the form of a salt causes a change in conductivity that is measurable. The extent of the change depends on the temperature "[4]. Thus, physical experiments with wines is not new. Based on the measurement results, winemakers can intervene in practice in the structure of wines in a timely manner, thus increasing their stability.

Dealing with wines as special electrolytes is certainly remarkable. The topic should not be ruled out, as the health-protecting substances of wine and the mechanisms of their action have been known (or should be mentioned) and wine have been part of our culture since ancient times. We deal with the electrical properties of some Hungarian wines in this paper, using a simple measurement method that is used in the secondary school as well.

2 THE MEASUREMENT

One of the tasks of school leaving exam in physics deals with the electrical resistance of electrolytes [5]:

"Investigate the current consumption of the circuit with incandescent lamp and electrodes as a function of the immersion depth of the electrodes immersed in the water. Take the measurement with hot and cold water! " (See the left side of Figure 1, without lamp.)

Based on the evaluation of the measurement results, it can be said that the specific conductivity of tap water (exponentially) increases as a function of temperature, in contrast to metals. In case of metals, the more intensely vibrating lattice atoms make the flow of electrons more difficult, while electrolytes are second-type conductors, that is, not electrons but the ions play role in the electrical conduction. Ions are significantly larger in size than electrons, and their mobility is strongly influenced by the viscosity of the liquid, which decreases with increasing temperature. Overall, the electrical conductivity (σ) of electrolytes depends on the temperature (T), the charge of the ions (q) and their mobility (μ) at a constant voltage between the electrodes:

$$\sigma(T) = n(T)q\mu(T) \qquad (1)$$

Assuming a Boltzmann distribution, the electrical conductivity depends on the temperature (based on the

temperature dependence of n and μ). It can be seen from Eq. (1), that the more complex an electrolyte is, i.e., the more ions and molecules it contains, the more difficult it is to estimate its conductivity in advance, since the concentration, the diffusion, and even the composition (caused by dissociation) can vary as a function of temperature. Nevertheless, it is exciting to study "real" materials that we often come across and are also curious about their structure.

Our interest in the topic (measuring the conductivity of wine) began when, in the wine cellar, the wine splashed on the pump switch while the red wine was being pumped off with an electric pump. We consulted immediately as to whether wine conducts better than tap water (see Figure 2 later)? Good question! There was a lot of humor, curiosity and of course physics on the subject. We want to share these with readers now.

Measurements were performed as described in the school leaving exam, except that no incandescent lamp was used and the electrodes were immersed in alcoholic beverages instead of water (for the actual measurement setup, see the photo on the right of Figure 1). In a certain 150 ml beaker, the liquids were filled to level 100 and the electrodes were immersed to tuch the bottom so that the immersion depth was 50 mm (the width of electrodes was 29 mm, electrode spacing 12 mm).

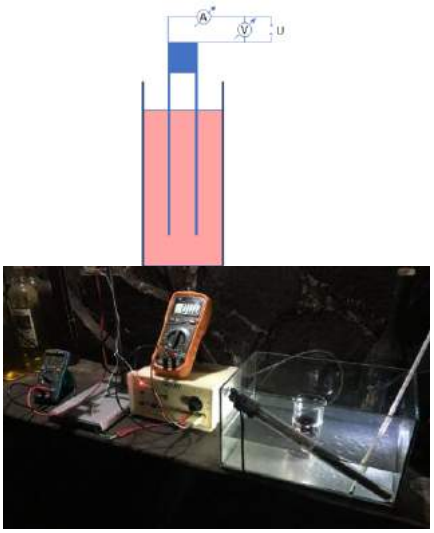

Fig 1. On the left: the circuit diagram. On the right: the circuit assembled in the wine cellar with the water bath.

In our first series of measurements, the specific conductivity of several alcoholic beverages was determined, and the obtained values arranged in ascending order in Fig.2.

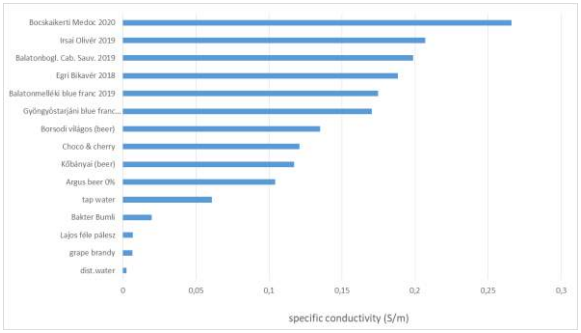

Fig 2. Conductivities of distilled water, tap water and various spirits in ascending order.

The worst electrical conductor is the distilled water, then brandies, followed by tap water, beers, and finally wines. An interesting exception is the "Chocco" spirit, which took on a "more prominent" place probably because of the citric acid it contained (indicated on its label).

In the next series of experiments, we were interested in whether conductivity is directly related to acidity, so pH measurements were carried out as well; the results are presented in Fig.3. From the graph, it can be said that the pH of beverages is an influencing factor in electrical conduction, but upon detailed study we can see that there is no close relationship between their pH and conductivity: more acidic wines are not necessarily better electrical conductors. One of the most acidic wines was the Gyöngyöstarján blue Frankish (from Bocskaikert), but its conductivity was still the lowest among the examined red wines. In general, it can be said that the acid content of the wines ranged at roughly the same level (pH 3.4–3.8), yet strongly variable conductivity was measured. Outstanding σ-values were obtained for Hungarian sand wines, but what ion(s) may have caused this, further investigation was needed to find out: we had to use certain testing methods (see later). The conductivity of the nearly neutral Törkölypálinka, which had a pH of about 7, was minimal, while the more acidic "Lajos szilvája" brandy produced higher conductivity. The relatively good conductivity of the Chocco spirit drink may have been due to the added citric acid (pH = 3.3).

It has to be noted that the error of the specific electrical conductivity increased from 0.01 S/m to 0.02 S/m with increasing specific conductivity in Fig.3.

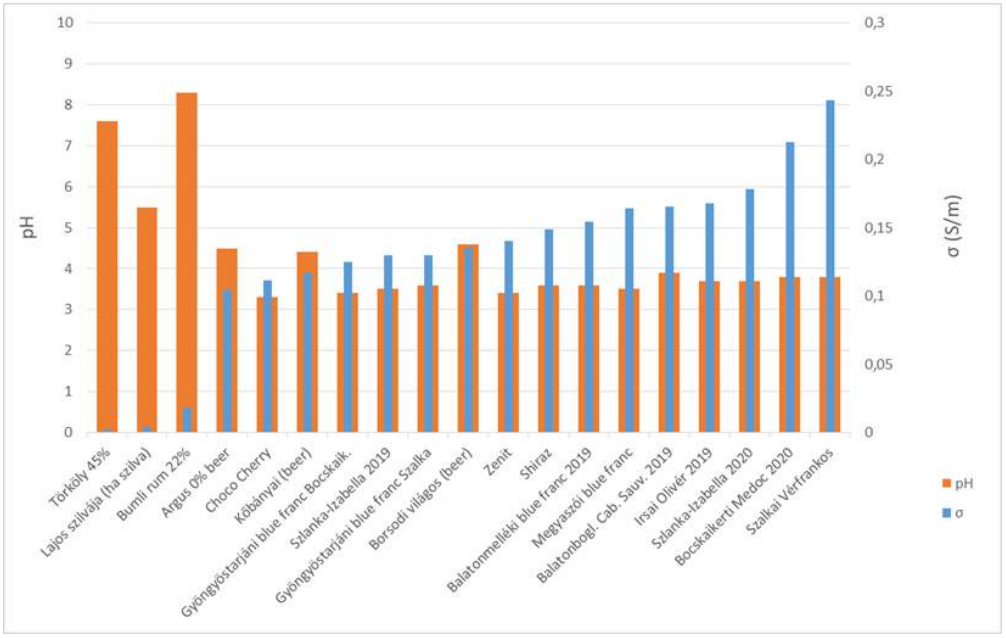

Fig. 3. pH and specific conductivity of the beverages tested in our measurements (at 12.5 °C).

The graph in Fig. 3 shows the pH values and conductivities measured at a given temperature, but it can be seen from Eq. (1) that these values must vary at different temperatures. Therefore, the experiments were extended to different temperatures. Temperature of the wine samples were regulated by using the water bath shown in Fig. 1, and then measurements were repeated with some samples as detailed above. The results of the measurements are shown in Figures 4a and 4b. An exponential increase in conductivity as a function of temperature was observed in Fig. 4a, as suggested by Eq. (1), while the exponential-like behaviour cannot be observed in Fig. 4b due to the narrow temperature range. The pH values decreased as a result of heating (since the heating promotes and accelerates the oxidative processes: the alcohol is converted into an organic acid in the presence of air). Based on the literature, we also plotted a line characteristic of stable wines in the Fig. 4b, so comparing the graphs of the wines we examined, we can say that they also have sufficient stability [4].

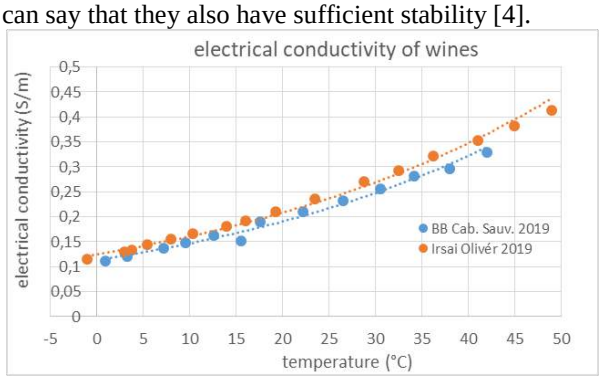

Fig 4a. Results of specific cunductivity measurements on two wine samples (red wine: BB Cabernet Sauvignon; white wine: Irsai Olivér) in a wide temperature range.

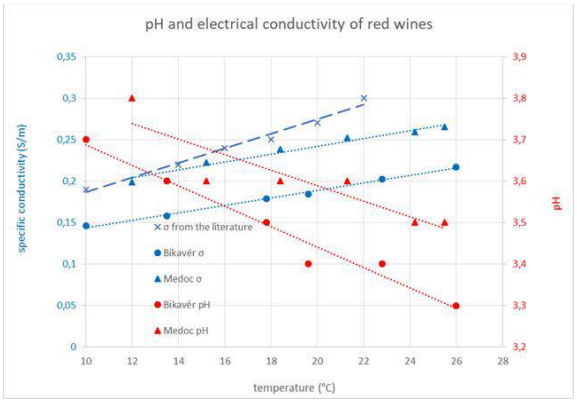

Fig 4b. Results of measurements performed on two different red wine samples (Bull's Blood and Medoc): pH and electrical conductivity as a function of temperature. Literature σ data are taken from [4].

3 EMPIRICAL INVESTIGATIONS

After(!) having the measurements completed we carried out empirical examinations, too, with the samples. Since the "measuring instrument" in this case is the taster person himself, his subjectivity makes it difficult to form an objective, generally valid opinion. To achieve the most efficient wine tasting, we provided the following conditions [6]: the wine-tasters were in the best possible physiological condition (mental and physical freshness, meals at the right time and quality), we provided the best environment (suitable wine cellar) and the expected best condition of the wine to be tasted (temperature 12-16 °C). The no. of tastings did not exceed 15, where the ingestion of a small sip has not yet compromised our objectivity.

Briefly summarizing our experiences:

The Irsai Oliver: muscat and pear aroma (probably due to molecules formed during cold fermentation),

characterized by a light, high degree of minerality, its acids were harmonic.
The BB Cabernet Sauvignon: strawberry-scented (it is more of a rosé wine scent), watery, stronger minerality is felt at first, varietal characteristics appear on the second sip, medium astringency in the final taste (we expected stronger from the variety).
The Balatonmelléki blue Frankish: harmonic, but characterized by constant acids, it lacks the final acidic "whiplash" (we don't remember anything else)
Comparison of empirics and measurement: empirical results correlated well with the measured pH values, confirming the "presumed acidity sensor" of the tongue [7], but unfortunately we do not have such a sensor to detect conductivity.

4 MEASUREMENTS WITH SCANNING ELECTRON MICROSCOPY

To investigate the outstanding conductivities of sand wines not justified by the measured pH values, we wanted to investigate the composition of the wines. It has been suggested that the presence of various naturally occurring metal ions [3] in wines also has an effect on the electrical conductivity. For these further investigations, we used an energy dispersive X-ray spectroscope (EDX) in a Hitachi SU1510 scanning electron microscope available at the University of Nyíregyháza, which is suitable for determining the elemental composition of the sample.

In order to place in the specimen chamber, the specimens were placed on sample holders. The instrument can only measure solid state specimens, which were prepared by evaporation of the wines: the aluminum specimen holders were wrapped around with plastic tape to be able to fill them "high" with the wines and then waited for the liquid to evaporate. This was repeated several times to form thick, dry layers of wine. The obtained specimens are shown in Figure 5.

Fig 5. Solid wine samples on the specimen holders: 1 - Bocskaikerti Medoc 2020, 2 - Gyöngyöstarjáni Kékfrankos (fermented in Bocskaikert) 2020, 3 - Balatonmelléki Kékfrankos 2019, 4 - Hilltop Neszmély Irsai Olivér 2019

The X-ray detector can calculate the chemical composition only in the case of point analysis, so spectra at several (seven) randomly selected points were collected for each sample and averaged the composition values obtained. As an illustration, Figure 6 shows one of the spectra taken from the wine sample 1.

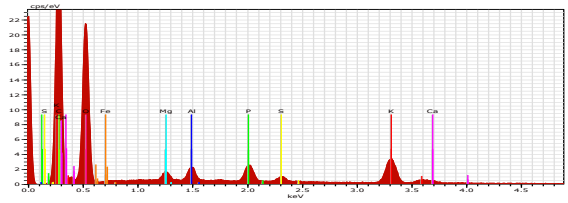

Fig 6. EDX spectrum at one point in Sample 1. The vertical lines indicate the elements that occur at that particular energy. The quantity of a given element can be determined from the "size" (area) of the peak.

Quantities of the elements can be determined from the "size" (area) of the peaks, the evaluation is done automatically by the system. (It is worth noting that according to the literature, the amount of metal ions in wines is usually very small - we also obtained tenths of a percent (at%), and this method has a very large error for such small amounts.)

High levels of carbon and oxygen indicate the presence of organic matter in the dried wine samples.

As the most important result of the tests, we can state that among the examined wines, the potassium content of the sand wine Bocskaikerti Medoc (sample 1) and Neszmélyi Irsai Olivér (sample 4) also showed outstanding values - in accordance with their outstanding conductivities.

5 CHEMICAL LABORATORY RESULTS

The electrical conduction properties of the wine are also strongly influenced by the content of metallic ions. The main elements in wine (10-1000 mg/l) are three metals: K, Mg and Ca, but also some other metals (1-10 mg/l) have to be mentioned (Na, Fe) [3]. As these are the most common metals in wine, they may be the most important in terms of electrical conduction. In order to determine more accurately the element content (due to the mentioned large error of the electron microscopic measurements), we sent the wine samples to a chemical laboratory (at the University of Debrecen), too.

The wine samples were prepared by microwave wet destruction. For this, a CEM Mars 6 destroyer was used with 2 ml of wine sample and 5 ml of 67% (w / w) nitric acid. After the destruction, the samples were diluted to 25 ml with deionized water.

The K and Na contents of the destructed samples were determined by flame emission spectrometry (FES), while for Ca, Mg and Fe by flame atomic absorption spectrometry (FAAS). These determinations were performed with a Thermo Fisher iCE 3300 instrument. The analyzes were performed in triplicate.

These recent measurements confirmed the results obtained by electron microscopy and showed a clear correlation between metal content and conductivity, as can be read from Figure 7. Detailed studies also showed that Bocskaikerti Medoc had a very high Potassium content (> 1600 mg / l), which may have been responsible for the higher conductivity. The K-content of the soil is basically determined by the soil-forming rock (K-rich feldspars and mica) and the more important K-

binding clay minerals [8]. As the potassium content decreases continuously during must fermentation and winemaking activities, the K content of sand wines can be attributed to the soil properties.

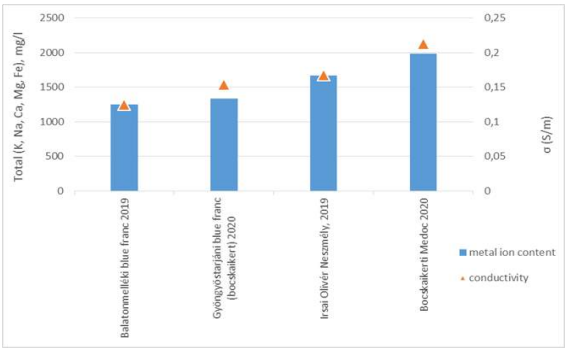

Fig 7. A common diagram showing the metal contents (examined for the five most important metals) and electrical conductivities of selected wine samples.

6 MEASURING THE ELECTRICAL CONDUCTIVITY OF SOLUTIONS IN SCHOOL

In the introduction, some experiments have already been mentioned that students can carry out even in the elementary school. From the experiments we can generate simple measurements. Instead of electric conduction it is better to calculate the resistance so that schoolchildren can apply their knowledge on Ohm's law after current and voltage measurements. The concentration of the salty water can be adjusted using a kitchen scale, so even the change of the resistance of the solution can be investigated as a function of concentration.

In secondary school measurements, the composition of beverages can be deduced from examinations of the electrical conductivity of mineral waters and other liquids. It can be an interesting series of measurements if the students live in students hostel, ie they come from different geographical places: by measuring the electrical conductivity of domestic tap water, they can study the local variations of the composition of drinking water, too. This indirect experience can be understood as a kind of abstraction, the presence and concentration of certain ions can be deduced. Oral presentation of different investigation techniques of soil composition (for example electrical conductivity measurements) can be their task, as well.

Of course, it is worth to investigate solutions first with the simplest possible compositions, and dealing with multicomponent systems is allowed only after the basic measurements. This is why wine was choosen as a final goal in the present paper, a solution whose examination went beyond physical examinations. In order to find answers of additional questions arosed during the analysis of the data, we had to call on the help of a chemical laboratory.

Finally, it was very exciting to work with wine, to notice how much it differs from other spirits, which is, without a doubt, one of the basic definitions of wine culture.

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Authors addresses

[1]Dr. Imre Beszeda, *University of Nyíregyháza, Institute of Engineering and Agricultural Sciences, H-4400 Nyíregyháza, Sóstói Str. 31/b. Hungary,* beszeda.imre@nye.hu

[3] *Dr. Áron Béni, University of Debrecen, Faculty of Agriculture, Food Science and Environmental Management, Institute of Agrochemistry and Soil Science, H-4032 Debrecen, Böszörményi út 138. Hungary, beniaron@agr.unideb.hu*

Diagnostics of internal accretions in the processing industry

Assoc. Prof. Univ. Dr. Ec. Vasile BÎRLE[1]

Abstract: The desire of the managers of processing enterprises, the ones that produce added value, is related to the increase of patrimonial accretions. Any patrimonial accretion is possible if the requirements of economic and financial balance are met. In modern economies, the state of balance is increasingly and strongly influenced by the fluctuations of the specific markets' aggregate demand and supply that influence in an unforeseeable manner the temporary accretion mechanisms of the so-called "player enterprises" on those specific markets. Any vibration of the markets is automatically taken over by the entrepreneurial system and is directly experienced by the economic processes. The identification of the initial moments of economic and financial loss of balance may be achieved with the aid of diagnostic analysis instruments. Knowing the initial moment when exogenous factors exert their influence on the economic and financial mechanisms of the added value producing enterprise is of special importance to the management. The action moment of the factors leading to balance loss is marked by the diagnostic based instruments represented by relevant economic and financial indicators. The values of these indicators are also the results of diagnostic analysis and they represent, by themselves, the argument on which the decision process of balance deviation correction is based. Maintaining a positive trend of patrimonial accretion by the managers of the processing industry, in the context of substantial fluctuations of specific markets, is an increasingly hard task to accomplish. Managers ask the economic and financial analysts to provide mechanisms able to identify the starting point from which balances may be compromised. The diagnostic analysis comes up with a solution and with effective assistance to the managers of the processing industry, supporting their efforts to increase their patrimonial accretions even in the context of specific market fluctuations.

Keywords: analysis, diagnostic, indicator, instrument, procedure

1 INTRODUCTION

At the end of 2020, the European market had over 20 million entrepreneurs in the private sector, with over 200 million employees, of which 25% work in the processing industry with a quarter of them performing activities related to it and relying on this sector.

The processing industry is the engine of the innovation processes but also the main solution provider for the issues that affect society in its entirety. Form this perspective, productivity within the processing industry and its associated services is both a purpose and an aspiration regarding aid for jobs, health and economic sustainability in the European context.

The economic crisis and the financial recession that started in Europe at the beginning of 2009 have brought up to the entrepreneurial way of thinking the fundamental importance of maintaining the integrity of the industrial processing value chain. Along with the economical revival and the restoration of financial balances, the entrepreneurial trend is directed towards strategies that are able to generate added value, part of an integrated and autonomous industrial policy, capable of increasing patrimonial accretions by generating the economic and financial stimuli needed to uphold jobs and incomes.

With over one million employees, the Romanian processing industry gathers most of the employees of the private sector, some paid better than others. For the number of employees in this sector to increase, conditions for better salaries should be created. The incapacity of employers to raise salaries is related to the general non-fulfilment of two parameters on which this operation is based: productivity and added value.

The aim of the paper is to provide the managers of the processing industry with a diagnostic analysis instrument able to emphasize the structure and the rates of patrimonial accretions, the ones that allow the achievement of a substantial and sustainable salary increase.

2 INDICATORS FOR THE MEASUREMENT OF PATRIMONIAL ACCRETIONS

According to Prof. Vasile Robu, the important aims of patrimonial analysis should be established by starting with the net patrimony, the indicator that shows the assets of shareholders, and by proceeding subsequently with the"*description of patrimonial items*".

From a legal stanpoint, an interesting definition is found in the Civil Code of 1864, art.1718: „*any individual who is personally compelled to accomplish his/her duties with all his/her assets, movable or immovable, present or future".* The actual civil law defines patrimony as "*The duties, the movable and immovable assets, present or future…". From an economic standpoint, the complete definition of patrimony is found in the object of accounting, art.12 (1): "… the reflection in money expression of movable and immovable assets, including the ground, the natural resources, the deposits and other commodities with economic potential...".* Essentially, the opinions of theorists, legal professionals or economists, converge towards the essence of the concept of patrimony: *tangible and intangible assets that form the wealth of a natural or legal person.*

We may state that the the patrimony of an enterprise points at the tangible and intangible accretions

expressed in money units, abiding by the market conditions of acknowledgement. The *market acknowledgement of patrimonial items* component makes a clear distinction between the patrimony of economic units and the one of natural persons.

According to its quality and quantity related aspects, the patrimony may be expressed with the aid of three indicators, three instruments of disgnostic analysis: net assets, added value and work productivity.

a) ***Net assets*** *indicates the net value of patrimony, namely the financial value of the enterprise's wealth (At), absolved of any kind of obligation or duty (Dt)*

$$AN = A_t - D_t$$

The positive result of the dynamic analysis indicates the degree of quantitative valorization of the enterprise:

$$AN_1 > AN_0$$

The degree of quantitative valorization is in a proprotional reliance relationship with the fixed and current assets, when confronted with the total debt. The category of assets include fixed and current assets and the category of debts include the obligations undertaken by the enterprise in relation with the credit system, the state, the providers, the employees, etc.. Each of these active or passive components influence in a direct and proportional manner the size of net asstes.

b) **Added value**, *also identified as qualitative accretion rate of the of the patrimony or the effect of the endogenous effort directed towards reaching general efficiency.*

Added value is one of the indicators employed by diagnostic analysis which expresses the wealth that was newly created by the enterprise within a determined time span. Economic analysts have identified several added vlaue calculation methods, varying according to specific enterprises and sectors of the national economy. Each method is applied in compliance with the analysis related interest.

For this paper I have chosen the cumulative method of component factors as it is relevant from the standpoint of the identification possibility of the participation level of each item that contributes to the added value (Qa). This method requires the summing up of the human factor contribution (Fs) with the net profit (p), with the depreciation (a), with the payments to the state representing taxes and duties (It) and with the customs taxes for imports (Iv), as follows:

$$Qa = \sum Fs + p + a + I_f + I_V$$

The advantages of the employed method:

✓ *indicates the way in which the influence of the exogenous factors generated by the specific market is being perceived by the enterprise;*

✓ *is the main assessment criterion of the sustainable growth of enterprises, due to the fact that the growth rate of the turnover is less realistic;*

✓ *highlights the intergration degree of an enterprise when compared to the volume of achieved production (Q) or to the turnover (CA);*

✓ *facilitates the achievment of some horizontal comparisons between various players of the same market;*

✓ *reflects, to a significant extent, the efficiency of using the resources involved in the economic processes (production factors);*

✓ *indicates the workforce yield in the economic processes;*

✓ *highlights the ways in which incomes are being distributed to the employees;*

✓ *indicate the remuneration growth reserves for the employees.*

c) **Work productivity** is the efficiency measurement tool for the work performed as part of economic activities, expressed as relation between production and consumption.

Paul Krugman said that *"Productivity isn't everything but, on the long run, it represents almost everything."*

The calculation formula for work productivity (W), generally accepted by economists, is the one in which the production volume indicators (Q) are compared to the consumption volume indicators (M):

$$W = \frac{Q}{M}$$

The factors that have an influence on work productivity are:

- **technology** – the reduction of economic operations related time consumption;
- **organization** – the functioning of enterprises as an interlocking whole;
- **purposes** – the growth of the valorization degree and the patrimonial accretion;
- **motivation** –professional preparation (courses, specialized trainings, perfectioning trainings, competitions, etc.) helps increase their involvement degree at the workplace;
- **budget** – activ control of budgets.

3 DIAGNOSTICS OF PATRIMONIAL ACCRETIONS

The term "diagnostic" has its roots in the medical sector.

The mechanism of medical diagnostics is adopted by economists to identify the financial imbalances that affect the health condition of their enterprises. Such an analysis is made for the information taken from the financial and accounting documents. Once imported as samplings they are structured and grouped according to well-defined categories that will become part of the processing procedures, employing work instruments such as economic calculation, tables and graphics based reports. The processing procedure of samples is concluded when a chart of results has benn completed.

The final stage, closely related to the professionalism of the economic analyst, is the one of results interpretation, diagnostics delivery and actions to be undertaken.

Any deviation or omission from the sequence of the previous stages may have a negative impact upon the analysis process. The time required to perform the analysis should be connected to the effects of the undertaked correction actions. In order to overcome this shortcoming, partial conclusions may be issued whenever required by the specific situations. The most efficient revival actions are the ones adopted in an operative manner.

3.1 1. Building an analysis database

After having selected the work indicators (AN, Qa and W), the information on which work indicators will be assed is to be sampled. The reference period is 3 years.

Table 1. Database for the assessment of diagnostics indicators

Indicators	n-2	n-1	n
Turnover	34.971	39.678	48.167
Average payroll number	91	100	112
Expenditures with the employees	3.000	3.444	4.810
Fixed assets	18.471	19.763	25.385
Current assets	8.106	11.400	13.223
Total debts	2.631	2.575	5.259
Depreciations	3.801	3.329	4.810
Net profit	3.836	5.241	5.813
Taxes and duties	400	291	526

During the **2nd stage** the work indicators for each moment of the analysis are being calculated.
For instance, for the year n-2, the following values emerge:

a. $AN = A_t - D_t$ = (18.471+8.106)-2.631 = 23.946 thousand lei
b. $Qa = \sum Fs + p + a + I_f + I_V$ = 3.000+3.836+3.801+400 = 11.037 thousand lei
c. $W = \frac{Q}{M} = \frac{34.971}{91} = 308{,}29$ thousand lei

Proceeding with the determinations for the periods n-1 and n, we acquire the following data:

Table 2. Work indicators within the diagnostic analysis framework

Indicators	n-2	n-1	n
Net assets	23.946	28.589	33.349
Added value	11.037	12.305	15.283
Work productivity	384	397	430

A partial conclusion indicates that, for the time spread subject to analysis, each of the 3 indicators show a significant growth.

The 3rd stage involves the identification of the relation between the reference indicators and the patrimonial accretion. In this respect, there will be an assessment of the weight of indicators (Ii) within the total amount of the turnover, indicators that show the extent of the market segment occupied by the enterprise, as follows:

$$\mu = \frac{I_i}{CA}$$

Table 3. Weight of reference indicators in the Turnover

Indicators	n-2	n-1	n
Net assets	0,68	0,72	0,69
Added value	0,31	0,31	0,32
Work productivity	0,01	0,01	0,01

Work indicators do not form the turnover and consequently, the summed up weight cannot have ”1” as value.

The partial results of weight determinations suggest the following:

- ✓ *a constant weight of added value and of work productivity throughout the entire analysed interval;*
- ✓ *an weight increase of net assets for the three moments of the analysis, with a peak recorded in (n-1).*

During the **4th stage** the evolution of work indicators for the analysed interval is being determined in order to obtain the argumentative elements of the diagnostics:

Table 4. Dynamic evolution of the turnover and of their reference indicators

Indicators	(n-1)/(n-2)*100	n/(n-1)*100
Turnover	113,46	121,40
Net assets	119,38	116,65
Adeed value	111,49	124,20
Work productivity	103,38	110,25

4 DIAGNOSTIC ISSUING

The aforementioned data provides, as part of a corroborated system, at least the following information that may lead to the issuing of the final diagnostics, as follows:

- ✓ The turnover has an increase of 13,46 percentage points in the year (n-1) as compared to (n-2) and of 21,4 percentage points as compared to (n-1), with an average of about 17 percent;
- ✓ The net assets, the ones indicating the degree of quantitative patrimonial accretion has grown at an average rate of 18 percent;
- ✓ The added value, specifically the qualitative side of the patrimony made of the newly created value, has an average increase rate of almost 18 percent;
- ✓ The general productivity is at a level growth level of 7 percentage points;

In order to assess the diagnostic, the information included in charts 1 – 4 will be employed as follows:

a.Net assets:

- ➢ In chart no. 2 we notice that the net assets increase throughout the entire interval, fact that allows us to state that we have ***a positive degree of enterprise valorization***;
- ➢ The weight of net assets in the Turnover is fluctuating, with a general growth tendency (chart no.2), indicating that ***the quantitative patrimonial accretion is made throughout the entire analysis interval***;
- ➢ The average growth rate is superior to the one recorded by the Turnover (chart no.4), showing ***an increase of net accretion***.

b. Added value:

- ➢ ***an absolute increase of patrimony net accretion*** (chart 2) is being noticed;
- ➢ the weight of added value in the Turnover follows a growth trend at the end of the analysis interval (chart 3), fact that highlits ***the sustainability of patrimonial build-up***;
- ➢ the rate of patrimonial acrretion, seen from the quality standpoint, is higher than the quantitative one (chart 4), situation that allows us to assert that ***the qualitative accretion is made at a higher rate than the qualitative one***;

c. Work productivity:

- ➢ records an increase in absolute values (chart 2) throughout the entire analysis interval, a ***positive aspect as far as the qualitative side of the patrimony is concerned***;
- ➢ the progression rate is inferior to the one recorded by Qa or AN (chart 4): we may assert that the enterprise has important reserves as far as work productivity is concerned.

The enterprise is in a state of balance from the perspective of quantitative and qualitative patrimonial accretion and is following a growth trend. The accretion is deemed to be sustainable. The reserves identified on the quality side (W) of the accretion indicates the direction of management decision towards the increase of the patrimonial accretion rate.

The diagnostic analysis can be an accessible and efficient instrument for the managers in the processing industry aimed at managing patrimonial accretions in an operative and efficient manner.

If the patrimonial accretion is achieved in a state of balance between the quantitative and the qualitative sides of the patrimony, the valorizing process of the business is a healthy one.

A sustainable patrimonial accretion allows enterprises to preserve their specific markets even in fluctuating circumstances.

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Authors addresses

[1] BÎRLE ,Vasile, Conf. univ. dr. ec, Technical University of Cluj Napoca, Baia Mare NORD University Center.,vasile.birle@imtech.utcluj.ro

Improvement the safety device of a feed baler

Ceclan Vasile[1,*] Besoi Nicolae [2] Grozav Sorin[3]

Abstract The main purpose of this work is to modify the safety system of the feed baler, existing on it, with an equally safe system, but which has certain advantages during operation. Safety systems are very useful because they prevent the destruction of mechanical parts of the machine and the baler, but also prevent injury to the operator. To arrive at a suitable technical solution, several types of finite element analysis were performed, and it was concluded that for this type of feed baler, the centering pin device is a recommended device. In choosing this device, the machine that transmits the movement, the surface of the land where the fodder collection takes place, the operating time of the fodder baler considered.

Keywords: Safety Device, Feed Baler, Finite element method

1 INTRODUCTION

Automation in balloons, as well as handling and transport are very interested in the agricultural sector [1-4]. The purple this paper is to improve the Maschio FERABOLI Entry 120 feed baler. This machine is very useful for feed processing, it is worked with during the collection of fodder, many hours a day. This is the main reason why at the time of its failure, it is very important that the repair time is as short as possible.

At the same time, the safety of the machine must be considered, but also the safety of the operator on the machine. For this type of press, a machine with a minimum power of 50HP is required. The compaction of the bale is done up to a pressure of 150 bar. To improve reliability, safety factors for the feeding device were calculated using FEM simulations at different values of displacement and throughput. The variation of mean force was determined with safety factor of 1.3.[8]

Figure 1 shows the feed baler and the machine that operates this press.

Fig. 1. Maschio FERABOLI Entry 120 feed baler

Figure 2 shows the main features of this baler. The Maschio FERABOLI Entry 12 feed baler has a length of 3560, a width of 2050, and a height of 2510. The unit for taking over the raw material is 2000mm. This press has a hydraulic compression. The size of the bale having a length of 1200 mm and a diameter of up to 1200 mm. The opening of the machine is done hydraulically, with automatic control, from the machine cabin.

This machine is productive, making 30-40 bales in one hours. A cylindrical feed bale can weigh up to 200-400 kg depending on the feed. The handling of these bales will be done with the help of a front loader.

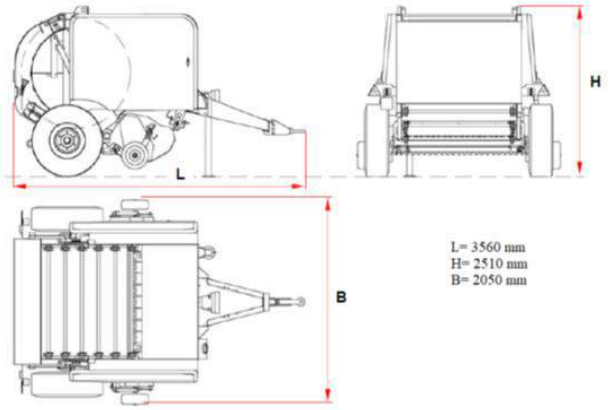

Fig. 2. The main features of the feed baler

2 SAFETY DEVICE

This baler is equipped with a torque-limiting clutch safety device. Determination of the couple and power required for bale and packaging was carried out by researchers [5-6]. The role of this device is to stop the movement transmitted from the machine to the press when the pressure in the threshing press increases above the limits. This device prevents damage to the machine, or injury to the operator. This device is shown in figure 3.

Fig. 3. Safety device with torque limiting clutch

This device is attached to the cardan shaft, from the machine, shown in figure 4.

Fig. 4. Cardan Shaft

The cardan shaft has the role of transmitting the rotational movement to the reducer in the baler. This spindle moves the entire machine by means of the power take-off from the machine.

For it to reach working speed, the cardanic shaft must rotate at 540 rpm, this rotation being created by the transmission of the machine at an engine speed of 1750 rpm.

Figure 5 shows the new type of safety device with pin.

Fig. 5. Safety device with pin

Unlike the first safety device, it has a great advantage, because the time in which it is rearmed is much shorter. The scissor pin has a simple construction, and the rearmament of the safety device is very simple.

At the top of this device, you can see the pin slot. Figure 6 shows the mounting of the pin device on the cardanic shaft.

Fig. 6. Cardan Shaft with safety device with pin

3 FINITE ELEMENT ANALYSIS OF THE PIN

By finite element analysis of the pin, an engineering study is performed, which determines whether the chosen solution is one that responds to mechanical stresses.

This pin is subjected to shear stresses that occur during the rotational movement of the cardanic shaft.

The design of the pin was done in the SolidWorks program, and the analysis with finite elements was made in SolidWorks Simulation. In figure 7 it is presented the 3D model of the pin.

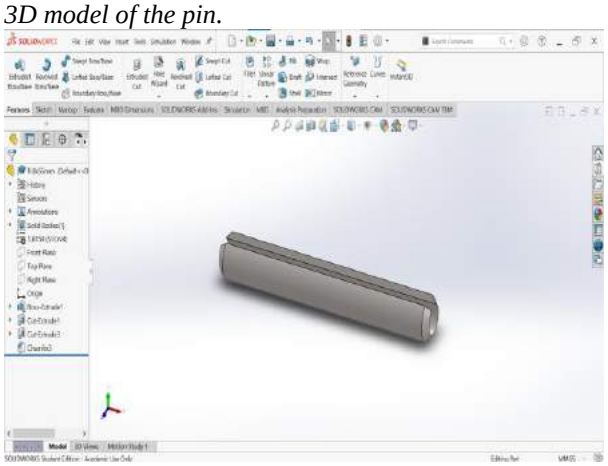

Fig. 7. 3D model of the pin

This pin has a length of 55 mm and a diameter of 8.8 mm. The material used was 14CrV4, in order to have mechanical properties that meet the conditions of breaking the pin. This can also be seen in figure 8.

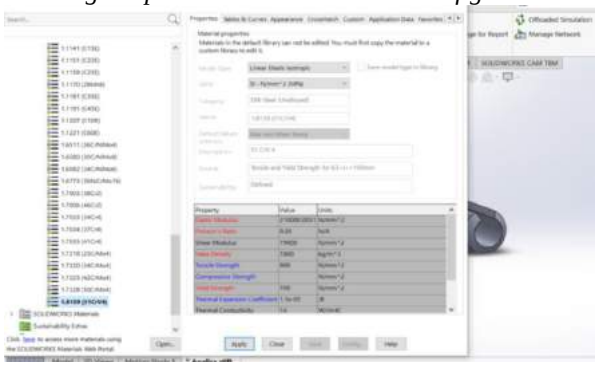

Fig. 8. Material of the pin

The next step in finite element analysis was to force-load at the model and fix it. After which the discretization of the models took place for analysis.

To obtain a more accurate analysis of the 3D model, the discretization was performed by dividing it on the minimum area into at least 3 elements. The solution obtained through Solid Woks Simulation is an approximate solution, very close to the real solution. With the help of this analysis, it is possible to determine if the material of the model is a correctly proposed one, being an easy solution to implement. In our case it is enough to have 3 elements on the minimum size, as this piece will be sheared when a high pressure appears

inside the feed baler. In figure 9 it is presented the discretion of the 3D model.

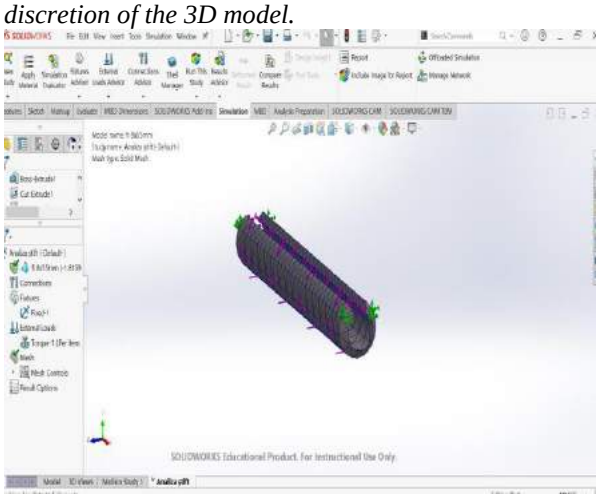

Fig. 9. Model Discretization

After performing the actual simulation, we can see what the behavior of the model during operation is. In figure 10 it is presented the von Mises stress.

Following these results, we can say that the pin subjected to stresses during operation is good.

It can also be seen that the stress inside of the material increase from 52.5 N/mm^2 to the maximum stress it reaches at 348.9 N/mm^2 . The maximum value of stress for this material it is 700 N/mm^2.

Another analysis performed in this study was the analysis regarding the deformations inside the model. This is also shown in Figure 11. For this type of analysis, our model reached a displacement of 3,394 mm in the middle of the pin. This displacement is obtained in the most unfavorable case, so we can say that the pin corresponds to this analysis.

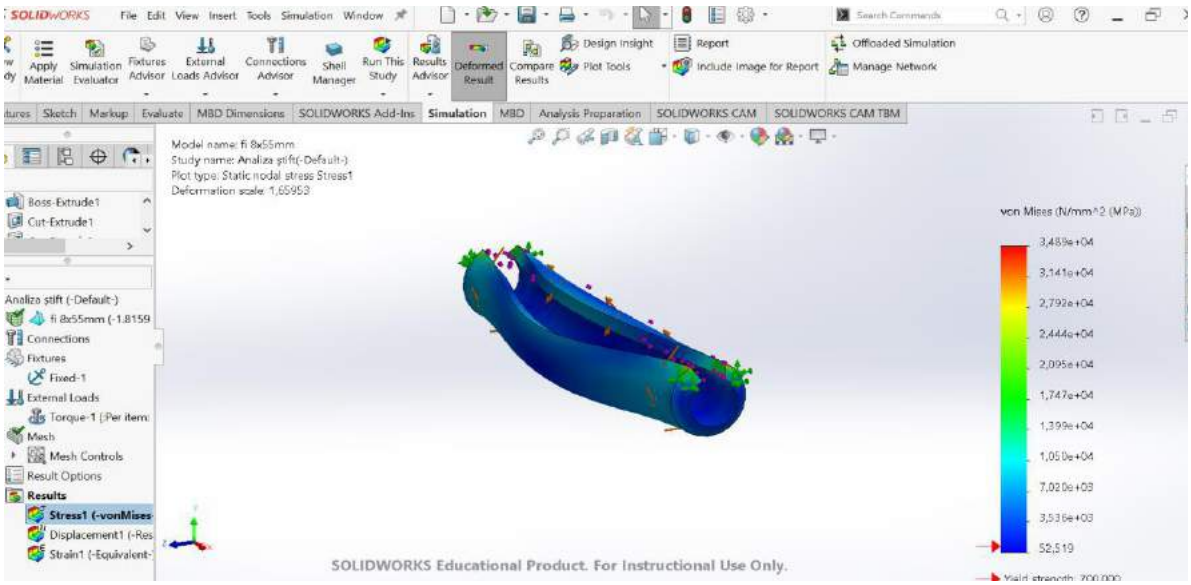

Fig. 10. Stress von Mises

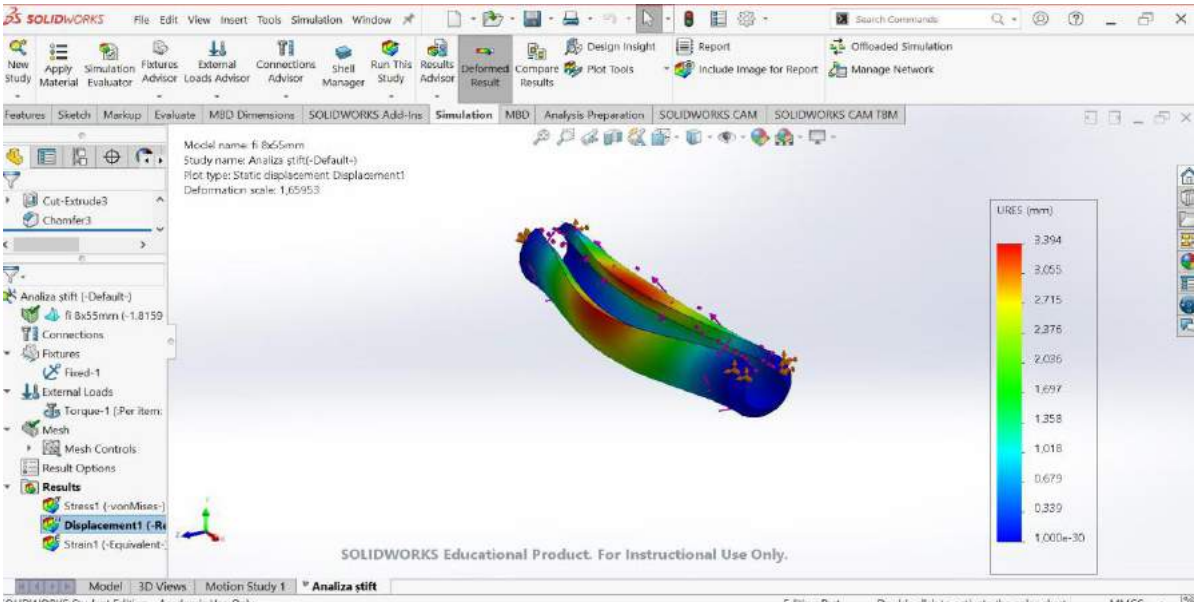

Fig. 11. Displacement of 3D model

4 CONCLUSIONS

The use of safety devices for the PTO shaft is not recommended, it is a necessity. Because when there is a problem, the mechanical parts of the machine do not fail.

The correct operation of these devices also saves money, by stopping the machine question before the failure of the mechanical parts, but they can also save the operator's injury.

Feed balers manufactured in recent years, have in their component safety devices of several types.

The great advantage of the safety pin device is the economical one. The cost price of a centering pin is about 1 euro, while the replacement of the clutch disc is about 80 euros. These replacements do not appear at a precise time interval, which is why they are not replaced during maintenance operations.

Another advantage from an economic point of view is that the replacement of the pin requires a much shorter time than in the case of replacing the clutch. This operation can be done by a person who is not very qualified. Regardless of the nature of the shock that appeared in the machine or in the baler, the pin protects both machines.

Another positive thing about replacing the clutch device is that during operation it does not appear to decrease the speed of the PTO shaft. This phenomenon occurs due to excessive forces that occur during operation. If the shaft speed decreases, a result of a decrease in the working capacity of the machine. For this reason, the productivity of the ballot press will also decrease.

As a disadvantage when replacing this safety device, it is the cost price of the device and the replacement time of the entire device.

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Authors addresses

[1]Vasile Ceclan, Phd eng, Technical University of Cluj Napoca, B-Lv Muncii 103-105., vasile.ceclan@tcm.utcluj.ro

[2] Nicolae Besoi, eng, Technical University of Cluj Napoca, B-Lv Muncii 103-105., nbesoi@yahoo.com

[3] Sorin Dumitru Grozav, Phd eng, Technical University of Cluj Napoca, B-Lv Muncii 103-105., sorin.grozav@tcm.utcluj.ro

Contact person

[1]Vasile Ceclan, Phd eng, Technical University of Cluj Napoca, B-Lv Muncii 103-105., vasile.ceclan@tcm.utcluj.ro

Examining the vegetarianism among Hungarian intellectuals, forecasting possible further growth

Judit Csabai* - Béla Szabó – Ágnes Szabó Tarczaliné-Mária Szanyi –Edit Kosztyuné Krajnyák

Abstract: We all feel that vegetarianism is spreading in Europe and beyond. Several countries have begun to research the causes and factors of the spread, but in many countries, such as Hungary, the available data are incomplete. Our research plan did not aim to clarify the basic data, but would have examined the question of what effect this spread may have on the structure of agricultural production and whether changes can be predicted. However, as we could not find adequate basic information, we decided to conduct a quick survey in which we can get an idea of the spread of vegetarianism in Hungary. A series of questions was sent to anonymous respondents who volunteered for the research. The questionnaires were compiled based on the results of foreign research in order to be comparable with these previous researches. At the time of publication, the number of participants in the research was 356. It was easiest to involve university graduates / university students in the research, so the results can be applied to Hungarian intellectuals the most.

According to our research, vegetarianism strongly affects the younger generation, the proportion is high in cities and among those engaged in intellectual work, the worldview is more liberal in nature, its spread is supported in part or in whole by highly educated persons, only a few reject it. If the current trend continuing, and a significant proportion of the population will live in cities, and increasing the proportion of people with tertiary education to 40%, as set and targeted by the EU, will continue to contribute to the spread. The spread of the movement is also aided by its strong social acceptance, with very few rejecting it.

We could state that based on the examined parameters, vegetarianism can be expected to grow slowly but surely.

Keywords: vegetarianism, special diets.

1 INTRODUCTION

The importance of various diets dates back to antiquity, as Hippocrates but also ancient Egyptian medicine consider it an essential tool for maintaining and healing health (GOLDBERG, 2006; HAWLEY, 2012; KARAGIANNIS, 2014). Eating restrictions can be found in all religions for spiritual or health reasons too. For a very long time, this health role of diets was paramount. In the 20th century, diets appeared whose main purpose was to follow the fashionable female ideal, i.e. to preserve or acquire a slender figure (ELMADFA 2013). At the end of the 20th century, diets that did not focus on the individual but on the purpose of the diet to protect the environment or other living things became more widespread. One such diet is vegetarianism (RUBY, 2012). Following a plant based diet can also have health reasons, as although little research is available in this regard, it is believed that the health benefits of vegetarianism have been associated with a reduced risk of obesity, diabetes, heart disease, and some types of cancer as well as increased longevity (MARSH, 2011).

According to Nezlek &Forstell (2020), food choice can be a way for people to express their ideals and identities. In particular, for those who identify as vegetarian, this label is more than just a set of dietary preferences. Choosing to follow a plant-based diet shapes one's personal and social identity and is likely to influence a person's values, attitudes, beliefs, and well-being. The available data suggest that vegetarians are more pro-social than omnivores and tend to have more liberal political views.

The plant-based diet has several levels and forms, defining 6 different forms in different literature. One end of the spectrum is type I. They consume reduced amounts of meat. A II. types of vegetarians avoid eating meat and poultry, but they eat fish, also known as pesco-vegetarians. Type III. vegetarians also avoid fish too. The IV. type vegetarians who do not consume eggs and type V. vegetarians who do not consume dairy products. At the opposite end of the spectrum are Type VI vegetarians, or vegans, who consume only vegetable-derived foods, avoiding all animal-derived food products (BEARDSWORTH AND KEIL, 1992; RUBY, 2012) (1. table).

Table 1. The type of vegetarianism

	Meat	*Fish*	*Egg*	*Dairy product*	*Plant based food*
Omnivore	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Semi-vegetarian/Flexitarian	*Occasional*	*Yes*	*Yes*	*Yes*	*Yes*
Pesco-vegetarian/Fishcatarian/ Pescatarian	*No*	*Yes*	*Yes*	*Yes*	*Yes*
Lacto - ovo Vegetarian	*No*	*Yes*	*Yes*	*Yes*	*Yes*
Ovo-vegetarian	*No*	*Yes*	*Yes*	*No*	*Yes*
Lacto-vegetarian	*No*	*Yes*	*No*	*Yes*	*Yes*
Vegan	*No*	*No*	*No*	*No*	*No*

Nevertheless, research on vegetarianism is rudimentary and the results are difficult to compare, partly because the proportion of vegetarians in the population is still low and partly because different research examines different forms of vegetarianism, so numbers do not always measure the same form. However, vegetarianism is expected to be the subject of more and more research in the coming years. This is due to the sudden jump in the proportion of vegetarians. This phenomenon is evidenced, for example, by the Economist, which called 2019 "Year of the Vegans" (BANIS 2018). *Leahy et a*l. estimate, that there are one and half billion vegetarians. Only 75 million choose a vegetarian lifestyle of their own choosing. This number will gradually increase as prosperity and education increase. The other 1,450 million are vegetarians of necessity. They will start to eat meat as soon as they can afford it. This means that the proportion of conscious vegetarians in the world is almost 10% and this proportion will increase. The topic is most thoroughly researched in Germany. According to a poll conducted by *YouGov* in 2014, 10% of the population was vegetarian and just over 1% were vegan. As a result of this very high proportion, the proportion of various meat substitutes has increased by 10-43%. A good indicator is that the revenue of *Alpro*, a company producing alternative milk replacer products, increased by 20% in 2014. However, this can also be caused by a significant increase in the proportion of milk sensitive people (STRECKER, 2016).

There has been several research on the subject in England. The results are difficult to compare because the assumptions were made differently in each. Representative surveys in England generally estimate 1-2% of the adult population to be vegans, 2-7% of vegetarians, and 3-9% of pescetarian. The rate of those who are flexitarian and/or have some desire to reduce their meat consumption was 10-34% (BRYANT, 2019).

A survey of Finnish adults repeated annually showed that the proportion who chose meat-avoiding or vegetarian lifestyles increased sharply. From 2014 to 2018, the proportion of non-consumers of red meat rose from 3.8% to 6.6%, while the proportion of those living a vegan and vegetarian lifestyle rose from 2.1% to 5.5% (NIVA AND JALLINOJA, 2018, JALLINOJA, 2020). And in Sweden, the proportion of vegetarians increased from 4% to 6% between 2009 and 2018 (DJURENS RÄTT, 2014,2018).

A recent poll conducted by Gallup has found that 5 percent of Americans saying they are vegetarian and 3 percent saying they are vegan. Both diets are more common among young people with 7 percent of those aged 18-29 saying they are vegetarian along with 3 percent who are vegan. Among those aged 30-49, the figures are 8 and 4 percent respectively. According to research, this is the more affected generation on the subject (GALLUP, 2018, MCCARTHY, 2018).

Perhaps the most comprehensive research on the subject was conducted by Vomad in 2019, an Australian-based organization. 12,814 vegans from 97 countries around the world participated in the research. The study shows that the proportion of vegans is highest among those aged 25-34 (3913 people), not far behind this value, the 18-24 (3379 people) age group. In Finland, the proportion of vegetarians and vegans is the highest, among women in the 15-24 age group, and among men aged 25-34 (NIVA & JALLINOJA, 2018).

In general, current research suggests that vegetarianism is more common in the middle-upper class than in the lower strata, manual workers consume more meat than intellectuals. The degree of education influences the propensity for vegetarianism (FRASER et al., 2000). For example, children with higher levels of intelligence 30 years later were more likely to be vegetarians in a research. (GALE, DEARY, SCHOON, & BATTY, 2007). All current research demonstrates that women are much more prone to vegan diets than men (GOSSARD and YORK, 2003).

There are countries, such as Hungary, where basic data on vegetarianism are not yet available, as no such surveys have been conducted so far on a representative sample of the population. Previous estimates in Hungary suggest that the proportion of vegetarians in Hungary may be around 1% (REISINGER, 2003). Exploration of the topic Small-scale research has been launched in Hungary with measurable results. In the previous research of Újvári *et al.* (2020) conducted in Hungary, was discovered a correlation between the level of education or the type of the residence and vegetarianism.

Statistical factors

The population of Hungary was 9.75 million in 2020. The proportion of newborn boys is around 51-52% move. The according to the basic version of the forecast is expected to be 53 years of age, the period and at the end, at the age of 61, will be the same, the ratio of two sexes. By 2070, only expected just over 100,000 people will be the deviation from the for the benefit of women. Women live longer on average than men, so their proportion within the population is increasing with age. The gap in life expectancy at birth for women and men is narrowing year by year (OBÁDOVICS, 2011).

In 2016, 21.8% of the population over the age of 20 had a tertiary education. 54.3% had a high school diploma or vocational secondary education. 26.5% have a basic degree. maximum (KSH, 2016). The proportion of tertiary graduates in society is expected to increase in the future, as a key objective of the Europe 2020 strategy,

that at least 40% of the 30-34 age group have a tertiary education degree in the European Union. Despite widespread progress towards the target, there are significant differences in the proportion of people with tertiary education, according to gender distribution and place of birth. Young women are much more likely to obtain a higher education degree in most European Member States: women with tertiary education nearly ten percentage points higher than men.

On 1 January 2014, there were 3,154 settlements in Hungary, which cover the entire country with a gap in their administrative territory and form both a territorial and a functional network. Legally, there are five categories of settlements today: village, large village, town, county town, capital. As of January 1, 2014, 346 cities out of 3154 settlements in the country (of which: 1 capital, 23 cities with county status), there were 2808 villages (of which 118 were large villages). Today, Budapest is the largest settlement among the settlements, with 525 km^2, 1.7 million people live in the area. The smallest settlement in size in terms of 1 km^2 os Remeteszőlős in Pest County, and Zala County in terms of population Iborfia with 8 inhabitants. Population concentration significant, seven - tenths of the population live in cities (a two-tenths of the capital). 3% of the population lives only in smaller villages (KSH, 2014).

2 MATERIAL AND METHODS

We started the research by compiling a questionnaire created through the google drive system. The questions were formulated on the basis of foreign research results, anticipating that our results can then be compared with international trends. An average essay or dissertation questionnaire requires at least 100 to be completed in order for the data to be considered relevant and conclusions to be drawn about society, so we tried to involve at least as many respondents in the experiment. Although we used social media to distribute the questionnaire, we did not want to rely entirely on it. We first distributed the questionnaire to former and current university students and then asked them to disseminate it further. We found several forums based on the principle of completing the mutual questionnaire. These fills helped ensure that the experiment did not remain in a narrow circle, but also reached people who were completely separated from us. The questionnaire was prepared on September 9, 2021 and sent to the first respondents. On 03 November 2021, the number of respondents to the first evaluation was 356. The experiment is not statistically representative, partly due to the number of participants and partly due to the method of evaluation.

The parameters examined were as follows:

What kind of diet do you have?

- What is the age distribution of vegetarians?
- What is the distribution of vegetarians in different habitats?
- What is the proportion of vegetarians doing intellectual and physical work?
- Is there a connection between the worldview and the vegetarian lifestyle?
- How the intellectual stratum judges the need for the spread of vegetarianism?

By 11/03/2021, 356 people had participated in the experiment and completed the questionnaire. The largest number of respondents, 31 %, were 19-25 years old, presumably university students. 19 % between 26 and 35 years, 20 % between 36 and 45 years. 46-60 year olds participated in the experiment in 18 % and those over 61 years old in 12 %. (Fig.1).

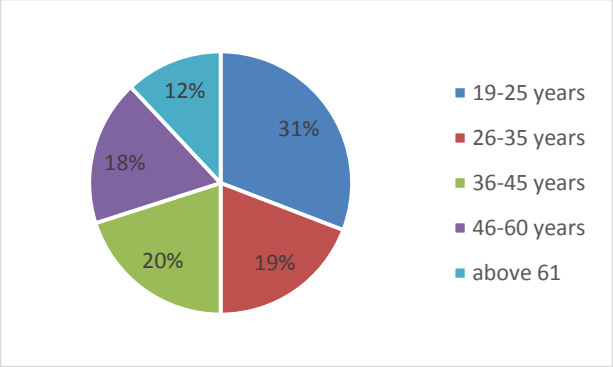

Fig. 1. Age of poll participants

73% of the respondents were women and 27 % were men. 68% of respondents live in cities, 31% live in villages and 1% live on farms.77% of respondents said they did intelleczual work while 23% said they did physical work.

Our hypotheses were as follows:

- Vegetarianism is a conscious decision, so presumably a form of eating associated with intellectuals.
- Based on the results of research abroad, we assume that young adults and university students are the most affected generations.
- As most of the intellectual work is tied to cities, the proportion of vegetarians in cities will be higher.
- If there is a link between vegetarianism and education, the rate is likely to be higher among

those doing mental work than among those doing manual labor.

- Vegetarianism, if associated with intellectual activity, can influence its development, the worldview of the individual.

3 RESULTS

In terms of age distribution, results similar to international trends were obtained. The number of vegetarians among the highly educated people is the highest in the 19-25 year olds group. 36% of vegetarians fall into this age group. It is also very high among 36-45 year olds, here the value is 27%. 26% of vegetarians are 41-60 years old. The 26-35 age group is only 14% represented among vegetarians. Over the age of 61, vegetarianism did not appear as a way of life at this stage of the experiment (Fig.3).

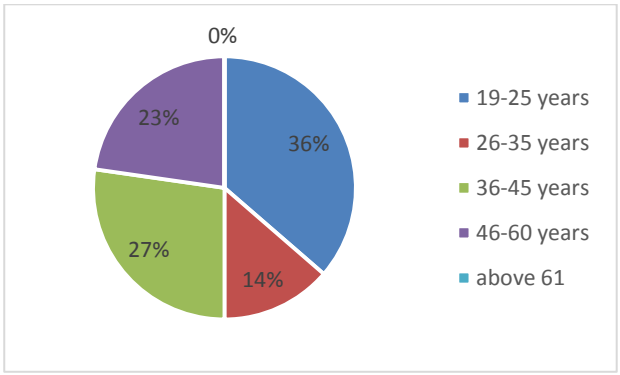

Fig. 3. Age of vegetarians

By researching the connections between habitat and vegetarianism, we can state, based on the results of a study conducted among intellectuals, 83% of vegetarians live in cities and 17% in villages. 10% of city dwellers are vegetarian, while only 6% of villagers. In our experiment, no vegetarian lives on the farm (Fig.5-6).

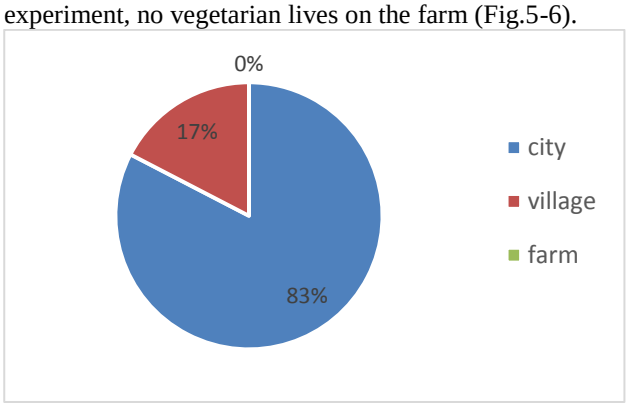

Fig. 5. Residence of vegetarians

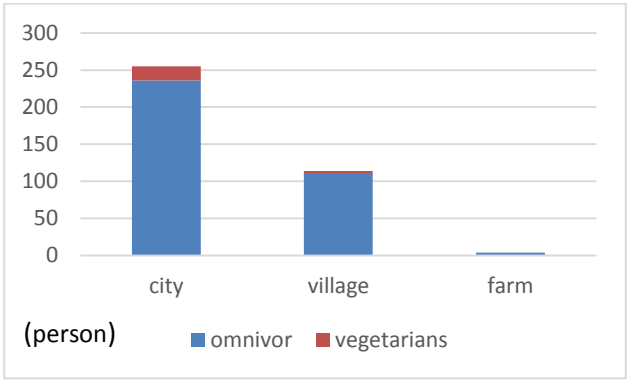

Fig. 6. Proportion of vegetarians in different residences

The proportion of intellectual and physical workers among the respondents was 79%: 21%, in favor of those doing intellectual work. For vegetarians, this rate rose further to 90%: 10% (Table 2).

Table 2. The proportion of those doing mental and physical work among Hungarian intellectuals and among vegetarians

	Rate of intellectual work/activity	Rate of physical work / activity
Hungarian graduates	79%	21%
among vegetarians	90%	10%

To the question of whether he feels the need to spread vegetarianism, 16% of respondents thought the spread of vegetarianism should be needed. 39% think the spread of vegetarianism may be necessary. 38% think it is not necessary at all and 7% would think it is particularly harmful (Fig. 7).

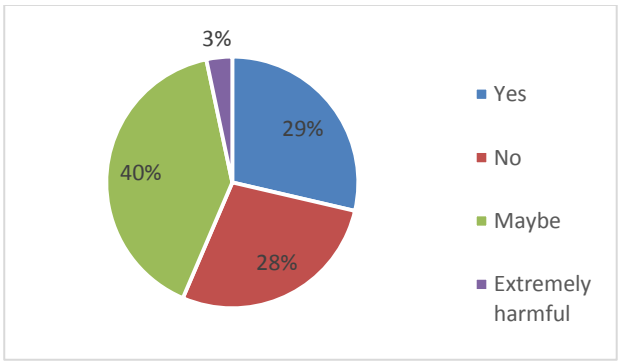

Fig. 7. Proportion of responses to the question of whether the participant considers the spread of vegetarianism desirable

In Hungary, a significant part of the people is reluctant to express their political views. This can be experienced during elections, when different polls are unable to make accurate predictions about the outcome of the election, as respondents are highly reluctant to

respond. We experienced the same thing in our experiment. 43% of respondents did not want to share their worldviews. However, it appears that 47% of vegetarians clearly profess to be liberal. Only 5% of respondents said they were conservative, while another 5% said they did not yet have a strong political view (Fig. 8)

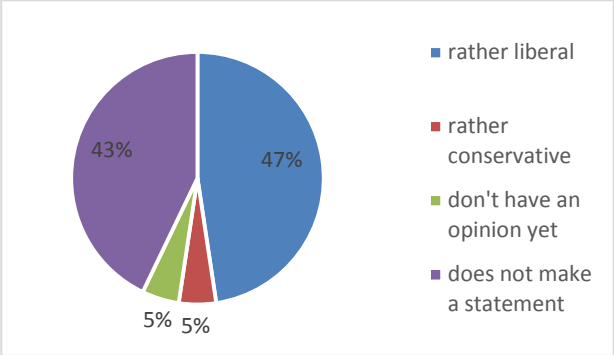

Fig. 7. Political affiliation and worldview of vegetarian respondents

4 COCLUSION

In order to determine whether vegetarianism will spread, we need to know which part of the population and under what circumstances will choose this lifestyle. The aim of our research was to find the factors that make an individual more likely to become a vegetarian.
In our experiment, the 19-25-year-old generation was the largest among vegetarians. If vegetarianism survives in this generation, as a lifestyle for a lifetime, and in similar proportions in the next generation, a significant increase is expected in Hungary as well, which could affect all sectors, including trade, industry, tourism and agriculture.

Based on our results, a significant proportion of vegetarians live in cities (83%). This is probably due to the fact that the services needed to maintain vegetarianism can be found in cities, as well as most of the urban jobs are intellectual jobs.

This result is confirmed by the fact that 90% of vegetarians do mental work.

29% of respondents think that the spread of vegetarianism would be necessary. Surprisingly, the proportion of those who believe that the need for spread is possible is very high. What's even more surprising is that very few are dismissive.

Due to the high rejection in Hungary, the political view cannot be considered authoritative as a determining factor. However, so much can be seen that liberal-minded people are more inclined to this lifestyle.

Summarizing the above, vegetarianism strongly affects the younger generation, the proportion is high in cities and among those engaged in intellectual work, the worldview is more liberal in nature, its spread is supported in part or in whole by some intellectuals, only a few reject it.

If the current trend of a significant proportion of the population in cities continuing and increasing the proportion of people with tertiary education to 40%, as set and targeted by the EU, will continue to contribute to the spread.

The spread of the movement is also aided by its strong social acceptance, with very few rejecting it.

Presumably, stronger growth can be expected in countries where liberal principles prevail. An analysis of this is not the subject of this article.

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Authors addresses

[1]Judit, Csabai , PhD, University of Nyíregyháza, Sóstói 31/b csabai.judit@nye.hu

[1]Béla, Szabó , PhD, University of Nyíregyháza, Sóstói 31/b szabo.bela@nye.hu

[1]Edit, Kosztyuné Krajnyák , PhD, University of Nyíregyháza, Sóstói 31/b

Contact person

*1Judit, Csabai , PhD, University of Nyíregyháza, Sóstói 31/b csabai.judit@nye.hu)

Effect of manufacturing orientation to surface roughness parameters of parts produced by metal selective laser melting

Gergely Dezső[1,*] - Péter Kósa[2] – Ferenc Szigeti[3]

Abstract: Additive manufacturing generally followed by postprocessing to achieve appropriate quality. Surface quality is an exceptionally important constituent of quality in industry. This why surface roughness of raw products resulted from additive manufacturing determines how much further machining is required. Test specimens were manufactured by metal selective laser melting from Ti6Al4V (ELI) material. It is confirmed that surface roughness of top surfaces are less than side surface. It is pointed out that manufacturing orientation is a highly important factor impacting properties of product. Here it is demonstrated that all statistical parameter of surface roughness measurement data of vertically manufactured test specimens are without exception less than corresponding parameters of horizontally built up ones.

Keywords: additive manufacturing,selective laser melting, surface roughness, Ti6Al4V

1 INTRODUCTION

Additive manufacturing (AM) is a rapidly developing field of production technology opening up opportunities for manufacturing parts directly from electronic body model with almost arbitrary shape, from continuously increasing types of materials. The expression "additive manufacturing" is a collective noun covering hundreds of different technologies. All of these technologies have three common steps: creating electronic body model, slicing and layer-by-layer manufacturing. First two steps are essentially common, difference in AM technologies appears in third step, which means from what material and how the real part is built up. AM technologies are classified into seven class, one of them is class of powder bed fusion. [Behzad]

Selective laser melting (SLM) is a powder bed fusion technology. Part is produced from powder melted layer-by layer. First a thin layer is formed by a blade in the tray from the powder, this determines the layer thickness. Then a laser bean scans through the surface to be melted. Powder particles melts together and melts onto the underlying, previously melted layer. This production method is applicable for several kinds of plastics, metal, ceramics and composites. Direct metal selective laser melting (DMSLM) is a powder bed fusion technology applied for metals. In this case a high power laser is necessary, and high temperature have to be reached because of high melting point of metals. Because of this accompanying physical phenomena like balling, residual stresses coming from thermal expansion and contraction, possibly failure arise characteristically, and special attention has to be payed for reduce or optimize those. [Yap, Buican]

Metal selective laser melting results in metal parts with special surface morphology and relatively large surface roughness. Changing manufacturing parameters, like laser power, scaning speed, layer thickness, hatch distance, pulse frequency or duration, production slope angle on tray is a strategy for influencing surface thickness. First issue with this strategy is that it usually leads to nonlinear response. An other strategy is postprocessing by a treatment of surfaces by additional laser melting. However this can be applied for parts with compact shape with surfaces which can be enlighted by laser beam directly. Surface modification of selective laser melted metallic parts by different technologies, like alumina sandblasting, carborundum disc polishing and ultrasonication in isopropyl alcohol were studied [Cristina]. In case of parts with trabecular structure, most part of surface is hidden inside the part, it can not be reached from outside neither by laser beam, nor by mechanical surface modification technologies like abrasive blasting or grinding. A promising and extensively studied way of surface modification of trabecular parts produced by direct metal selective laser melting is chemical etching. Chemical etching is applicable for two functions, one is removal of unmelted, but adsorbed metal dust particles, second is surface modification. It has been studied how surface roughness, structure element dimensions and mechanical properties changed by etching. It was demonstrated that chemical concentration of etching solution has most significant effect of modification of part properties. [pyka] Surface roughness of parts produced by electron beam melting technology has been studied as function os manufacturing parameters. In this case [safdar]

Surface roughness plays an important role also in medical applications. Since Ti6Al4V alloy is biocompatible, and has good mass-strength ratio, it is frequently applied for manufacturing internal orthopaedic bone implants. One of most important step in implantation is osteointegration, which means accomodation of the metal part into the human body so that bone grow onto the metal surface. This is a definitely surface process. Many kinds of proteins have to adsorb on the surface of metal, bone cells attached to the surface and then proliferation of those follows. Experiments showed that surface roughness significantly inluences cell attachment and proliferation. [Deligianni] Effect of different type of surface modifications were also studied. Osteointegration of Ti implant screws were studied. It has been shown that nano/micro nest-like and nanotube surface structures have better osteointegration ability than TiO_2 coated versions. [Liwen]

2 MATERIALS AND METHODS

Test specimens for surface roughness investigations had multiple function in a wider experiment series. We manufactured Charpy impact test specimens according to standard MSZ EN ISO 148-1:2017 with size 5 x 10 x 55 mm, and with notch 2 mm in depth and 0.25 mm of notch bottom fillet. Surface roughness of plane surfaces of test specimens were studied. Plane surfaces have the advantage from the viewpoint of measurement, because such surfaces are the most simple to study with a surface tester equipment.

Material of samples is Ti6Al4V (TC4, Ti64) alloy. In starting state it is in the form of EOS Titanium Ti64ELI powder. Then it is melted by laser of the additive manufacturing machine. Chemical composition of this powder is 5.5-6.75 wt% Al, 3.5-4.5 wt% V the balance is composed of Ti, and some elements like O, N, C, H, Fe are guaranted to be under a certain low limit. ELI means reduced content of oxigen, nitrogen, carbon and iron, containing extra low interstitials. It is often called grade 25 titanium alloy. ELI ensures higher ductility and improved fatigue resistance related to Grade 5 Ti6Al4V materials. Grade 25 titanium alloy is suitable for medical implants and devices. Size of powder particles changes in the range of 20-80 micrometer according to the data sheet [datasheet].

Test dpecimens were produced by az EOS M290/400W additive manufacturing system. Five specimens was built so that edge of 10 mm stands in vertical position, another five so that the same edge lays in horizontal position (Figure 1.).

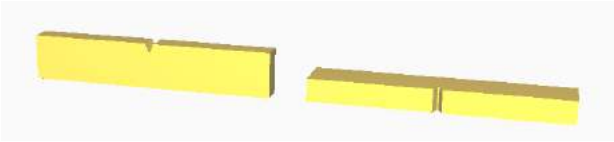

Fig. 1. Vertical *(left) and horizontal (right) orientation of test specimens in the tray of additive manufacturing system*

Test specimens were labeled by codes that is numbers. Ones produced in horizontal position got 1-5, ones produced in vertical orientation got 6-10.

After manufacturing parts have to be removed from the base plate. It is performed by milling technology. Surfaces involved in removal process are modified. Surface roughness of those are no longer influenced only by additive manufacturing technology. This is why those are not measured in our recent experiment series.

Surface roughness were measured on planes indicated on Figure 2 and 3. Notations are also introduced on the same figures. Red lines denote sampling pathway of surface tester. There were two times three sampling on each test specimen. This is why top and side surfaces significantly differ consequently from the layer by layer manufacturing technology, and it can be observed even by inspection and touch.

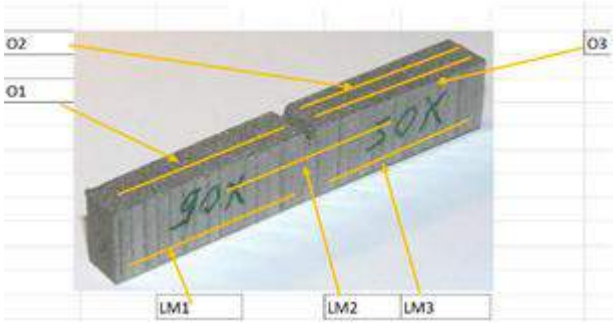

Fig. 2. Surface roughness measurement base lines and their notation on case of test specimens produced in horizontal orientation

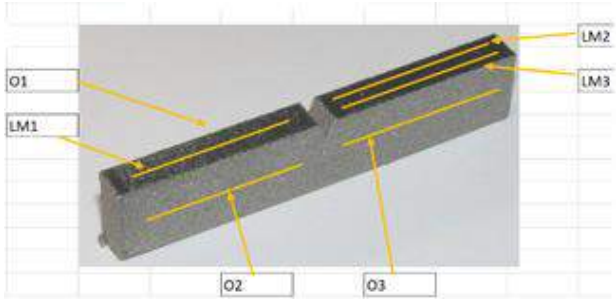

Fig. 3. Surface roughness measurement base lines and their notation on case of test specimens produced in vertical orientation (O1 is on the back face on the figure)

Generally, letter O refers to surfaces on the side of the test specimens, letters LM refers to top faces during the manufacturing process, which are scanned near perpendicularly by the laser beam. Distinction in notation drives at the fact that during the manufacturing process these surfaces are formed in different way, so we can expect differences in surface roughness parameters.

Here we deem important to emphasize what is common and what is different in sampling lines with same labels on different test specimens. As it was explained before, sampling lines labelled with O1, O2, O3 are on surfaces, which are on the side during the manufacturing process. This is common between "O"-s. But in case of specimens with code 1-5 (horizontally manufactured) this is a 5 x 55 mm face (including notch, but here it is not a highlight), and for specimens with code 6-10 the corresponding face has dimensions 10 x 55 mm. Conversely LM labelled sampling lines are on the 10 x 55 mm faces for 1-5 specimens, and on 5 x 55 mm faces in case of 6-10 specimens.

A Mitutoyo Surftest SJ-201 surface tester was applied in our surface roughness measurements (Figure 4.). Tis is a contact equipment. Raw data were processed by evaluation software provided to this equipment by manufacturer.

Measured data were the followings:

- *arithmetical mean deviation (R_a),*
- *root mean squared (R_q),*

- maximum peak to valley height of the profile (R_z).

All of those are given in micrometer units. Definition of these quantities are given by formulas 1,2, and 3.

$$R_a = \frac{1}{n}\left(|y_1| + |y_2| + |y_3| + \ldots + |y_n|\right) \quad (1)$$

$$R_Z = \frac{\left(y_{mp1} + y_{mp2} + y_{mp3} + y_{mp4} + y_{mp5}\right)}{5} - \frac{\left(y_{vm1} + y_{vm2} + y_{vm3} + y_{vm4} + y_{vm5}\right)}{5} \quad (2)$$

$$Rq = \sqrt{\frac{1}{l}\int_0^1 y^2 \cdot (x) \cdot dx} \quad (3)$$

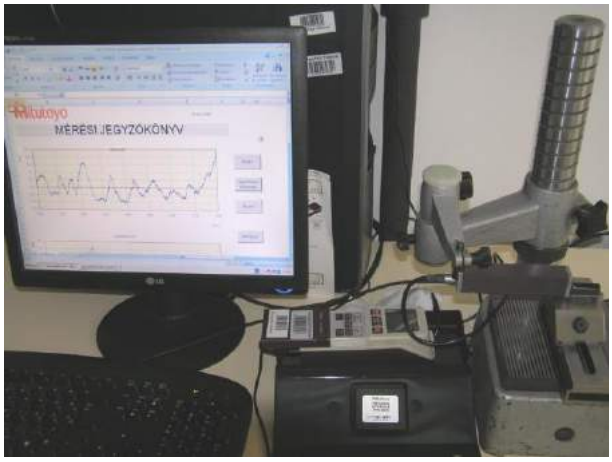

Fig. 4. Mitutoyo Surftest SJ-201 surface tester

Magnified images of sample surfaces taken by az electron microscope. A Hitachi SU1510 type scanning electron microscope with 15 kV acceleration voltage was applied in SE mode.

3 RESULTS

Table 1. demonstrates collected measurement data for test specimen with code 1, and main statistical features of those. This test specimen was produced in horizontal orientation.

Table 2. demonstrates collected measurement data for test specimen with code 6, and main statistical features of those. This test specimen was produced in vertical orientation.

Table 1. and Table 2. demonstrates how surface roughness measurement results differ. It is possible to compare results between O and LM sides on the same specimen. But the main reason why two tables of measurement data of certain test specimens are documented in this part of the paper is the opportunity for compare surface roughness data of a horizontally and a vertically produced test specimen.

Measurement data for samples 1-5 and 6-10 were evaluated separately. Those are summarized in Table 3. and Table 4. Each statistical parameter refers to 3 measurement data per piece of five test specimens, that is 15 data.

Figure 5. shows SEM electron microscopic image of a top face of a test specimen. Such faces are fully melted by laser beam, which hits it in nearly perpendicular direction. Pathway of laser scanning is observable on the surface.

Figure 6. shows SEM electron microscopic image of a side surface os a test specimen. This kind of surface is built up from the edges of melted layers. Laser beam hits such surfaces from tangent direction. Large amount of partially melted and adhesively bonded powder particles can be observed.

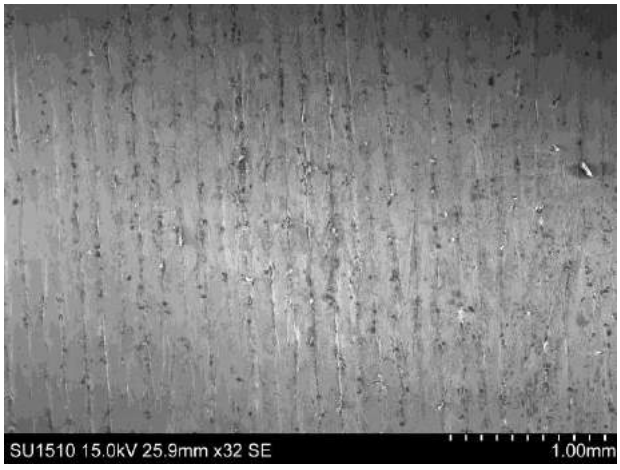

Fig. 5. Electron microscopic image of a laser melted (LM) face of a test specimen

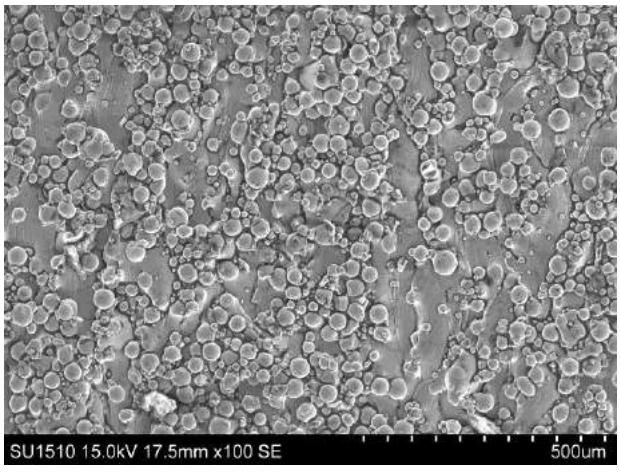

Fig. 6. Electron microscopic image of a side (O) face of a test specimen

By inspection of Figures 5. and 6. one can observe significant morphological differences. We can expect that surface roughness parameters of surfaces on

top of test specimens and on side of those will be different.

Table 1. Primary surface roughness measurement data of test specimen with code 1, and basic statistics

specimen code	label of sampling line	Ra	Rz	Rq		label of sampling line	Ra	Rz	Rq
1	O1	16,69	105,40	21,48		LM1	9,92	52,50	19,45
	O2	17,38	108,30	22,49		LM2	9,21	53,81	19,23
	O3	14,32	98,80	17,95		LM3	11,57	63,44	14,50
	mean	16,13	104,17	20,64		mean	10,23	56,58	17,73
	st. deviation	1,61	4,87	2,38		st. deviation	1,21	5,97	2,80
	median	16,69	105,40	21,48		median	9,92	53,81	19,23

Table 2. Primary surface roughness measurement data of test specimen with code 6, and basic statistics

specimen code	label of sampling line	Ra	Rz	Rq		label of sampling line	Ra	Rz	Rq
6	O1	13,24	85,94	16,59		LM1	6,74	33,08	8,17
	O2	13,03	79,02	16,05		LM2	6,29	30,2	7,55
	O3	13,81	88,95	17,42		LM3	5,43	28,02	6,6
	mean	13,36	84,64	16,69		mean	6,15	30,43	7,44
	st. deviation	0,40	5,09	0,69		st. deviation	0,67	2,54	0,79
	median	13,24	85,94	16,59		median	6,29	30,20	7,55

Table 3. Mean, standard deviaton and median over test specimens with codes 1-5, which are manufactured in horizontal (laid) orientation

statistics over samples 1-5	Ra	Rz	Rq
mean of all O	14,86	91,90	18,56
mean of all LM	10,81	65,22	13,83
st. dev. of all O	6,18	40,73	8,20
st. dev. of all LM	4,47	29,51	6,19
median of all O	15,14	92,66	18,81
median of all LM	9,98	67,54	12,90

Table 4. Mean, standard deviaton and median over test specimens with codes 6-10, which are manufactured in vertical (notch on top) orientation

statistics over samples 6-10	Ra	Rz	Rq
mean of all O	13,98	82,10	17,32
mean of all LM	6,67	31,68	7,27
st. dev. of all O	5,75	34,18	7,23
st. dev. of all LM	1,70	7,93	1,72
median of all O	14,54	89,35	18,10
median of all LM	7,79	39,16	8,88

4 DISCUSSION AND CONCLUSIONS

Charpy impact test sepcimens have a shape close to a brick. Those were manufactured in such a position that one of their surface was parallel with building plate. Layer by layer manufacturing implies that in case of a brick-like body manufactured in such orientations, construction of top surfaces and side surfaces (perpendicular to the building plate) are essentially different. Top surfaces are fully melted in each layer, consequently the topmost layer is fully melted possibly with dust particles bonded by adhesive forces onto it. However side surfaces are built up as a series of edges of sequentially melted planes packed onto each other. Difference can be visualized as top and side faces of a deck of cards.

First not so surprising observation is that in both Table 3. and Table 4. LM values are smaller than O values. It can be arisen from a pack of physical phenomena:

- *Top faces can absorb laser energy more effectively, because it hits those in near perpendicular direction, it implies more complete melting.*
- *When powder is melted on the top face, metal dust particles are fully surrounded by other ones hit by laser beam so heated up, but on the edge there are a "half-space" of metal powder what is not targeted by laser, so those remain cold, and conduct heat from the part of material, what should be melted. On the one hand it party prevents from melting dust particles on the edge. On the other hand heat conducted to neighboring area makes dust particles what should not belong to the body partly melt onto the surface or getting in adhesive bond.*
- *On top face gravitational pull and surface tension of melted metal acts in the same direction, namely perpendicularly into the surface. Of side gravitation pulls particles or melted metal drops in tangential direction, and only surface tension is the effect what "tends to make smooth" material into the surface.*
- *Laser beam hitting the surface creates a complex thermal-mechanical-aerodynamical push making particles moving sideway, and these phenomena have stronger effect of edges of layers.*
- *Laser beam approaches a certain place on the top surface more times during the scanning process, but less times on the edge. Approaching but not hitting a place may result in remelting, if that area had not enough time to cool down too much. Remelting decreases surface roughness significantly.*

An other observation can be taken by comparison of data between Table 3. and Table 4. Each corresponding data are smaller in Table 4. than in Table 3. without exception.

This fact strongly indicates that orientation is an essential factor impacting properties of products.

Table 5. Absolute differences between statistics of horizontally and vertically manufactured test specimens

absolute difference between horizontally and vertically manufactured test specimens data (μm)	Ra	Rz	Rq
mean of all O	0,89	9,79	1,24
mean of all LM	4,15	33,54	6,56
st. dev. of all O	0,43	6,55	0,97
st. dev. of all LM	2,76	21,58	4,47
median of all O	0,60	3,31	0,71
median of all LM	2,19	28,38	4,02

Table 6. Relative differences between statistics of horizontally and vertically manufactured test specimens in percents

relative difference between horizontally and vertically manufactured test specimens data (%)	Ra	Rz	Rq
mean of all O	6,35	11,93	7,16
mean of all LM	62,19	105,88	90,20
st. dev. of all O	7,51	19,16	13,48
st. dev. of all LM	162,19	271,96	259,20
median of all O	4,13	3,70	3,92
median of all LM	28,11	72,47	45,27

A more extensive investigation needed for a complete explanation. Now we can point to an effect which possibly plays role in this tendency. In vertical orientation top surface is smaller, so less time is needed to scan the whole surface. This is why laser beam returns in shorter times to places which can not cool down for this reason. This helps to maintain higher average temperature on edges, which helps better melting in of metal powder particles.

6 ACKNOWLEDGEMENTS

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Authors addresses

[1] Gergely Dezső, professor, University of Nyíregyháza, Institute of Engineering and Agriculture, H-4400 Nyíregyháza, Sóstói road 31/b, Hungary, +36-42-599400, dezso.gergely@nye.hu

[2]Péter Kósa, technical instructor, University of Nyíregyháza, Institute of Engineering and Agriculture, H-4400 Nyíregyháza, Sóstói road 31/b, Hungary, +36-42-599400, peter.kosa@nye.hu

[3]Ferenc Szigeti, professor, University of Nyíregyháza, Institute of Engineering and Agriculture, H-4400 Nyíregyháza, Sóstói road 31/b, Hungary, +36-42-599400, szigeti.ferenc@nye.hu

Contact person

Gergely Dezső, professor, University of Nyíregyháza, Institute of Engineering and Agriculture, H-4400 Nyíregyháza, Sóstói road 31/b, Hungary, +36-42-599400, dezso.gergely@nye

The effect of toxic elements on the morphological parameters of the *Ulmus minor* L.

Katalin Irinyiné Oláh[1,*] - Tibor Aranyosi[2] - Judit Csabai[3] - Edit Kosztyuné Krajnyák [4] - Miklós Szabó[5] - Csilla Tóth[6] - Zsuzsanna Uri[7] - Szabolcs Vigh[8] - György Vincze[9] - László Simon[10]

Abstract: Heavy metals result in a decrease in the growth and weight of plants by inhibiting physiological processes In addition, they can cause morphological changes in the roots, shoots and leaves of plants. In our pot experiments, we sought an answer to the effect of soil slightly contaminated with toxic elements on the morphological properties of Ulmus minor. The experiment was set up with 3 treatments (control, soil slightly contaminated with toxic elements, soil slightly contaminated with toxic elements, sorghum straw). 4 replicates per treatment were set up with 3-3 plants per repeat. The examined morphological parameters: plant height, shoot diameter, leaf plate length and width, total leaf, shoot and root weight. We found that mild toxic element contamination did not have a negative effect on the development of the assessed plant organs. Presumably, the significant nutrient content of the contaminated soil offset the toxic effects of the co-applied heavy metals. Sorghum straw had a positive effect on plant development in all cases.

Keywords: toxic elements, morphological parameters, Ulmus minor

1 INTRODUCTION

Plant species that can tolerate and bind certain metals (heavy metals) are suitable for reducing the heavy metal content of contaminated areas. Several researchers have addressed how soft and woody plants respond to heavy metal contamination and are suitable for phytoremediation of areas contaminated with heavy metals. Heavy metals have some - usually negative - effects on all plant life processes (growth, photosynthesis, water balance, ion uptake, etc.), which are also reflected in the external morphological properties of "contaminated" plants (Kabata-Pendias and Pendias, 2001; Simon, 2014).

In general, the goal in Hungary is to control the use of native Ulmus sp. remove as little contaminants and heavy metals as possible from the soil, water or air. The goal of environmental protection is that the plant comes into contact with as little heavy metal as possible, that it absorbs and accumulates in its body as little as possible. In contrast, the purpose of phytoremediation is to allow plants to accumulate as many heavy metals as possible in their above-ground organs. Three Ulmus sp. are also native to Hungary, which usually live in endangered waterside-mountainous areas, so their habitats are endangered in several cases. In addition, our three domestic species are also bioindicators, and their presence or absence may indicate the presence or absence of some environmental pollution. The woody Ulmus sp. its phytoremediation potential is less explored and more of a species studied as a bioindicator. Szalai (1998) studied heavy metal uptake by Ulmus minor, Acer campestre, Populus alba and Vitis riparia. Of these, coastal grapes were those in which lead and cadmium from the soil were not transported to the leaves. In Turkey, Ulmus glabra species has been used to biomonitor Pb, Cd, Ni, Zn, Fe, and Mn. Ulmus absorbed the least amount of manganese compared to the species studied, and showed a very modest accumulation of iron. Nickel and zinc were detected in the average of the other species tested, while in the case of lead the detected amounts were slightly above the average (Baslar et al., 2009). Ulmus pumila is the most common species in the field of phytoremediation, it was also used in Hungary (Nyíregyháza) for the phytoremediation and recultivation of landfills. In 2014, Nyíregyháza Városüzemeltető és Vagyonkezelő Nonprofit Kft. Populus euramericana cv. Koltay, Ulmus pumila-celer and Salix viminalis "ENERGO", bred by the Institute of Forestry, planted seedlings in the former landfill of Borbánya, an extremely fast-growing landfill with excellent phytoextraction (Közbeszerzési Hatóság, Közbeszerzési értesítő 2014). *The suitability of this species for phytoremediation purposes has also been confirmed by Dukic et al. (2014). Seed germination was studied in the presence of heavy metals, during which no significant difference was found between the germination of heavy and unloaded individuals, so the species is suitable for the remediation and recultivation of contaminated areas. Saba et al. (2015) also included Ulmus pumila in their phytoremediation experiments. In 2015, research was conducted in Zanjan Province (northwestern Iran) where the metallurgical industry is developing rapidly. Eight woody species were tested: Populus nigra, Ulmus pumila, Fraxinus excelsior, Robinia pseudoacacia, Acer hyracanum, Salix alba, Thuja orientalis and Cupressus sempervirens var. arizonica. Heavy metal content (Cr, Mn, Fe, Co, Ni, Cu, Zn, Cd, and Pb) was examined in leaf samples from the above woody stems. The results showed that the samples of trees near the industrial complexes of lead and zinc smelting have a much higher heavy metal content than average and show a high correlation with the metal concentrations in the soil. Compared with other species, the uptake of toxic elements by Ulmus pumila was located in the midfield (Saba et al., 2015). In Serbia, Ulmus leavis was used to detect the presence of heavy metals (Devetakovic et. Al., 2016; Devetakovic, 2017). Mleczek et al. (2017) set up an experiment with 5 other woody plants (Acer platanoides, Acer pseudoplatanus, Betula pendula, Quercus robur, Tilia cordata) with the same plant. They observed how plants develop in soil saturated with toxic*

elements. Acer platanoides and Tilia cordata formed smaller biomass than the control. The phytoremediation ability of various woody stalks in an area contaminated with heavy metals (Pb, Zn, Cd, and Mn) in Iran (in a city center) was also investigated in Shabanian and Cheraghi (2013). The tree species studied were Platanus orientalis, Ulmus carpinifolia (field elm), Fraxinus rotundifolia, Biota orientalis, Pinus nigra. The results showed that the accumulation of Pb, Zn and Cd in the trees developing in the contaminated area was significantly higher than in the control (uncontaminated) area. Most lead and cadmium were accumulated in Biota orientalis, most zinc in Fraxinus rotundifolia, while the highest manganese concentration was measured in Ulmus carpinifolia.

In the course of our work we sought an answer to the effect of the mild toxic element of the soil and the high content of organic matter and macroelement on the morphological properties of Ulmus minor.

2 MATERIALS AND METHODS

We set up our pot experiment under field conditions at the University of Nyíregyháza in 2018.

Our test plants tested were Ulmus minor and Ulmus pumila. In this publication, we report the results of Ulmus minor. Ulmus minor is the most common Ulmus sp in Hungary. He likes places rich in light (forest edges, pastures, loess winds). Climate extremes are characterized by an indifferent, warm-loving, yet good frost tolerance. Lime lover. It can grow up to 30 meters in height. Its leaves are characteristic of Ulmus leaf asymmetrical, double-toothed, 5.9 cm long and 2.5–5 cm wide (Bartha, 2016; Börcsök 2004).

The experiment was performed with 3 treatments (control soil without toxic elements from Nyírtelek, soil contaminated with toxic elements from Debrecen-Lovászzug, soil contaminated with toxic elements from Debrecen-Lovászzug mixed with 2.3 m / m% sorghum straw) with 4 repetitions per application, 3-3 plants per repetition.

The content of macro, meso-, micro- and toxic elements of control soil, soil contaminated with toxic elements from Debrecen-Lovászzug and sorghum straw used for the pot experiment is shown in Table 1. The control soil is strongly acidic (pH 4.00 in aqueous extract) with a total salinity of 0.03 w / w%. The physical type (KA 38) of the soil is loam, the CaCO3 content is below 0.100 m / m% and the humus content is 2.19 m / m%.

The soil contaminated with toxic elements from Debrecen-Lovászzug is slightly alkaline (pH measured in aqueous extract 7.11), loamy in terms of physical type (KA 39), with a relatively high humus content (2,27 m / m%) and low total salinity (0.057 w / w%). The CaCO3 content in the soil is between 2,13 and 2,45 w / w%.

The macro-, meso- and microelement supply of the Nyírtelek control (uncontaminated) and the contaminated soil of Debrecen-Lovászzug is also very good.

Table 1. Content of macro-, meso-, micro-, and toxic elements in soils and sorghum straw used in an outdoor pot experiment set with Ulmus minor (Nyíregyháza, 2019)

Elements examined (mg/kg)	Nyírtelek control soil	Debrecen-Lovászzug contaminated soil	sorghum straw	6/2009. (IV. 14.) KvVM-EüM-FVM limit value
Macro and meso elements				
K	4064	1859	53014	-
P	534	1122	4562	-
Ca	2681	17921	5179	-
Mg	3801	5055	3605	-
Fe	22273	11799	6,22	-
Micro elements				
B		10,1		-
Mo		1,00		7
Mn	618	306	10,6	-
Toxic elements				
As	7,11	7,16	0,069	15
Cd	**1,10**	0,33	**1,167**	1
Cr	45,33	**120**	1,167	75
Cu	20,85	44,4	6,22	75
Hg		<1,00		0,5
Ni	**47,36**	31,8	1,31	40
Pb	27,27	35,8	0,204	100
Zn	55,09	176	141	200

Content values for sorghum straw were also favorable. The soil in Debrecen-Lovászzug is slightly contaminated with toxic elements, in which the chromium concentration significantly exceeded the 6/2009. (IV.14.) KvVM-EüM-FVM joint decree. We set up our pot experiment under field conditions at the

University of Nyíregyháza in 2018. The soil contains more zinc (17-6 mg / kg) than the national average (<25-75 mg / kg).

The values of cadmium and nickel in the soil of Nyírtelek exceeded the level of 6/2009 by a minimum. (IV.14.) KvVM-EüM-FVM, and the same applies to the cadmium content of sorghum straw. To set up the experiment, the culture vessels were filled in December 2018 with soil not contaminated with toxic elements from Nyírtelek, soil contaminated with toxic elements from Debrecen-Lovászug and, as treatment 3, 2.3% by weight of sorghum straw (corresponding to 65 t / ha field application). During the incubation, the soils were watered regularly. The Ulmus seedlings were planted in March 2019, and the nursing work involved watering the plants.

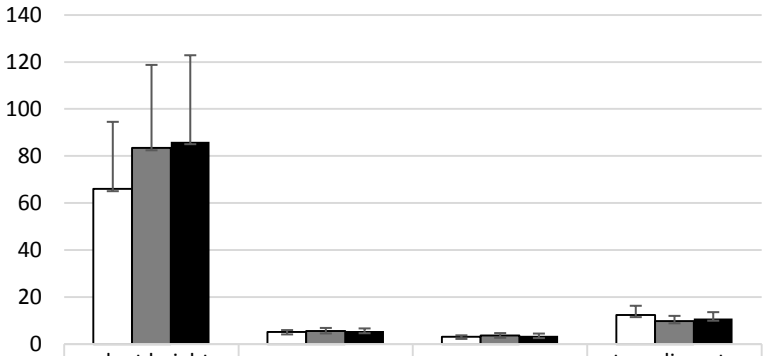
The morphological survey of the experimental plants took place in July 2019, during which the following parameters were recorded: plant height, shoot diameter from the soil surface approx. 5 cm from the tip of the shoot 5-6. leaf plate length and width (Fig. 1). At the end of the experiment, leaf, shoot and root weights were measured.

Fig. 1. Morphological recording of Ulmus minor (Simon, 2019)

3 RESULTS AND DISCUSSION

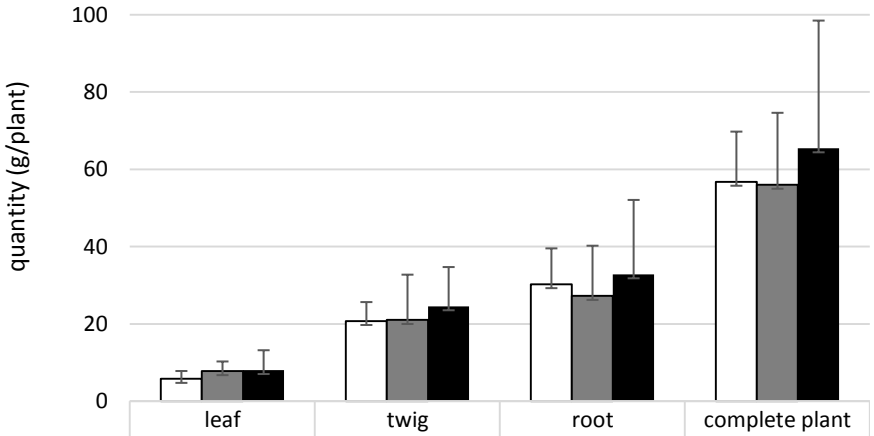
Based on our pot experiment with Ulmus minor, it can be stated that the total length of plants grown on contaminated soil from Debrecen-Lovászzug and soil contaminated from Debrecen-Lovászzug mixed with sorghum straw exceeded the length of plants grown from Nyírtelek by 25-30%. Ulmus minor is an Ulmus species with short and broad leaf blades, the leaf blade length ranged from 5 to 5.5 cm. As a result of our treatments, the leaf blades of plants growing on uncontaminated soil from Nyírtelek are 8-10% shorter than the leaves of plants in contaminated soil and 10-20% shorter than the leaves of plants grown in contaminated media mixed with sorghum straw. The plants with the longest leaf plates developed in the growing pots where we mixed sorghum straw (grown in the same area) with the soil contaminated with heavy metals from Debrecen-Lovászzug. The leaf blades of plants grown on uncontaminated soil from Nyírtelek are smaller than those of plants grown on contaminated soil and soil mixed with sorghum straw. The difference was 22-25%, i.e. 22-25% larger leafy plants developed on soil mixed with D-L contaminated and D-L contaminated sorghum straw. The change in stem diameter varies from treatment to treatment. The smallest diameter plants were measured on D-L contaminated soil. Compared to the unpolluted soil, the stems of the plants of the contaminated soil mixed with sorghum straw and from Debrecen-Lovászzug were 13-17% thinner. On the soil from Nyírtelek and mixed with sorghum straw, the stems of Ulmus minor plants are about 10% thicker than on the soil from the contaminated Debrecen-Lovászzug (Fig. 2).

Assessing the total leaf weight measured at the end of the experiment, it is striking that the plants grown on D-L contaminated soil gave the highest green mass. Sorghum straw increased the green mass by 40% compared to the uncontaminated soil, but not significantly compared to the contaminated medium, here the difference is 4%. Compared to the plants grown on the soil from Nyírtelek, the leaf weight decreased by 43% during the treatment with sorghum straw. Compared to plants grown on D-L contaminated soil, the total leaf weight was 50% lower than that of plants also equipped with sorghum straw. The twig weight of the studied plants developed similarly to the leaf weight. On the uncontaminated soil from Nyírtelek and on the contaminated soil from Debrecen-Lovászzug, the cane yield of the plants was almost the same (20.74g and 21g). Mixing sorghum straw with the contaminated soil, the twig weight increased by 17-18%. The root weight of our test plant was minimally modified compared to the control unpolluted soil (we measured a difference of 8–10% in the contaminated soil, reducing the root weight in the soil mixed with sorghum). The root of Ulmus minor developed best on the contaminated soil from Debrecen-Lovászzug, to which we also mixed sorghum straw. Summarizing the leaf, twig and root weight values of the plants, we can see that there is no difference between the values measured on uncontaminated soil and contaminated soil, but on contaminated soil mixed with sorghum straw, the total plant weight increased by 15–17% (Fig. 3).



	plant height (cm)	leaf length (cm)	leaf width (cm)	stem diameter (mm)
control	66	5,08	3,16	12,43
soil with toxic elements	83,4	5,49	3,65	9,8
soil with toxic elements+sorghum straw	86	5,58	3,51	10,9

Fig. 2. Effect of toxic elements on the morphological parameters of Ulmus minor (Nyíregyháza, 2019)



	leaf	twig	root	complete plant
control	5,76	20,74	30,27	56,77
soil with toxic elements	7,76	21	27,23	55,99
soil with toxic elements+sorghum straw	8,05	24,55	32,82	65,42

Fig. 3. Effect of toxic elements on the total mass of Ulmus minor (Nyíregyháza, 2019)

4 CONCLUSIONS

Individuals loaded with a toxic element determined by our experiment with Ulmus minor produced slightly thinner stems than the control plants, but the mild toxic element did not tend to have a negative effect on the other morphological parameters of the test plant assessed. Plants grown on contaminated soil from Debrecen-Lovászzug mixed with sorghum straw produced higher biomass than plants grown on uncontaminated soil from control Nyírtelek or plants grown on D-L contaminated soil. The positive effect of heavy metal contaminated soil on plant growth can be explained by its high content of organic and mineral matter, which plants were able to utilize well despite the heavy metal content.

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Authors addresses

[1]Katalin Irinyiné Oláh, assistant professor, *University of Nyíregyháza, Institute of Engineering and Agricultural Sciences, H-4400 Nyíregyháza, Sóstói Str. 31/b., (06 42) 599 400/2607, olah.katalin@nye.hu*

[2]Tibor Aranyosi, PhD student *University of* Debrecen ATC Research Center Nyíregyháza, H-4400 Nyíregyháza, Westsik Vilmos u. 4-6., (06 42)594 301, aranyositibi@gmail.com

[3]Judit Csabai, assistant professor, *University of Nyíregyháza, Institute of Engineering and Agricultural Sciences, H-4400 Nyíregyháza, Sóstói Str. 31/b., (06 42) 599 400, judit.csabai@nye.hu*

[4]*Edit Kosztyuné Krajnyák,* assistant lecturer, *University of Nyíregyháza, Institute of Engineering and Agricultural Sciences, H-4400 Nyíregyháza, Sóstói Str. 31/b., (06 42) 599 400/2380, krajnyak.edit@nye.hu*

[5]*Miklós Szabó, Vetőmag és szárító Kft., H-4466 Tímár, Szabadság út.2.*

[6]*Csilla Tóth, college associate professor, University of Nyíregyháza, Institute of Engineering and Agricultural Sciences, H-4400 Nyíregyháza, Sóstói Str. 31/b., (06 42) 599 400/2415, toth.csilla@nye.hu*

[7]*Zsuzsanna Uri, college associate professor, University of Nyíregyháza, Institute of Engineering and Agricultural Sciences, H-4400 Nyíregyháza, Sóstói Str. 31/b., (06 42) 599 400/2390, uri.zsuzsanna@nye.hu*

[8]*Szabolcs Vigh, associate professor, University of Nyíregyháza, Institute of Engineering and Agricultural Sciences, H-4400 Nyíregyháza, Sóstói Str. 31/b., (06 42) 599 400/2606,vigh.szabolcs@nye.hu*

[9]*György Vincze, professor, University of Nyíregyháza, Institute of Engineering and Agricultural Sciences, H-4400 Nyíregyháza, Sóstói Str. 31/b., (06 42) 599 400/2239, vincze.gyorgy@nye.hu*

[10]*László Simon, professor, University of Nyíregyháza, Institute of Engineering and Agricultural Sciences, H-4400 Nyíregyháza, Sóstói Str. 31/b., (06 42) 599 400/2391, simon.laszlo@nye.hu*

Contact person

[*]Katalin Irinyiné Oláh, assistant professor, *University of Nyíregyháza, Institute of Engineering and Agricultural Sciences, H-4400 Nyíregyháza, Sóstói Str. 31/b., (06 42) 599 400/2607, olah.katalin@nye.hu*

Modeling a real tire load experiments with a hydraulic pressure tool

Dr. Zsolt Péter Kiss [1*]

Abstract: The aim of our research is to be able to measure the agricultural and agricultural conditions of different designs under laboratory conditions. the effect of off-road tires on different types and conditions of soil. To this end, we have developed a special device that simulates the effect of different profile tires on the ground in a special soil box. The type of soil selected for the purpose of the test is placed in the box, which we try to bring to the condition corresponding to the natural conditions by means of various soil preparation methods. Among other things, we obtain by grinding and adjusting the moisture content, e.g. to the crumbly soil condition prepared for sowing. This is when the special radio frequency pressure sensing probes are placed in the ground. Then, with the help of the measuring device, a so-called a preload is applied to adjust the natural compaction of the soil ("in situ"). This is followed by a load test with the selected tire profile. Using the various pressure sensors, the stresses in the ground under the loaded tire and its spatial distribution are measured. In this publication, we would like to present the course of the tests and some of its results.

Keywords: soil compaction, tire, soil tension

1. INTRODUCTION

As a result of our previous investigations, we have a database that allows us to tell the state of moisture and compaction of a given soil type for an entire year. Thus, in the case of the selected soil type in the test soil box, we try to set the soil condition, which was previously measured under natural conditions, with the two most important parameters mentioned above (moisture content and compaction). In this way, we want to ensure the identity between the soil box and the real conditions. The so-called soils in kind. The "in situ" stress state is created in the soil box by a special test device developed by us. After preloading, the structural and conditional identity of the soil samples and the field condition were confirmed by penetrometer measurements.

2. APPARATUS AND TEST METHOD

2.1 The conception of the measuring process

The model of the measuring process is shown in the 1. figures below.

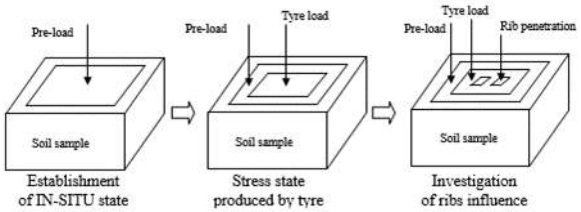

Fig. 1. Model of the measuring process

For determination of stress distributions generated in soil samples by different segments application of oriented pressure sensors mounted under the appropriate segments is necessary. In addition to the stress state determination measuring the deformation on the surface and inside of the sample is also resource of important information.

A number of mechanical, hydraulic and software developments and modifications were needed for the realisation of this conception. Of course, the main element of this was planning and production of the hydraulic pushing tool approximating the tyre model.

2.2. Development of a pushing tool approximating the real tyre model

The main point of the work in addition to determination of the initial stress state of soil samples modelling the field conditions was examination of the influence of simplified tyre elements.
The scheme of the pushing tool is shown in Fig. 2. From the point of view of the simplified tyre model it contains 3 main parts.

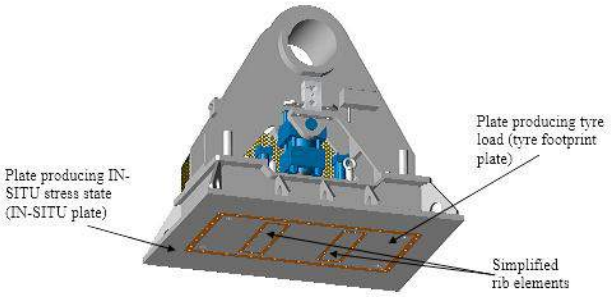

Fig. 2. The simplified tyre model

The 3 main segments shown in the figure above are movable independently from each other and have functional properties as follows.

Controlling the plate generating the initial stress state of the soil sample – at the start together with the 2 other segments – assures development of the pressure specified for the soil surface (IN-SITU), but later, during the loading process – when the 2 other segments get out of their planes – keeps the pressure on a constant level.

The main point of this is to assure a constant state of the soil outside the tyre as the situation is in the reality as well. Subsequently we have 2 different loading opportunities and it is difficult to decide which one of these is closer to the reality.

The first version is when during keeping the pressure of the soil surface at a constant level the ribs get out of their planes at a prescribed length (rib height). After this the footprint modelling plate gets out of its plane to such an extent that the soil surface pressure generated by it reached a prescribed value, namely the practical soil compaction defined by the tyre surface. Naturally this value is higher than the pressure kept continuously at a constant level by the IN SITU plate.

The second version is when the ribs and the footprint plate displace in an opposite order. In this case the footprint plate's control mechanism has to assure a constant soil pressure value under the plate even during movements of the ribs. Of course, controlling the IN SITU plate assures all the time a constant soil surface pressure.
All three segments are equipped with road sensors and force-measuring cells and so after finishing the measurements the appropriate force-displacement diagrams can be produced.

The control mechanism, road sensors and force-measuring cells of the machine are designed for both, horizontal and circumferential movements of the system. This provides the opportunity to further develop the tests even for analyses of movements of a real tyre with slip.

The hydraulic pushing tool models the real tyre with a considerable simplification, so later other designs closer to the reality could be required. For this sake the pushing tool is of modular character, the prism modelling the tyre footprint and the simplified rib segments are changeable.

2.3. Elaboration of a controlled procedure of measurements conducted by the machine

The control mechanism of the machine made possible to perform controlled measurements during determination of initial stress state of soil samples. This means during the measurement process the system controlled the pre-load value, but when the process became instable – especially in case of loose and wet soils – the control mechanism was not able to produce the specified pre-load value. In those cases non-conformity of the measurement was proved and it was repeated. But in view of high time and work requirements of the sample preparation this caused considerable wastes.

In consequence it was decided to further develop the control system of the measuring equipment so that it could perform a controlled measurement process. Thanks to this the system is able to correct defects when it detects non-conformities during realisation of the measurement program. Because of the loading program's complexity this is of an especially great importance when applying a hydraulic pushing tool. One of the conditions necessary for elaborating a controlled measurement process was development of an electro-hydraulic air-pilot valve system what is shown in the figures below: (Fig.3 & Fig.4.)

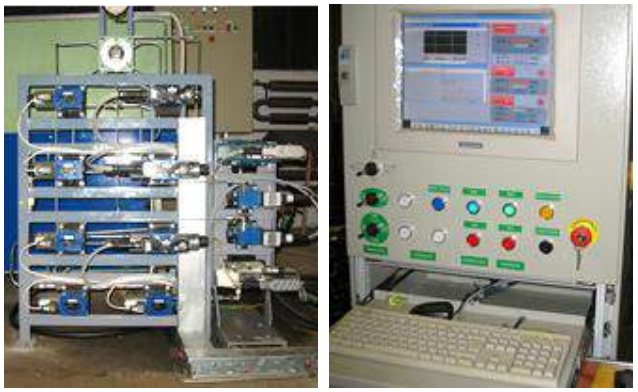

Fig. 3. The electro-hydraulic air-pilot valve system and the process control computer

Fig. 4. The complete measuring system

2.4. Providing the pressure sensors necessary for the measurements

In was proved in practice that the material applied for the membranes functioned properly only during in a relatively short, 1 or 2 month period. In case of keeping them in stocks for more long time, that is more than half a year, one could see them relax, and their tight arched surface became loose and concave.

So simultaneously with testing the actual measuring system new latex was approved as well. In this case under the membrane also oil was the pressure transmitting medium. Moreover, the membrane from this kind of latex was limpid, so it had the advantage over the previous membranes that in case of air absorption the air bubbles formed inside the sensor can be visually detected. Those air bubbles twist measurement results but at the same time their presence can not be detected with the sensor verifying unit.

Installation of the oriented pressure sensors in the soil is a very scrupulous procedure requiring high accuracy. One has to be careful that the sensors should be oriented with the appropriate direction in order to avoid their interactions. For this sake a so-called positioning shape is used.

These are matrices formed from rubber strips of high flexibility fixed on a metallic frame, in nodal points of which the properly oriented sensors are mounted. By means of this flexible rubber mesh sensor interactions and constraint of their displacement can be avoided and distortion of the measurement results reduced.
This shape is shown in Fig. 5.

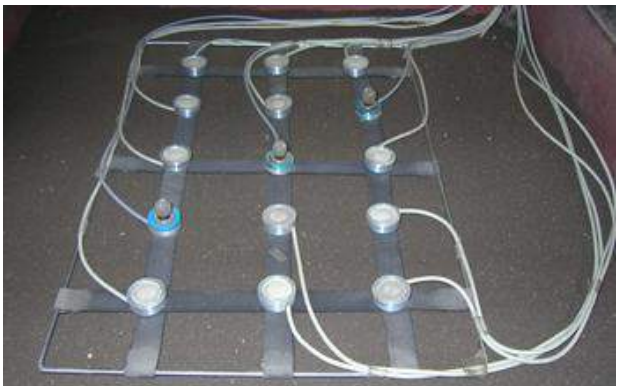

Fig. 5. The positioning shape with sensors

Due to inflexibility, sensibility and distortion effect of wires application of wire type sensors always cause some problems. When we have just one loading plate the difficulties born of these problems can be more or less easily overcome.
But in case of measurements conducted there were already 3 loading segments: the IN-SITU loading plate, the footprint unit, and the simplified ribs. At the start these 3 segments are situated in the same plane up to developing IN-SITU state on the total measurement surface, but at the end of displacements they are situated in 3 different planes. One can easily understand that sensor wires are firmly fixed in the soil of IN-SITU state developed and grown hard after the preloading period.
Nevertheless this could not cause a problem yet, since the sensors and their wires are situated in the same plane and move together with the soil becoming harder and harder. In the second phase of the loading planes of different segments come out of place what cause wire rupture of sensors under the tyre footprint segment in the soil previously grown hard. Fig. 6.a. and 6.b.

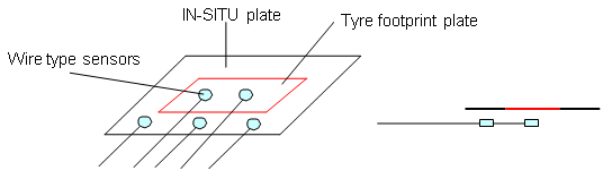

Fig. 6.a. The initial positions for sensors

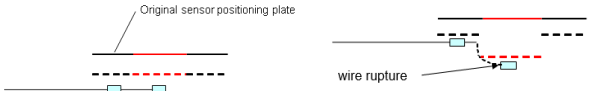

Fig. 6.b. The positioning shape with sensors

The previously detailed rupture hazard of the wire type sensors made necessary development of wireless sensors. We are now working on development of a system operating on radio-frequency principle testing the prototype of which is to be started in 1 month.

Based on cost optimization considerations it would be reasonable in the future to apply both wire type and wireless sensors. Wire type sensors will be applied under the IN-SITU loading plate, while wireless ones under the tyre footprint and simplified rib segments will be mounted.
After considerable mechanical modifications of the measuring equipment first of all its load test was needed to be performed. After having checked the critical points of the equipment the experts proved that the measuring equipment passed the test without any failure. Afterwards the sensors could be mounted in the soil sample, and the planned measurements performed.

For these measurements the local "nyírség" sandy soil of dry state was chosen. During the previous procedure also this soil type and state was applied, as in this case the soil sample preparation procedure requires the least time. Taking into consideration that during the process the soil bin had to be prepared about 20 times, it resulted in a considerable time saving.
Naturally, afterwards the system has to be tested on all three soil types with all three humidity grades, as stability of these differ from each other.

2.5. Measurement of soil sample deformation

One of the important development goals was determination of the loaded soil's deformation. Application of an equipment capable to determine displacements of the strained soil's internal points is needed. For this purpose a so-called remembering plastic bar was developed. This is a steel spring placed in a thermoplastic tube. Under the influence of current this turns into a plastic tool, which "remembers" previous plastic deformations. The section of the tool is shown in Fig. 7.

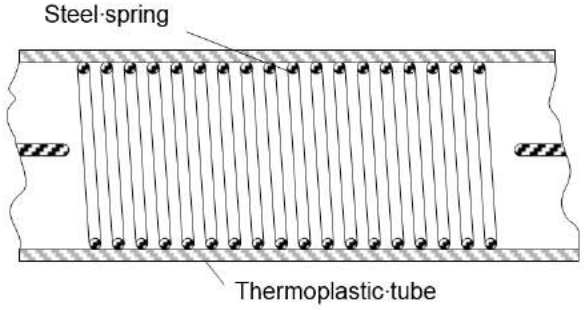

Fig. 7. The remembering plastic bar

The remembering plastic bar is applied as follows:
The originally straight tool is placed into the soil bin, and before beginning the loading procedure by the help of current it is softened and afterwards kept in this condition up to the end of loading. After unload the system is cut off and the bar solidify. Releasing the remembering bar from the soil sample it represents the deformation of the given soil segment. During the prototype tests this tool was proved to be a successful solution.

2.6. The measuring processes

In the course of planning the test measures the following parameters were determined.
1. Loading procedure - Achieving the IN-SITU state:
The soil surface pressure is 1 bar, what is reached in 5 load stages with constant increment of 0,2 bars. Every load stage can be set in 15 seconds and afterwards there is a 15 second conditioning period at every given pressure value.
2. Establishing the simplified tyre footprint
The soil pressure under the tyre footprint modelling segment is a 1,8 bars increment relative to the IN-SITU state, that is altogether 2,8 bars. The load running up to the IN-SITU state +1 bar value is continuous and is realized in 60 seconds, afterwards 15 second increment of 0,2 bars and conditioning cycles alternate with each other.
3. Letting out the simplified rib segment
Simplified rib elements penetrate into the soil sample modelling 50 mm rib height. Achieving this state requires 60 seconds.
During the test 20 pressure sensors are placed at the depth of 200 mm in the prepared soil sample. The scheme of their localization is shown in Fig. 6 and photos of this installation in Fig. 8.

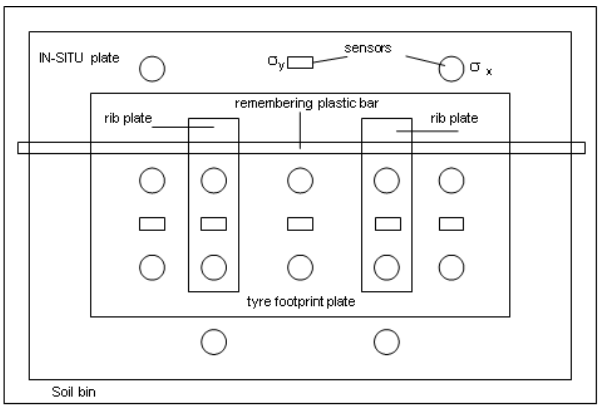

Fig. 8. The scheme of sensors localization

One can see in Fig. 9. that wiring this installation is a rather complicated task, what implies a certain risk of distortion of measuring results as well.

Fig. 9. The installation of the sensors

Control of the valve system required creation of a computer program. (Fig. 10.a. and 10.b.)

Fig. 10.a. Process control computer screenshot

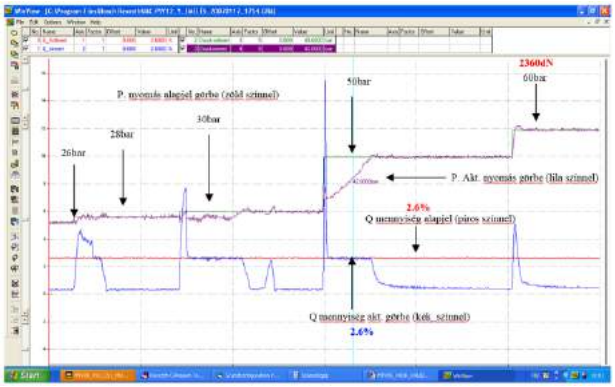

Fig. 10.b. Pressure diagram of the test process

3. DESCRIPTION AND EVALUATION OF THE MEASUREMENTS

Pressure distribution measurements
The measurement was undisturbed until reaching the IN-SITU state, but in the second phase when establishing the simplified tyre footprint response of sensors was different from the usual.
Due to observation of this problem in the third phase the simplified rib elements were let out just 2 mm instead of the originally planned 50 mm, so that we could test their proper control.

This part of the process functioned normally but for the sake of preserving the sensors the test was stopped.
The values measured by sensors during loading procedure are shown in Fig. 11.

The most remarkable thing in this figure is that after reaching the IN-SITU state the pressure in sensors under the IN-SITU plate suddenly fall. According to the considerations detailed in connection with the wire type sensors this type of sensors can be applied without any failure risk just under the IN-SITU plate.

A logical reasoning for this can be that during the loading procedure the control mechanism of the IN-SITU plate cannot keep continuously the soil surface pressure at a constant 1 bar value, and sensors indicate this.

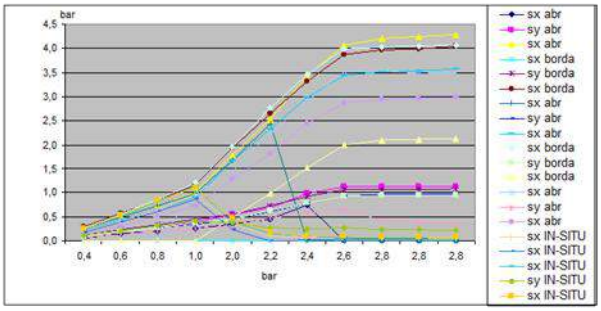

Fig. 11. The measured values by sensors

In this second loading phase 3 sensors experienced pressure loss and in case of 2 from them the pressure suddenly took zero value.
These incidents can be explained by the facts recited with Fig. 11. The continuous pressure loss of the third sensor can be explained by oil leakage.

The pressure values under the tyre footprint plate are higher than expected. The cause of this phenomenon can be that wires spanned during the measurements make sensors displace pressing them against the hardened soil surface. Similar phenomenon was experienced when we used rigid measuring frames for settling the sensors.
In case of further 4 sensors we can see that values measured by them are considerably lower than those measured by the others. This irregularity can be explained by absorption the air bubbles mentioned. This anomaly can be eliminated by replacing oil by silicone rubber as pressure transmitting medium, what is already in progress. This solves the previously mentioned oil leakage problem as well.
In case of just one sensor we can see, that in spite of its normal functioning the sensor once experienced a zero value, what could be the result of an instant contact error.

3.1. Displacement distribution measurements

After finishing measurements the soil sections hardened around sensors were removed.

After this we measured vertical direction displacements of all sensors and different points of the plastic bar along its length. The results of these measurements are shown in Fig. 12. Previously we supposed the proper response of the plastic bar in terms of deformation measurements could be justified by unobstructed displacement of the sensors.

Analysing this figure can state fairly strictly describes displacement of the soil sample's internal points. This can be neatly seen in Fig. 12.

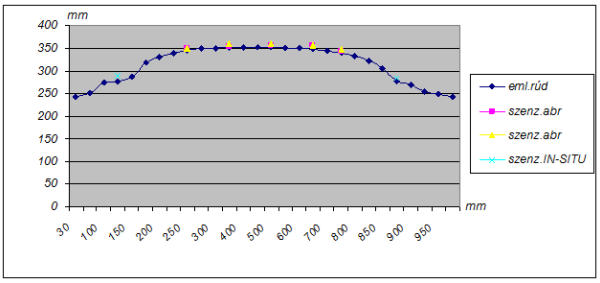

Fig.12. Displacement of the soil sample's internal points

Judging on this diagram one can see, that the sensors positions are not situated along one line, what proves though we loaded the system with a plane surface, but loading was not even. Fig. 13.
This is an indirect confirmation of the supposition that the IN-SITU loading plate should be the largest possible in order to have the measured points at a proper distance from load edges, so avoiding distortion of the results. During the development we paid special attention to this.

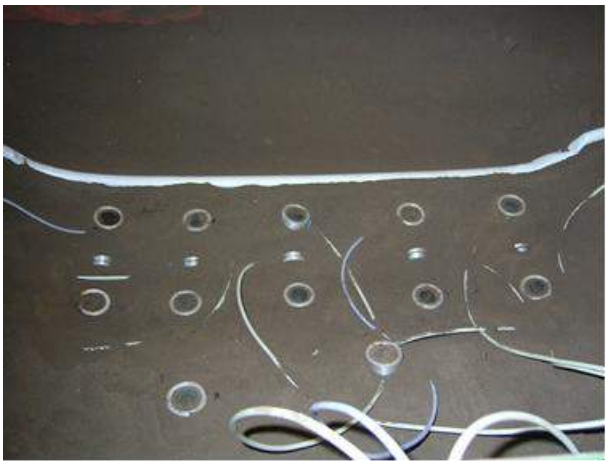

Fig. 13. The sensors position after the measuring

3.2. The changes of the soil compaction and moisture

After determining the pressure distribution of the soil sample, the actual compaction and moisture content of the soil sample was determined by penetrometer measurement in the distribution shown in Figure 14. The 3T System penetrometer we use determines the water content in the given soil sample in relation to the field water capacity in percentage by volume.

Fig. 14. Penetrometer test points

In the initial unloaded soil sample with homogeneous moisture content, the moisture contents shown in Figure 15 are obtained at different depths after loading.

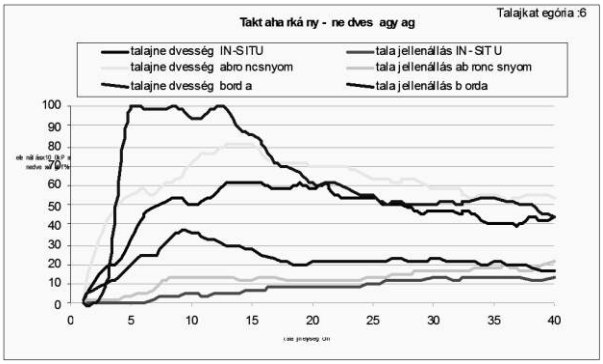

Fig. 15. Initial and post-load values at different depths

The main purpose of the measurements is to determine the ratio of vertical and horizontal stress coordinates as a function of soil type, moisture and load. The results are summarized in Table 1, which are used as input data for finite element analysis to validate the mechanical parameters of the Cambridge Cam-Clay soil model.

Table 1. The ratio of vertical and horizontal stress coordinates

Talajminta neve	Talajminta nedvességtartalma	IN-SITU		abroncsnyom		borda alatt	
		σ_y	σ_x / σ_y	σ_y	σ_x / σ_y	σ_y	σ_x / σ_y
száraz agyag	12%	1,22	0,31	1,65	0,28	2,71	0,24
közepesen nedves agyag	52%	0,98	0,40	1,66	0,37	3,45	0,28
nedves agyag	72%	0,96	0,47	1,61	0,44	3,56	0,44
száraz vályog	41%	1,08	0,42	1,65	0,36	3,43	0,32
közepesen nedves vályog	52%	1,08		1,60		3,07	
nedves vályog	92%	1,03	0,38	1,52	0,35	2,80	0,29
száraz homok	35%	1,06	0,46	1,72	0,42	4,42	0,34
száraz homok	41%	1,05	0,44	1,73	0,40	4,48	0,33
száraz agyag	12%	1,28	0,29	1,81	0,25	2,83	0,24
nedves vályog	100%	1,07	0,39	1,86	0,37	4,24	0,61
száraz homok	32%	1,10	0,46	1,81	0,47	4,76	0,37
száraz homok	19%	1,14	0,40	2,28	0,31		
száraz homok	19%	1,08	0,39	2,42	0,31		
száraz homok	18%	1,23	0,35	2,54	0,31		
száraz homok	24%	0,91	0,54	1,93	0,43		
száraz homok	35%	0,97	0,48	1,63	0,45		
száraz homok	35%	1,05	0,45	2,36	0,37		
száraz homok	32%	0,96	0,50	2,25	0,39		
nedves homok	98%	0,88	0,48	1,93	0,42		
nedves homok	92%	1,02		1,62		4,83	
nedves homok	76%	0,98		1,66		4,96	
nedves homok	72%	1,02		1,73		4,95	
nedves homok	68%	1,04		1,72		5,11	

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Authors addresses

[1]Zsolt Péter, Kiss Ph.D. college professor, University of Nyíregyháza, Sóstói str. 31/b. Nyíregyháza, H-4400, kiss.zsolt@nye.hu

Contact person
*Zsolt Péter, Kiss Ph.D. college professor, University of Nyíregyháza, Sóstói str. 31/b. Nyíregyháza, H-4400, kiss.zsolt@nye.hu

COMPUTER INTEGRATED MANUFACTURING

doc. Ing. Peter Košťál, PhD.; peter.kostal @ stuba.sk

Institute of Production Technology, Faculty of Material Science and Technology
Slovak University of Technology
J. Bottu 25, 91724 Trnava
Slovakia

Abstract: *This paper presents the proposed steps to be taken for the smooth working of the implemented drawingless manufacturing system. These activities, we will demonstrate on devices which are situated on our institute. These devices are parts of computer integrated manufacturing.*
Keywords: *drawingless, CIM*

1 INTRODUCTION

Modern information technology has opened up new possibilities of flexibilisation and cost reduction in production. One of these possibilities is drawingless manufacturing.

2 ICIM SYSTEM

WE demonstrate the production with the integration of computer support in all phases of the production system. All of these phases are connected. It is called computer-supported production (Computer Integrated Manufacturing – CIM). It is a network of connected computers that includes activities related to production, starting with the product marketing and ending with an expedition to the customer.
CIM - Computer Integrated Manufacturing - is a concept for the structuring of industrial enterprises. Manufacturing technologies demand a CIM concept that can be realised through the capabilities of information processing available today. The idea of integrating different areas of CIM, such as production planning and control (PPC), computer-aided design (CAD) and computer-aided manufacturing (CAM), is explained through operating chains and put into a CIM architecture based on a hierarchy of EDP systems.
If the CIM is a computer-controlled production, iCIM is then the open system of the computer-controlled output of CIM. ICIM 3000 is a training and available model system of CIM made by company FESTO. In Fig.1, we can see the 3D model of iCIM by FESTO. This system consists of stations which are marked in fig. 1. by numerical character 1-8.

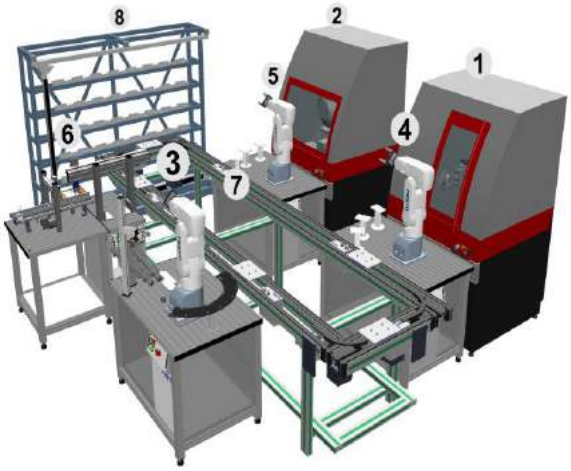

Fig. . The 3D model of iCIM by FESTO
1-Concept Turn, 2-Concept Mill, 3- Flexible Robot Assembly Cells, 4,5-Service robots of concept machines, 6- Pallet Handling and Quality Station, 7-Pallet Transfer System, 8- Automatic Storage / Retrieval System

2.1 Transport system

In the whole system, the transport system is responsible for the transport of workpieces placed upon special workpiece carriers.

Fig. 2. Transport system (Festo didactic, 2013)

2.2 Quality handling station

The quality handling station (fig. 3.) is responsible for the workpiece (pen holder) testing and the manual feeding of the system with pallets. The pallet handling is linear, and the testing is executed with an analogue positional transducer and an additional camera system.

Fig. 3. Quality Handling station (Festo didactic, 2013)

2.3 Robot assembly station

The robot assembly station (fig. 4.) has the function to assemble desk sets, the Independence of the order; the robot completes the desk set. Once the desk set has been completed, it is moved to the AS/RS station.
Once the desk set is assembled, the required palettes containing the necessary components are requested for placement onto the palette receptions.

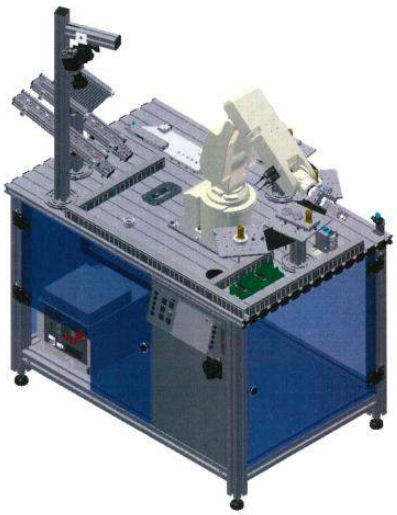

Fig.4. Robot assembly station (Festo didactic, 2013)

2.4 CNC feeding turn

The CNC feeding turn (fig. 5.) is responsible for the production of single parts. The robot takes the raw parts from the magazines to equip the turning machine. Before the workpiece comes on the conveyor systems, the processed workpieces are made available on pallets. There the workpieces are processed corresponding to their order.

Fig. 5. CNC feeding Turn (Festo didactic, 2013)

2.5 CNC feeding mill

The CNC feeding mill (fig. 6.) is responsible for the production of single parts. The robot takes the raw parts from the magazines to equip the milling machine. Before the workpiece come on the conveyor systems, the processed workpieces are made available on pallets. There the workpieces are processed corresponding to their order.

Fig. 6. CNC feeding Mill (Festo didactic, 2013)

2.6 Storage

The Storage Station (fig. 7.) has the function to provide and store the workpieces and various palettes.

Fig. 7. Storage station (Festo didactic, 2013)

3 STEPS FOR IMPLEMENTATION OF DRAWINGLESS MANUFACTURING

The first step will be to analyse the current drawingless production software package suitable for drawingless environments. The second step will be the creation of a general methodology for implementing drawingless production into FMS. The next step will be the specification of measures necessary to implement the drawingless output in FMS. The last step is the verification and application of the established methodology and setting the drawingless production into the environment of the iCIM system.

4 USE OF PMI INFORMATION

Simple elimination of the risks and the ability to utilise all the information is to concentrate. All the data concerning the product in a single source, which should be the 3D model of the components. Nowadays, setting possible manufacturing information into a 3D model offers the use of the PMI, or Product & Manufacturing Information. The possibility of creating PMI information now offer all major CAD systems, and PMI information is gradually becoming part of the ISO and ASME standards (ISO 1101:2004, ASME Y14.41-2003).

PMI aims to transfer a complete set of information necessary to produce the component directly into the 3D model. This information has to be used in all downstream processes such as CAM, CAE, tolerance analysis, brochures and other visualisations, etc. Finally, the PMI has to use the information to communicate with a supplier or customer in so-called drawingless documentation.

PMI information must be created and managed using a single module PMI. Tools for creating PMI information provide a comprehensive description of how to use the 3D model itself PMI size dimensions, add the necessary dimensional tolerances and use geometric tolerances of form and position. Other areas used to describe a 3D model with information are PMI manufacturing information such as surface quality or welding. Among the tools, PMI must also find a wide range of tools to create notes that are otherwise shown on the drawings. Finally, the PMI module has to offer tools for creating 3D models of sections or slices that allow a detailed description of the product.

Important features of all such generated PMI have to be the associativity of generated information of the objects on which the PMI information is created, so it is possible, for example, one mark of quality like finishing assign the entire set of surfaces to be machined with the same rate. At the same time, it must be the logic of the individual instruments controlling derived from the tools for creating the same information on the drawing, which makes the transition from 2D to the 3D environment much more effortless.

5 EXPLOITATION OF 3D MODEL WITH PMI INFORMATION

3D models have to carry the PMI information and serve as a document of controlled documentation managed by the PLM system, providing complete data management and control. Approval Data PLM system must be provided through a defined process so that it has to be traceable in every moment when is something happening with that document and what is his actual status. 3D models containing PMI information have to be the only bearer of comprehensive information about the shape, dimensions and manufacturing requirements among all actors across its life cycle.

6 COMMUNICATION OF PMI DATA

The only reason the drawings through the development process are still created is its necessity for communication across the development process. This communication, however, today, in the electronic age, becomes slow, error - simply outdated. This chapter should focus on sharing electronic form PMI information between different actors in the development cycle.

It will start with the simplest model of communication between the entities. These already have their work available to the appropriate imaging tools. These are CAD systems or other DMU systems - Digital Mock-up. These entities can share information with the support of PMI's information system format, or PMI has the opportunity to share information via universal forms, such as JT or STEP (AP242).

It may be a discrete entity that shares the mere discrete data, or it may be a cooperating entity based on the controlled data database.

Another problem is sharing data with the subcontractors or partners who do not have access to the database. They are dependent on sharing discrete data. They nor have the tools to enable them to collaborate based on information sharing PMI. Even in this case, now there is a very effective way of sharing data in the form of DMU browsers those companies such as Siemens provides free. These are, for example, browsers as browser JT2Go designed generally for any data in the JT format and viewer Xpress Review, intended for SW NX and Solid Edge development laboratories of Siemens.

The possibility of sharing data, including PMI information, is now only a matter of wanting to get away from, in my opinion, the obsolete model sharing information using drawings and embark on a new phase of electronic data sharing.

With the current state of computer technology, we can share this data and, thanks to PLM systems to manage and control, which is fully completed, the process refunds 2D documentation for 3D documentation.

7 THE FORMATION RATE OF PMI INFORMATION

The formation rate of PMI information is one of the cons of using PMI information. In the next step, I will show some principles that the work with PMI information make easier and achieve faster formation, against the creation using a combination of the model with the drawing.

The first principle is to simplify. Then the number of PMI information decrease. This means it is unnecessary to create the 3D model information, as in the drawing. Still, only those essential for the production, respectively, to achieve the desired quality of the components, i.e. only tolerated and checked dimensions, geometric tolerances, notes, and other surface quality.

The second principle is the formation of PMI information already in the actual construction. PMI information is possible (and recommended) already defined in the design work when the designer has a clear idea of what requirements must be designed product accomplishes. This enables to capture of the information immediately at the time of the request. This prevents the complex procedure of inventing and re-thinking all dependencies when creating drawings.

The third method is the conversion of existing parameters—acceleration of opportunities arising from the transformation of the current parameters of the components. For example, in system NX, we will mark only the parameters that we want to convert. Then, with the help of the context menu, I will create the PMI information only from chosen parameters.

8 CONCLUSION

This paper aims to describe the iCIM3000 system, which is situated in our institute, and the further drawingless production methodology steps for its implementation. Categorising these machines, which are presented in this paper, is the first step in the process.

The possibility of sharing data, including PMI information, is now only a matter of wanting to get away from, in my opinion, the obsolete model sharing information using drawings and embark on a new phase of electronic data sharing.

With the current state of computer technology, we can share this data and, thanks to PLM systems to manage and control, which is fully completed by the process, refunds 2D documentation for 3D documentation.

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The importance of hairy vetch (*Vicia Villosa* Roth) in improving the fertility of the acidic sandy soils of Nyírség

Edit Kosztyuné Krajnyák

Abstract: *The typical soil type of the Nyírség is acidic sandy soil, the agronomic utilisation of which is still an unsolved challenge. The unfavourable water and nutrient management, including the easy nitrogen leaching, limits the range of crops that can be grown here and the expected yields. Among the nitrogen-fixing legume crops, the specificity of the species of the hairy vetch makes it an excellent nitrogen-fixing plant for improving acidic sandy soils due to its symbiotic Rhizobium leguminosarum. In our experiments with nitrogen-fixing legumes in the autumn of 2019, we conducted our tests in pure seeding and mixed seeding. Our observations on rhizobium nodules were conducted at 3 seeding times and 3 development stages. The results of the study clearly demonstrated the excellent suitability of hairy vetch for running arable farms on sandy soils.*

Keywords: *Nyírség, hairy vetch, acidic sandy soils, root nodule, N-fixation*

1 INTRODUCTION

The Nyírség is the second largest quicksand area in Hungary, located in the north-eastern part of the Great Plain. Rivers and wind have played the most important role in the formation of its surface (BORSY, 1961). Due to the large grain size of the soil particles, their water-holding capacity is very low, as they lack the higher clay-silt content necessary for the higher water-holding capacity and better water regime. They tend to dry out rapidly, making them less resistant to the wind erosion. As the conditions for humus formation are unfavourable, soil fertility is low and, due to the above-mentioned soil structure, the environment necessary for the proliferation of important micro-organisms is not favourable. The low pH further hinders the storage and uptake of nutrients by plants (STEFANOVICS et al., 1999; LAZÁNYI, 1994).

Originally, these soils are generally poor in colloids, humus and nutrients. They are extremely sensitive to environmental harm or improper human intervention. Since the filtering, buffing and binding capacity of sandy soil are low, they do not provide adequate protection against soil contamination (KÁDÁR, 1999, NÉMETH, 1966). Because of the above, it is important not only for agriculture to care for sand soils, but also for the preservation of the environment and environmental protection and environmental management (KÁDÁR et al., 2011).

Light soils cover more than a quarter (16% are sandy and 9.5% sandy loam) of the total area of our country. As a result, their fertility is limited by the following factors: very high permeability, poor water holding capacity and low available water and low soil test level. They are also prone to drought and wind erosion (VÁRALLYAY, 1984).

The biggest problem of Hungarian plant growing is the mass production and the simple crop rotation based on cereals. The troubleshooting is hard because of the dramatic decrease in number of animals and homeland consumption. In the past few years there was a decrease in sowing area of protein crops which raises crucial issues concerning crop rotation and land use. Therefore, wide range of alternative plants should be taken under close examination in order to establish biodiversity (LAZÁNYI, 2010).

Farmers know that in acidic sandy soils only the crops can be grown that tolerate or require low soil pH (VÁGVÖLGYI et al., 2018).

Its role in maintaining soil fertility has long been known for butterfly plants, although it has not yet been sufficiently utilized in practice. Several experiments prove that by introducing butterfly plants, the demand for nitrogen fertilizers for seedlings can be significantly reduced (BORBÉLY et al., 2007). Among the butterflies there is a unique luster in that it provides a large amount of knotted nitrogen and easily decomposing organic material in the spring, so it is not exposed to the wash-off effect of the autumn-winter precipitation. Long-term, regular use of the grain cereal mixture changes the soil organic balance in a positive direction, although this can only be measured after many years. The advantages of limping can be observed in the year of cultivation (GONDOLA-SZABÓNÉ, 2010).

In the sandy soils of Nyirség, we can find everywhere the cucurbits, beet crops, other oilseed crops besides sunflowers, and also minor plant species that are nowadays referred to as alternative crops (PEPÓ, 2019).

In Hungary, the hairy vetch is a "pioneer plant" of the poor soils. It can be grown everywhere as a mixed fodder. It is a frost-tolerant, overwintering annual plant. Despite this, it is only grown on loose sandy soils (ANTAL et. al., 1996; ANTAL, 2000).

In Hungary its cultivation started only in the end of 1800 years mainly for green forage. Nowadays, it is grown as green manure and cover crop (GONDOLA-SZABÓNÉ, 2010; KUTASY, 2019).

On low nutrient-supply power sandy soils of the Nyírség region, it is also an excellent crop for seed production (SZABÓ et al., 2020). It is one of the most widespread green manure crops in Hungary. Growing legumes as green manure crops is mainly focused on N fixation of symbiotic Rhizobium bacteria (KAHNT, 1986).

The nodule formation is due to the production of NOD factor by Rhizobium bacteria, which promotes hair root deformation and cell division (HIRSCH-FANG, 1994, HELD et al., 2010). MIKO et al. (2012) found that biomass yield of green manure plants and their positive effect on soil fertility, under unfavourable ecological conditions, can be increased by adding 50 kg/ha nitrogen. Newly incorporation of green manure plants causes inadequate off-spring and slow early developing of after-crop. Therefore, 4-6 weeks should be kept between the incorporation and sowing.

During nitrogen fixation, each legumes can form symbiotic relationships with different Rhizobium species. Beech species can fix 50-80 kg nitrogen per ha by Rhizobium leguminosarum (SÁRKÖZY - SELÉNDY, 1994). According to CLARK (2007), the annual nitrogen fixation capacity of the hairy vetch is reported to be 90-200 kg nitrogen per ha, which is outstanding among the legume species. According to GONDOLA-SZABÓNÉ (2010), different vetch species have favourable impact on the economic and sustainable use of acidic sandy soils. The most widely cultivated vetch is the hairy vetch having excellent adaptability.

2 MATERIAL AND METHODS

Our experiment was set up in the Demonstration Garden of the University of Nyíregyháza, where we carried out an open field, container-grown experiment with the cultivation of the hairy vetch (Figure 1).

Fig. 1. The experiment site
Photo: Kosztyuné K.E.

Our study was carried out in a small plot, field experiment. The hairy vetch variety used in the experiment is Hungvillosa, bred in Kisvárda. Valuable features of this variety are: high green mass even in early spring on low fertile soils, excellent winter hardiness and tillering capacity and high productivity. As a supporting crop, we have sown the triticale cultivar Titan, having excellent stem solidness, high yield potential, outstanding tillering capacity, and likes acidic sandy soils. In the experiment, three cropping systems were used (sole vetch, mixed cropping, sole triticale) in 6 replicates at 3 sowing times. The sowing dates were 20/09/2019, 10/10/2019, and 30/10/2019. The experimental pots with a volume of 40 litres were lowered into the ground and filled with soil from the University of Nyíregyháza Training Farm. To avoid the edge effect, we also seeded the surroundings of the plots. In sole cropping systems 20 triticale or hairy vetch, in mixed cropping system 26 triticale and 13 hairy vetch seeds were placed in each plots. Our recordings were made before the onset of winter (28/11/2019), at bud formation (23/04/2020), and at harvest (30/06/2020). We counted and recorded root nodules. Soil test results shown in Table 1, representing the typical Nyirség soils with poor water management, low nutrient supply and low fertility. The data also clearly show that it is light, acidic, non-calcareous sandy soil.

Table 1. Soil test result for the experiment plots (2019)

Parameter	Value
Sampling depth (cm)	0-30
pH-KCl (-)	4,44
Soil plasticity according to Arany (K_A)	27
Total watersoluble salt (m/m%)	<0.02
$CaCO_3$ (m/m%)	<0.1
Humus content (%)	0,89
NO_3^--N+NO_2^-N (mg/kg)	18,7
SO_4^{2-}-S (mg/kg)	<50
Mg (mg/kg)	73,3
P_2O_5 (mg/kg)	173
K_2O (mg/kg)	381
Na (mg/kg)	48,5
Zn (mg/kg)	0,86
Cu (mg/kg)	0,99
Mn (mg/kg)	50,6

Source: Hungarian Horticultural Propagation Material Non-profit Ltd.

Macromorphological survey and nodule counting were carried out on 10 plants. During this process plots were lifted out, and the soil was removed from roots by hand carefully before the root washing. (Figure 2).

Fig. 2. Lifting out of plots, root washing and nodule counting

Photo: Kosztyuné K.E.

In the cropping year of 2019-2020, precipitation was high in November, December and February. Spring was dry and the first, and the first remarkable quantity of rain fell in June. (Figure 3).

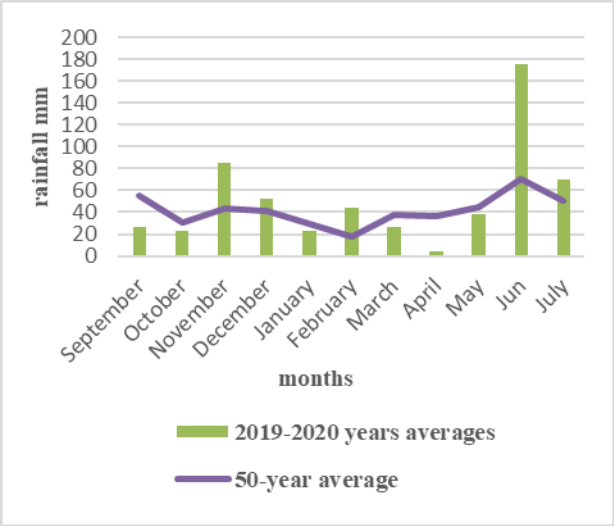

Fig. 3. Monthly averages of rainfall in the growing season
Source: measurements done by DE AKIT Nyíregyháza Research Institute

In that cropping year winter and autumn temperature averaged over a 50-year period. In spring, temperature was only close to those of a 50-year period (Figure 4).

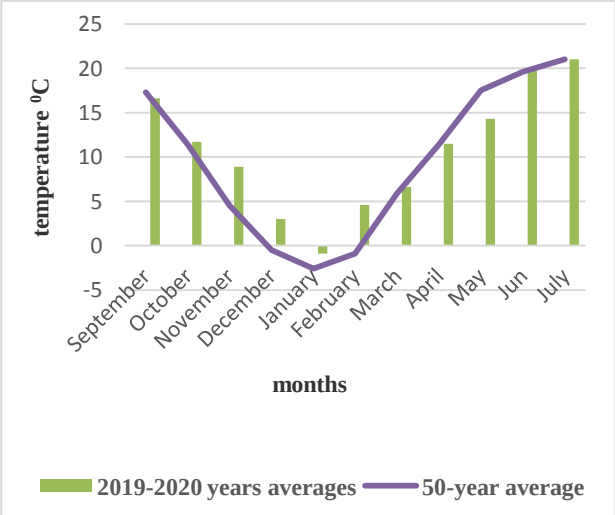

Fig. 4. Evolution of the monthly average temperature data of the growing season
Source: measurements done by DE AKIT Nyíregyháza Research Institute

3 RESULTS

Figure 5-7 show the nodule numbers in sole cropping system.

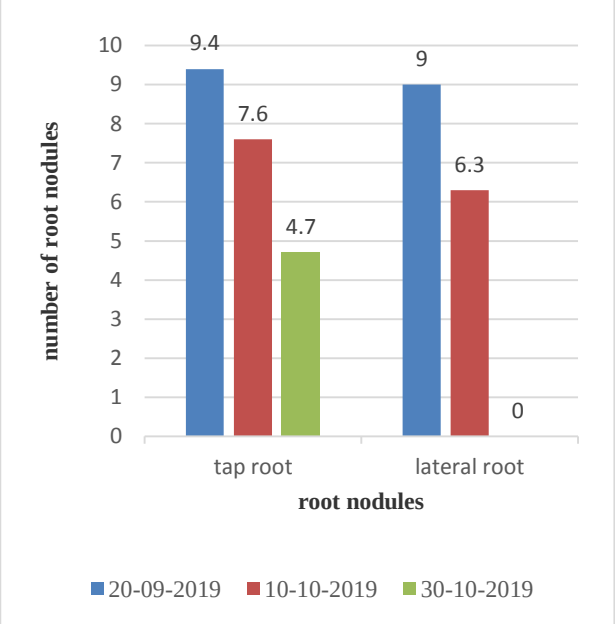

Fig. 5. Changes in Rhizobium nodules before winter in sole cropping system

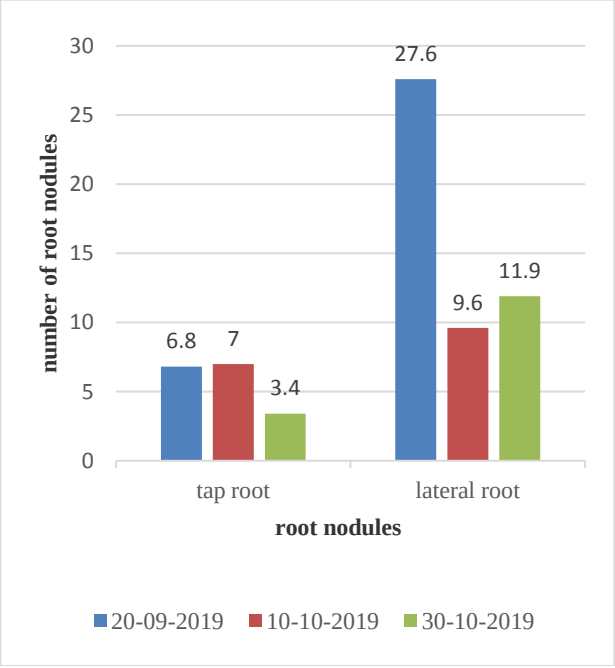

Fig. 6. Changes in Rhizobium nodules at bud formation stage in sole cropping system

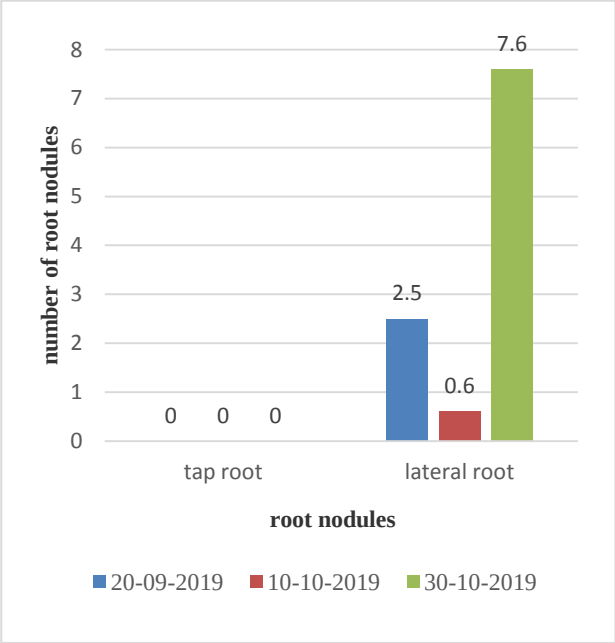

Fig. 7. Changes in Rhizobium nodules at harvesting in sole cropping system

The number of nodules on the main root just before winter was well above the values measured at bud formation stage. As the harvest approached, the root nodules were
increasingly located on the lateral roots. Practically no root nodules were found on the main root.

Nodule numbers in mixed cropping system is shown in Figure 8-10.

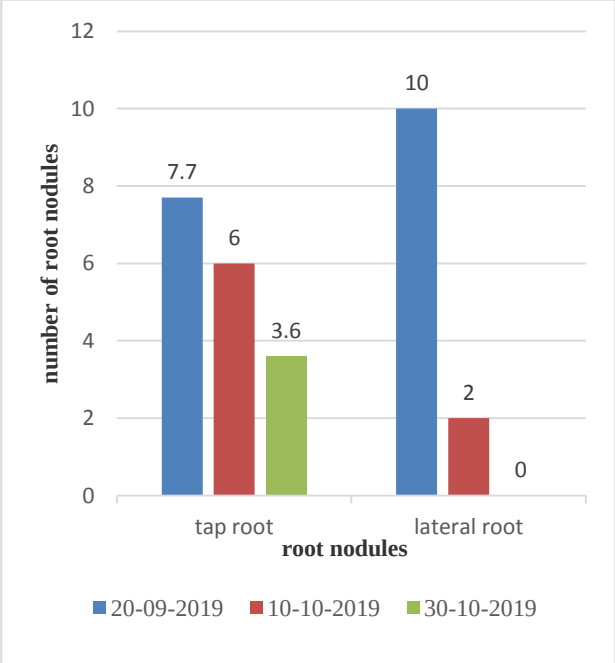

Fig. 8. Changes in Rhizobium nodules before winter in mixed cropping system

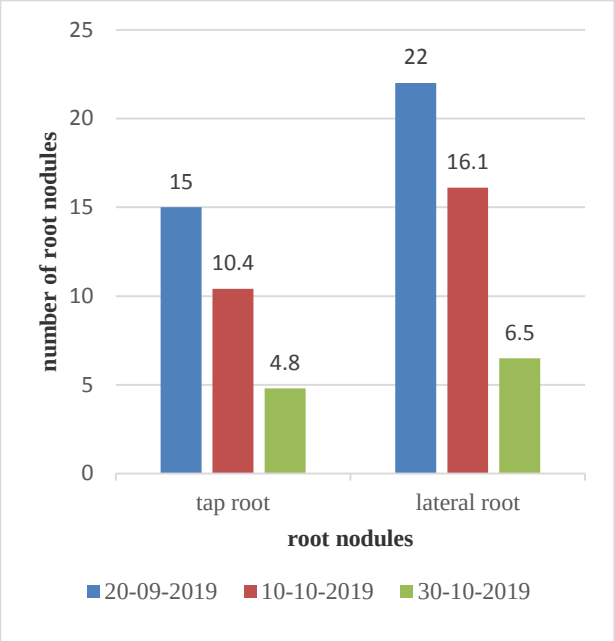

Fig. 9. Changes in Rhizobium nodules at bud formation stage in mixed cropping system

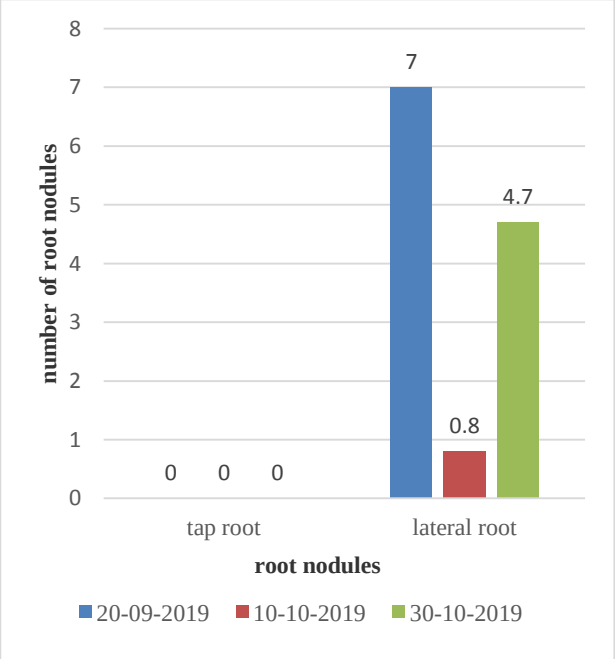

Fig. 10. Changes in Rhizobium nodules at harvesting in mixed cropping system

In mixed cropping system, rhizobium nodules persisted on the main root, but were no longer observed at harvest. Again, as development progressed, the nodules became increasingly located on the lateral roots.

4 CONCLUSION

Soil fertility is remarkably affected by rhizobium nodules on the roots of nitrogen-fixing plants. As for hairy vetch the nodule formation in the main and lateral

roots starts intensively within 6-8 weeks after emergence. This is important because, even in the case of green manure cropping, a remarkable amount of nitrogen is accumulated in the root zone. Nodule formation is continuous throughout the growing season, but variation in nodule location is observed. The number of nodules increases on the side roots, which form continuously, while on the main root their number decreases continuously as the growing season progresses. The increase in soil nitrogen content is almost the same for all uses (green manure, green fodder, seed production). The soil improvement effect of the hairy vetch goes far beyond the amount of nitrogen collected in the rhizobium nodules, as it provides adequate soil cover from early autumn to early summer in the otherwise easily mobile, loose-textured acidic sandy Nyirség soils.

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Authors addresses

Edit, Kosztyuné Krajnyák, University of Nyíregyháza, Sóstói 31/b krajnyak.edit@nye.hu

Contact person

Edit, Kosztyuné Krajnyák, University of Nyíregyháza, Sóstói 31/b krajnyak.edit@nye.hu

Evolution of instationary performance balance of agricultural tractor with active front axle suspension

Zoltán Kovács[*]

Abstract: The usage of the active front axle suspension to tractors with mechanical front wheel drive has started for only in 1990's years. During the operation on the fields the load of tractor is not stable, but it is a strongly time varying one instacioner load. The suspended front axle changes the shock parameters of the tractor and this also affects the traction parameters as well. During the research we would like to find the answer that how the drawbar force, tractive performance and wheel slips change because of the active front axle suspension. Using the results of field tests, it was proved that active front axle suspension significantly reduces slip, in other words, increases the potential traction force at a given slip. It was also proved that on the chassis more moderate shock waves develop. Due to this the range of the different traction parameters (statistical dispersion) will be more moderate. This results in more constant, less fluctuating drawbar force and the tractor will be able for higher tractive performance.

Keywords: agricultural tractor, tractive performance, active front axle suspension

1 INTRODUCTION

Nowadays of the universal agricultural power machines with mechanical front wheel drive (MFWD) has been increased continuously. These tractors in most cases have linear characteristic suspended front axle. According to the manufacturers by using the suspended front axle not only the comfort of the driving improves but the drawbar force of the power machine increases as well, the slip reduces and the stability of the tractor increases on the roads.

The traction features typical of the tractors are influenced by several parameters and these can be classed into three groups:

- soil mechanical parameters,
- the features of the tyre-soil relation, the features of the given tyre,
- the structural construction of the tractor, driving mode.

The usage of the active front axle suspension on the agricultural tractors has started about 20-25 years ago. The earlier tests were done mainly on examining the relations of the suspension and shocking and its analysis and the possible modeling and the simulation [1, 2, 3, 4, 5].

The researches till now defined the effect of the vertical shocks of the wheels on the drawbar force and the tractive performance of the tire based on mainly theoretical considerations and experiences done on single-wheel testing machines [6, 7]. By taking into consideration the fact that several scientists and publication deal with traction features of the mechanical front wheel drive tractors without suspended front axle it can be said that the examination and comparative analyses of the traction features of the active suspended front axle tractors are far from the complete.

One of the aims of the research introduced in the article was to examine how the active suspended front axle effect the major traction parameters (pulling force, velocity, tractive performance, wheel slips, etc.) of the mechanical front wheel drive tractors and the relation of the slip – drawbar force.

2 MATERIAL AND METHODS

2.1. Testing program

In order to achieve the targets I did traction tests on the field. The land was flat wasteland after harvesting. The definition of the soil characters was done by samples taking. From the 0-25 cm level of the soil randomly several samples were taken. . For defining the weight-bearing capacity and the compactness of the soil EIJKELKAMP 06.15.01 cone-shaped penetrologger was used. The penetrometer had standard cone and arm [8], the main technical parameters can be found in Table 1.

Table 1. Main technical parameters of the Eijkelkamp 06.15.01 penetrologger

Number	Name	Technical parameter
1.	Operational temperature range	0 – 50 ^{0}C
2.	Weight	2,9 kg
3.	Maximal penetration force	1000 N
4.	Force resolution	1 N
5.	Measure range	0 – 80 cm
6.	Depth resolution	1 cm
7.	Memory capacity	1500 measures

The field traction test was done in two modes (rear wheel and all wheel drive). The total weight of the tractor was set to 7.860 kg with spare weights. During the examination we used three different static axle loads:

1) 33,08 % of the total weight (2.600 kg) on the front and 66,92 % (5.260 kg) on the rear axle;
2) 40,71 %-of the total weight (3.200 kg) on the front and 59,29 % (4.660 kg) on the rear axle;
3) 48,35 % of the total weight (3.800 kg) on the front and 51,65 % (4.060 kg) on the rear axle.

The measuring was done under three different gear conditions:

1) v=1,53 m/s (5,5 km/h) – B1 gear;
2) v=2,19 m/s (7,9 km/h) – B3 gear;

3) v=2,92 m/s (10,5 km/h) – C2 gear.

The applied tire pressures were set in accordance with the static axle load settings as follows:

- Setting 1. – 1,0 bar;
- Setting 2. – 1,3 bar;
- Setting 3. – 1,6 bar.

In addition, we used the front axle suspension in active and inactive mode.

Altogether the number of examination settings was 36 (Fig. 1).

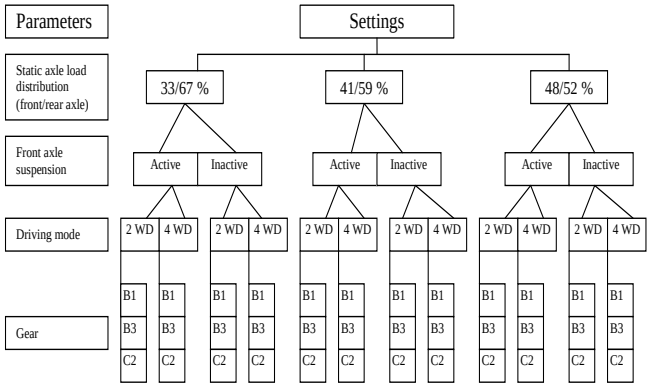


Fig. 1. Testing program

2.2. The objective of investigation - vehicles

The test tractor was a JOHN DEERE 6920S power machine. The tractor's front wheels are steered with mechanical front wheel drive. The main technical data of the power machine can be found in Table 2.

The tractor had TLS system (Triple Link Suspension) active front axle suspension. The main feature of the TLS system is that the stable front axle housing is connected to the frame by two hydraulic cylinders. The hydraulic cylinders are connected to three hydroaccumulators by an ECM, so they compose a closed system that ensures a continuous (active) suspension.

The loading of tractor was achieved by a specially built vehicle. This vehicle was prepared by the Hungarian Institute Agricultural Engineering in Gödöllő from a MAZ 537 rocket and tank mover vehicle. The connection between the tractor and the vehicle was ensured by a coupling rod with dynamometer (Fig. 2). We used a drawbar instead of a towing rope because it can be used to create also a "pushing" mode. The aim of "pushing" mode to measure the slips of driven wheels without drive.

During the field traction tests, a number of parameters were measured and recorded. The most important of these for the presentation and evaluation of the results were:

1) velocity [m/s];
2) RPM of the front and rear wheel [min-1];
3) RPM of the engine [min-1];
4) drawbar force [kN];
5) vertical acceleration on the left side of front axle [m/s^2];
6) vertical acceleration on the right side of front axle [m/s^2];
7) vertical acceleration on the frame [m/s^2];
8) engine fuel consumption [l/h].

Table 2. Main technical data of the JOHN DEERE 6920S power machine

Technical parameters	Unit of measurement	Size
Length	mm	5815 (with supplement weights)
Axle distance	mm	2650
Gauge on the front/rear axle	mm	1412 – 2087/1319-2311
Own weight (in marching order)	kg	5600
Supplement weight front/rear	kg	2290/3420
Technically highest allowable max. total weight	kg	11.000
Technically highest allowable max. axle load	kg	front: 4600; rear: 7800
The height of the drag hog from the ground	mm	850
Nominal performance	[kW/min^{-1}]	110/2100
Ratio of the differential	-	front: 2,214; rear: 4,9
Reductor	-	front: 6,4; rear: 6,4
Mode of wheel suspension	-	Front: stable, suspended axle housing Rear: stable, unsuspended axle housing
Tires	-	Front: TAURUS 14.9 R28 Rear: TAURUS 520/70 R38

Fig. 2. Testing program

2.3. Method of data processing

A SPIDER Mobil measuring and data collecting system with 16 channels received the data from the different transmitters. The established computer driven system provided the continuous tracking of the drawbar force-slip curves from the different measurement points. Due to this we had the possibility to evaluate and represent the measurement results directly after the measurements.
The applied sampling density was 200 Hz. The data collected by the measuring system was recorded by a CATMAN software. The measurement was done in the following steps:

- After the stabilization of the engine revolution and the tractor speed the "zero slip" point was recorded;
- After recording the "zero slip" point, the load of the drawbar force was increased in equal steps and the different measurement points were recorded;
- The time for the different measurement points was chosen to be 12 s and during this period the data was recorded (under 200 Hz data collecting frequency it means data is recorded every 0,005 s). In this way during a 12 s period, 2400 pcs of data were collected from the measurement points;
- After setting up every new measurement point, we waited till the load of the drawbar force and the engine revolution had stabilized and after that the data of the new 12 s measurement period was recorded;
- During the measurements we increased the load of the drawbar force at every setting until the slip of the wheel did not reach 25-30 %;
- During a taken measurement, based on experience 15-20 measurement points were taken;
- During the data processing we set 14 measurement points at every setting, taking into consideration that (if it was possible) the sequentially load steps increased evenly.

We counted the average of the data collected during the 12 s every second. Then from these averaged values we counted the average value of the given measurement point, and we used these average values for further data processing and evaluation.

3 RESULTS AND DISCUSSION

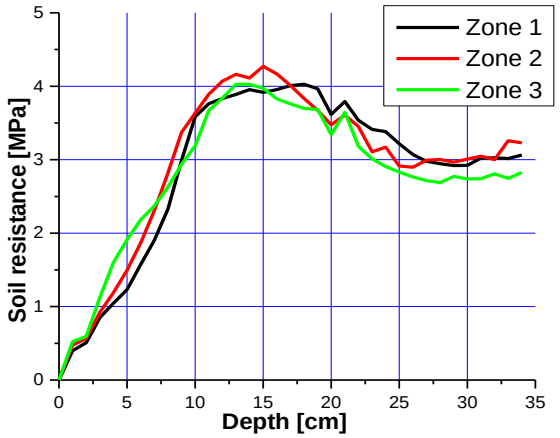
3.1. Results of the soil examination

Depth range [cm]	Soil moisture [mass%]	Soil moisture [volume%]	Density [g/cm^3]	Porosity [%]	Soil compact-ness	Physical type
0-5	4,77	6,82	1,36	49,63	Medium compacted	clay loam
5-10	6,92	9,79	1,32	51,12	Medium compacted	loam
10-15	8,26	12,07	1,34	50,38	Medium compacted	loam
15-20	10,98	15,57	1,62	40,0	Strongly compacted	loam
20-25	9,81	13,98	1,28	52,60	Mildly compacted	loam

The characteristics of the soil used for the examination can be found in the Table 3.

Table 3. Main soil characteristics of the experimental land

Based on the data from Table 3 we can draw the conclusion that the experimental soil was dry and medium compacted. The soil according to soil technology can be treated as loam. The compactness results of the cone penetrometer can be seen in Fig. 3.



The average cone index (CI) of the territory in the 0-15 cm layer was $CI_{0\text{-}15}$=2.365 kPa.

Fig. 3. The average soil resistance values of the experimental territory

3.2. Non-permanent performance balance of the tractor

During the operation of the tractor the load is not stable but varies acutely with time and is called an non-permanent load. This means that the performance balance of the tractor varies strongly with time and hence it has strong dynamics. Previous tractive tests and measurement technology methods treated the tractor's performance balance mainly as stationary. But up-to-date measurement technology instruments and methods make it possible to examine the performance balances dynamically, which were examined earlier statically. So we set up such a measurement system that offers the chance to set the frequency of the sample taking at 200 Hz. Based on practical experience, this sample taking frequency is sufficient for studying the value fluctuation of different components of the performance balance. Moreover, there is a chance to compare the momentary performance balances values under active and inactive front axle suspension. On Fig. 4 one can see the fluctuation of the drawbar force under 30 kN with active and inactive front axle suspension. From the diagram it can be clearly seen – though the load was stable during the measurement – there was a significant fluctuation in the values. This fluctuation – which means an non-permanent load for the tractor engine – is caused by the roughness of and the possible inhomogeneous soil.

The visual analysis of Fig. 4 shows that if the active front axle suspension is used, a smaller fluctuation of the drawbar force would be expected. Examining the further fluctuation of the drawbar force under different settings, but with the same load, we obtained similar results.
It is known that rolling resistance consists of tire and soil deformation and the energy loss caused by vertical oscillation. The vertical oscillations are caused by the combination of the roughness of the soil and the drawbar force. The oscillations develop on the front wheels of the tractor and they are transmitted to the frame. We therefore examined the vertical acceleration of the front tire and the frame during the exertion of the drawbar force. Fig. 5 shows the vertical accelerations values of frame which connected to the fluctuation of the drawbar force represented on Fig. 4.

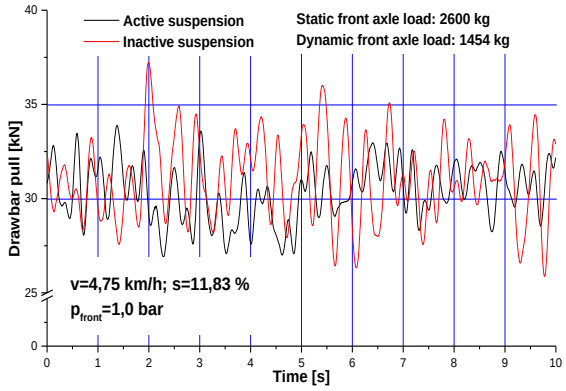


Fig. 4. Drawbar force fluctuation in case of active and inactive suspension under constant load

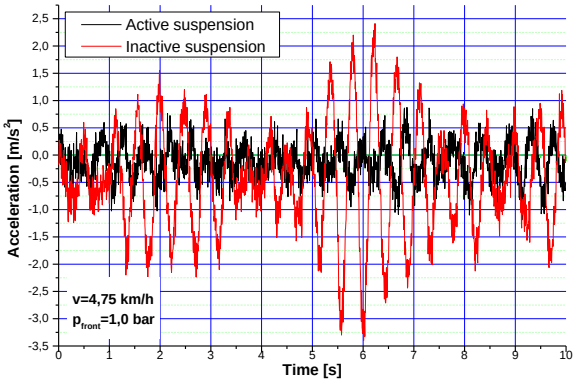


Fig. 5. Frame shock accelerations in case of active and inactive front axle suspension with stable load

After visual evaluation, the difference between the vertical accelerations of frame in case of active and inactive suspension became obvious. But for the more objective analyses, we determined the RMS (Root Mean Square) values of the vertical acceleration values of the frame and the right and left front wheels by using the (1) relation

$$RMS = \sqrt{\frac{x_1^2 + x_2^2 + \ldots + x_n^2}{n}}, \qquad (1)$$

where: x_1, x_2,… - values of investigated parameter;
n – number of data.

The values of the RMS calculation are summarized in Table 4.

Table 4. RMS values of the shock accelerations of the frame and the right and left front wheel under the different experimental settings ($F_{drawbar}$ ≈30 kN)

Gear	Static front axle load [kg]	RMS					
		Left front wheel		Chassis		Right front wheel	
		Active susp.	Inacti-ve susp.	Active susp.	Inacti-ve susp.	Active susp.	Inacti-ve susp.
B1	2600	0,841	1,298	**0,363**	1,065	0,839	1,354
	3200	0,922	1,165	**0,566**	0,787	1,152	0,978
	3800	0,908	1,193	**0,785**	1,070	0,972	1,415
B3	2600	0,906	1,327	**0,550**	1,042	1,009	1,309
	3200	1,073	0,788	**0,461**	1,109	1,352	1,089
	3800	1,139	0,993	**0,667**	0,772	1,280	0,987
C2	2600	1,263	1,347	**0,675**	0,963	1,076	1,198
	3200	1,295	1,859	**0,771**	1,154	1,637	1,686
	3800	1,531	1,767	**0,787**	1,308	1,485	1,662

The counted RMS values confirm the previous assumption that the active front axle suspension reduces the vertical acceleration of frame. For every test setting – due to the active front axle – demonstrable milder fluctuation appeared on the frame. Another important result is that even in the case of permanent shock acceleration and scatter on the right or left front wheel (e.g. gear B3, 3200 kg load) with active suspension, the shock acceleration appearing on the frame is still more moderate.
For the more detailed and objective analyses we defined the statistical scatters of the drawbar force values and the main traction parameters (velocity, tractive performance, front and rear wheel slip) by using the known (2) formula:

$$\sigma = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}}, \qquad (2)$$

where: x_i – the temporary value of the given parameter;
$\bar{x}$ - average value of the given parameter;
n – number of data.

By using the scatter as a statistical feature, the divergence from the average value of a given parameter can be examined with in case of active and inactive suspension. We defined the scatters of the examined parameters in all the three gears and in all the three static axle load distributions, with 30 kN average drawbar force. We did the calculations with the data collected during a 10-minute recording period. This meant – by taking into consideration the 200 Hz sample taking frequency – 2000 pcs of data with all the parameters. In Table 5 the scatter values in gear B1 (v=4,75 km/h) can be seen.

After reviewing the results of the scatter examination the following conclusions can be drawn:

- with all the three static axle loads the scatter of the drawbar force is lower in the case of active suspension than in inactive suspension. This means that the fluctuation of the drawbar force is smaller if the front axle of the tractor working with suspension;
- increasing load implies increasing scatter of the drawbar force in the case of both active and inactive suspension, hence the fluctuation of traction parameters of the tractor increases with the load;
- the scatter values of the velocity do not show significant changes with either active or inactive suspension.

Table 5. The scatters of the traction parameters and shock acceleration values under 30 kN average drawbar force

Gear: B1 (v=4,75 km/h);						
Traction parameter	Active susp.	Inactive susp.	Active susp.	Inactive susp.	Active susp.	Inactive susp.
	Q_{front}=2600 kg		Q_{front}=3200 kg		Q_{front}=3800 kg	
Drawbar pull	1,480	1,959	1,660	1,809	1,898	2,776
Velocity	0,019	0,027	0,022	0,025	0,021	0,027
Traction power	2,100	2,690	2,399	2,537	2,729	3,886
Front wheel slip	1,368	1,761	1,539	1,686	1,661	1,849
Rear wheel slip	1,463	1,811	2,003	1,807	1,559	1,797

The results of the scatter examination definitely support the conclusion that the active front axle suspension results in smoother drawbar force performance. This is because the dynamic vertical load results in an adhesion force which is also smoother, because of the suspension's peculiarity.

3.3. Examining the drawbar force-slip relation

We defined the drawbar force-slip relation of the whole load cycle from the data collected during the different settings of the field traction test. After that we presented the curves of the active and inactive suspension with the same settings on a common diagram. Fig. 6 is an example of this, that represents the changes of the drawbar force-slip at the first static axle load distribution (33/67 %) setting with B1 gear with active and inactive front axle suspension.

From the curve it can be seen that the drawbar force-slip relation during the whole load cycle is similar, even with active and inactive suspension. The positive effect of the active front axle suspension can be observed with higher drawbar force exertion. In the case of the examined setting, it could be seen that above the 30 kN drawbar force value the slip of the rear and front wheels were smaller with active suspension. It is also clearly visible that by increasing the drawbar force the differences also increase. This trend is true for the other experimental settings. Generally speaking it means that the usage of the active front axle suspension reduces the scale of the wheel slip, during a given drawbar force exertion. In other words during a drawbar exertion for a given slip value, a higher drawbar force is obtained in the case of active front axle suspension.

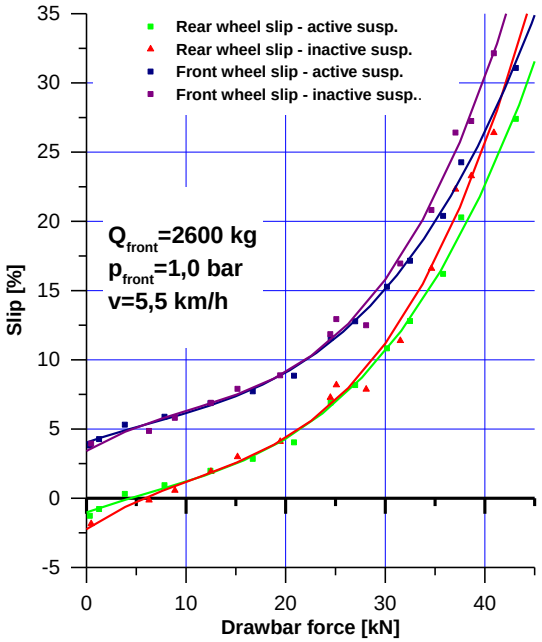


Fig. 6. Changing of the wheel slips plotted against the drawbar force

4 CONCLUSIONS

Based on the analysis and evaluation of the measurement results, the following general conclusions can be drawn:

1) The elaborated measurement method is suitable for defining the performance balance of mechanical front wheel drive tractors and comparing the active and inactive front axle suspension.
2) During the field tests, with the help of the 100 and 200 Hz digital sample taking, the changes of the tractor in static performance balance can be tracked well and the changes of the vertical acceleration during the operation can be analyzed in detail.
3) There is a significant difference, for the benefit of active suspension, in the scatter values of drawbar force, tractive performance and the vertical acceleration of the chassis.
4) After analyzing the measurements of the filed traction tests it can be said that in the case of all

wheel drive, the active suspension of the front axle results in a smoother dragging force of the tractor. With active front axle suspension and given slip, the tractor is able to exert a greater dragging force.

5) The reason might be that in the case of suspension with static front axle load – as an average value – smaller plus-minus changes can be observed. This proves that the measured drawbar force values show smaller fluctuation. Statistically it means more moderate scatter values.

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Authors addresses

Zoltán Kovács, college professor, University of Nyíregyháza, Institute of Engineering and Agricultural Sciences, H-4400 Nyíregyháza, Sóstói Str. 31/b., (06 42) 599 400/2415, zoltan.kovacs@nye.hu

Contact person

**Zoltán Kovács, college professor, University of Nyíregyháza, Institute of Engineering and Agricultural Sciences, H-4400 Nyíregyháza, Sóstói Str. 31/b., (06 42) 599 400/2415, zoltan.kovacs@nye.hu*

Typing, Modeling, Simulation and Manufacture of Internal Worm Gear Pairs

Gábor László PÁY

Abstract: *The internal worm gear pairs are special ones, which are composed by a helical worm and an internal teeth worm wheel. The paper presents some typing constructive model, mathematical model and simulation problems, and also, one of the manufacturing methods. Also, it presents the special devices which need for this manufacturing method.*

Keywords: internal worm gear, simulation problems, helical worm hob

1. INTRODUCTION

The internal worm gearings are composed by a worm gear and an internal teethed worm wheel. This type of worm gearing was patented by Pay E. [1]. After the publication of this patent appeared the necessity of the execution of helical worm, essential element of the worm gear pair. Thus in 1987 is patented the "Worm hob for the manufacturing the helical worm" [2]. Two years later, after solve of some technological problems, had been executed the first helical worm with the devices patented in 1987 (figures 1 and 2).

The results were promising. Were approach aspects regarding the precision, the mating surfaces, and the gearing conditions of these worm gears.

The first recognition of the success was obtained after a Ph.D. theses in this field in 2001 [4]. Also, was realized the first helical worm hob (figure 3.) [3,4,5] and were established the gearing limits in the general case [3,4] when the angle from the worm's and worm wheel's axis is between 0 and 90 degree.

My research can be resumed in the followings:

a). The determination and typization of construction models;

b). The manufacturing of the prototype of this gearing using the needed special devices;

c). The mathematical modeling of the internal worm gear pair in the case of perpendicular axes;

d). The simulation of connection surfaces of the prototype using the special devices;

e). The mathematical modeling of the general case, when the axes are not perpendicular;

f). The mathematical modeling and the manufacturing of helical worm hob.

In the paper I present the constructive models, the mathematical model and the simulation of the contact and the manufacture method of these special worm gear pair.

2. TYPING CONSTRUCTIVE MODELS

A helical worm and an internal teeth worm wheel compose the internal worm gear pairs. At this gear pair the axis can have different positions: parallel, perpendicular or general.

Figure 4 presents an internal worm gearing with parallel axes.

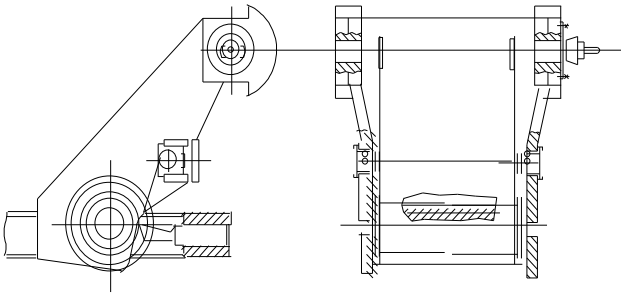


Figure 1. Arm device for helical worm manufacturing

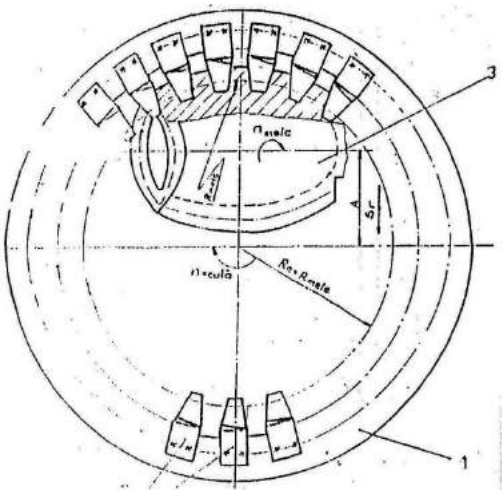


Figure 2. Multi-cutter device

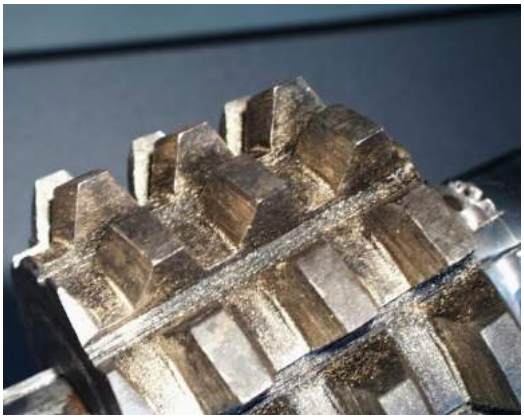


Figure 3. Helical worm hob [3], [4]

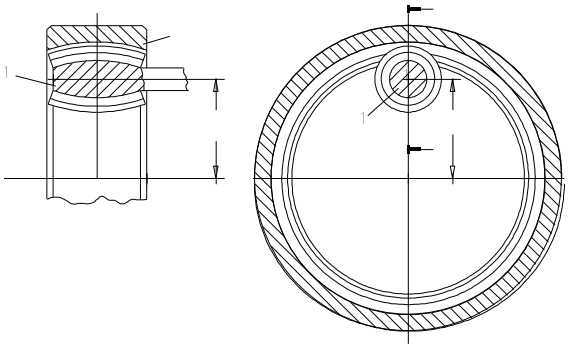


Figura 4. Parallel –axes internal worm gearing

For this case, mathematical modeling is relatively simple and its does not raise either technological or assembling problems regarding worm bearing. This type of gearing resembles the helical gearing, but as a worm

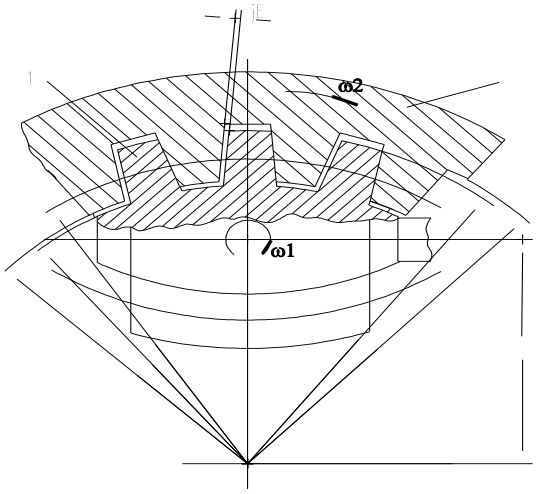


Figure 5. Internal worm gear pair with perpendicular axis

gearing higher transmission ratios and a higher covering degree can be obtained.

Figure 5 presents an internal worm gear pair with perpendicular axes. Mathematical modeling resembles that of the globoid worm gearing .At this type of gearing, assembling problems occur, as for worm bearing very large worm wheels are to be used.

Figure 6 represents the general case, which is the one when the angle between the worm's axes and that of the worm wheel encloses an angle between 0º and 90º.

Though mathematical modeling is more difficult, we can state that it is the most favorable case for an internal gearing, as worm bearing faces no problems and we can reach reasonable dimension, along with high efficiency.

At the same time, the driving elements can be fixed in the interior of the worm wheel so as to obtain a reduction of the necessary space also. The determining of the gearing field and the computer simulation of this type of gearing represent the research at present.

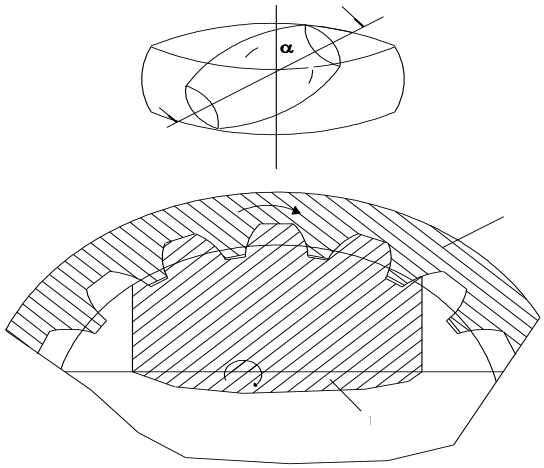


Figure 6. Internal worm gearing with any axes

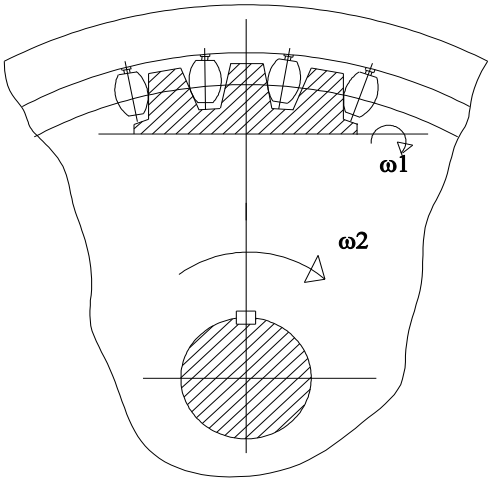


Figure 7. Internal worm gearing with worm wheel with pins

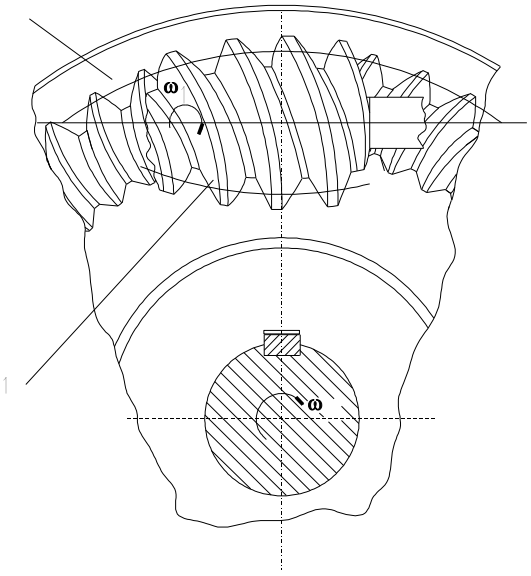


Figure 8. Tangential worm gearing

As we can observe from the facts above, at internal worm gearings it is not necessary for the angle between axes to be of 90º, even any angle between the axes being favorable, contrary to the cylindrical or globoid worm gearings, where the angle between the axes is of 90º.

Following I present two special type of this kind of gear pair. In figure 7 we have an internal worm gearing, where the internal teeth of the worm wheel was replaced by pins, so that the sliding friction from the gearing was changed into friction by rolling [4,5].

Figure 8 presents a tangential worm gearing, a case in which no assembling problems occur, and the worm can simultaneously gear with two worm wheels, thus achieving a type of differential.

3. THE MATHEMATICAL MODELING OF INTERNAL WORM GEAR PAIRS

This paper presents the analytical generation method in general case when the angle between the axes is between 0 and 90 degree [3] [4], [5]. This method is an analogy with the globoid worm gears [4], but is the reverse situation.

The used coordinate systems in figure 9 are the following:

- $O_1x_1y_1z_1$ - the worm related reference system; the worm rotation axis is the Y_1 axis; the relative position of the technological reference system is given by the φ_1 parameter - the worm rotation angle;
- $O_0x_0y_0z_0$ - the functional reference system; it is the reference system considers to be fixed;
- $O_1^*x_1^*y_1^*z_1^*$ - a fix system, which is rotate to $O_0x_0y_0z_0$ system with γ = constant angle, where $\gamma = (0°, 90°)$;

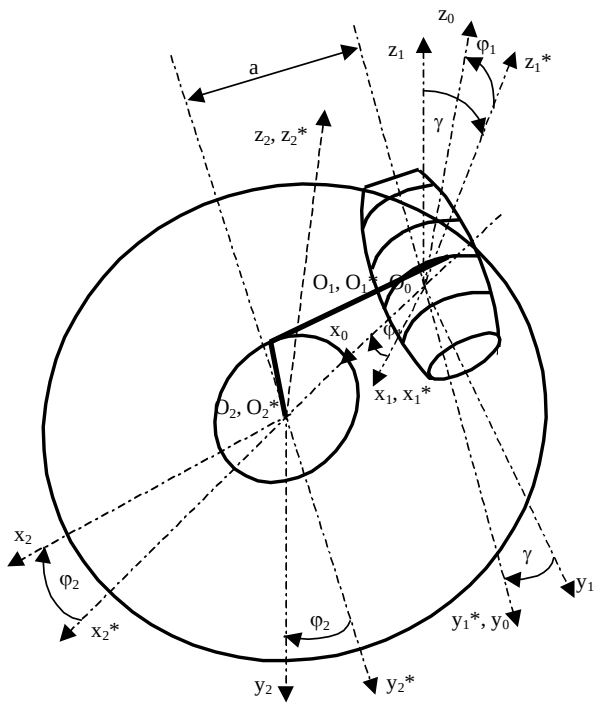


Figure 9.The model of internal worm gear pair

- $O_2^*x_2^*y_2^*z_2^*$- intermediary fix system which is translate to $O_0x_0y_0z_0$ system with the distance between the axis "a" on the direction of O_0z_0 ax;
- $O_2x_2y_2z_2$ - the wheel related reference system; the wheel rotation axis Z_2 is parallel to Z_1 and perpendicular on the paper plane; the relative position to the technological reference system is gave by the φ_2 parameter - the wheel rotation angle.

The worm's flank is generated by "u" straight line, which is in the paper plane, also the division diameter of the wheel. The generate line is always tangent to the profile circle with "r" radius (figure 10.).

The coordinates of motion point from the worm after the transformed of generate line's coordinate from the worm wheels system into the worm system is the follow:

$$\begin{aligned} x_1 &= -\cos\varphi_1\left[a - r_0\sin(\varphi_2 - \alpha_{ax}) + u\cos(\varphi_2 - \alpha_{ax})\right] \\ y_1 &= -\sin\gamma\sin\varphi_1\left[a - r_0\sin(\varphi_2 - \alpha_{ax}) + u\cos(\varphi_2 - \alpha_{ax})\right] + \\ &\quad + \cos\gamma\left[r_0\cos(\varphi_2 - \alpha_{ax}) + u\sin(\varphi_2 - \alpha_{ax})\right] \\ z_1 &= -\cos\gamma\sin\varphi_1\left[a - r_0\sin(\varphi_2 - \alpha_{ax}) + u\cos(\varphi_2 - \alpha_{ax})\right] - \\ &\quad - \sin\gamma\left[r_0\cos(\varphi_2 - \alpha_{ax}) + u\sin(\varphi_2 - \alpha_{ax})\right] \end{aligned} \quad (1)$$

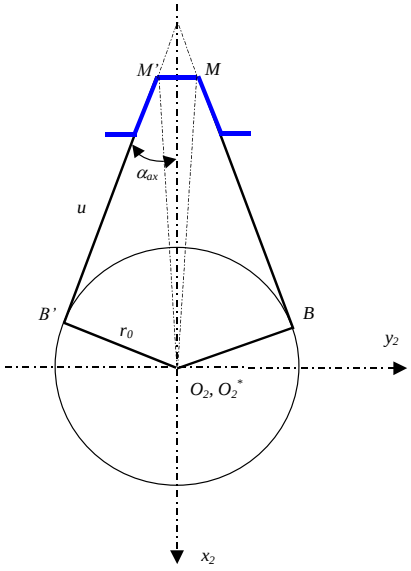


Figure 10. The scheme used for generation

Figure 11 presents the model of the worm used for simulation and figure 12 is the simulated worm used the relation 1.

I have obtained the gearing equation for this type of worm gear pair. I can write the equation as a square equation in „u" because the variable both in the normal components and the relative speed components is „u". The gearing equation will be [4]:

$$Mu^2 + Nu + P = 0$$

$$\begin{cases} M = a_1 \cdot c_1 + a_2 \cdot c_2 + a_3 \cdot c_3 \\ N = a_1 \cdot d_1 + b_1 \cdot c_1 + a_2 \cdot d_2 + b_2 \cdot c_2 + a_3 \cdot d_3 + b_3 \cdot c_3 \\ P = b_1 \cdot d_1 + b_2 \cdot d_2 + b_3 \cdot d_3 \end{cases} \quad (2)$$

where

a_1, a_2, a_3, b_1, b_2, b_3 are the components of the common normal

c_1, c_2, c_3, d_1, d_2, d_3 are the relative speed components

The discriminator of this equation is

$\Delta = \sqrt{N^2 - 4MP} \geq 0$, therefore the equation has real roots.

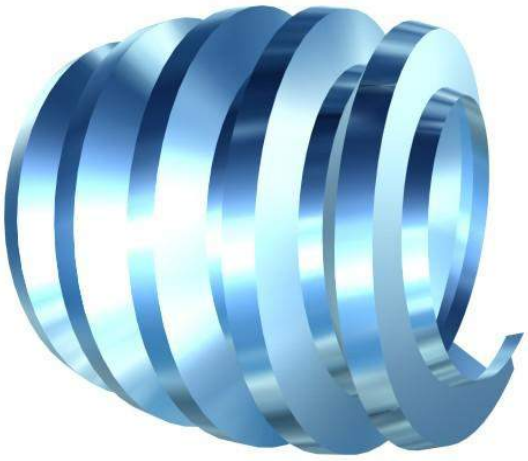
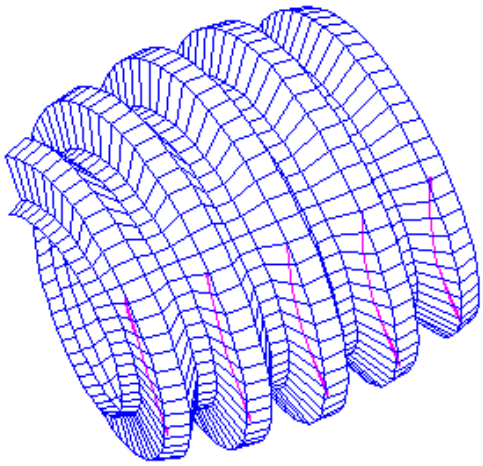
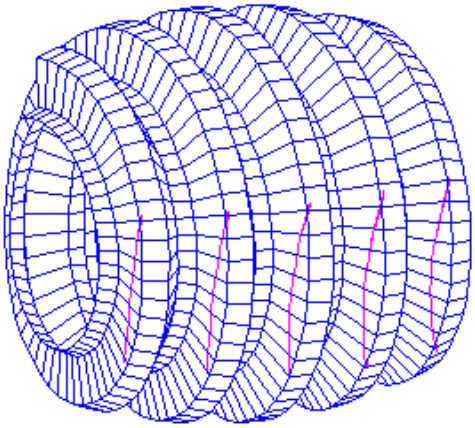


Figure 12. The simulated worm

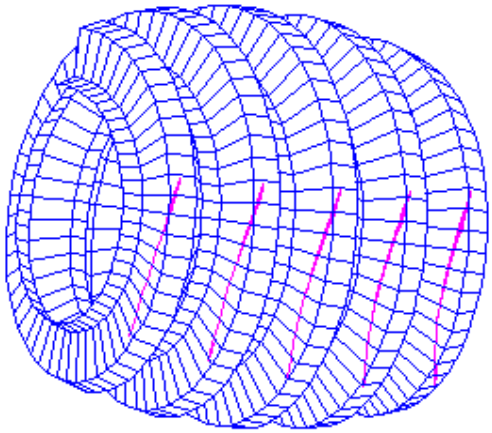
Figure 13 presents the mating surfaces for different angles between the axes [4].



i_{21} = 40, q = 14, m = 10, γ = - 10°



i_{21} = 40, q = 14, m = 10, γ = + 10°



***i_{21}** = 40, q = 14, m = 10, γ = + 20°*

Figure 13. Mating surfaces for different angles [3]

4. THE MANUFACTURE OF THE INTERNAL WORM GEAR PAIR ELEMENTS.

Taking into account the advantages of the ruled profile generation, we considered both the helical worm and the helical worm hob with ruled profile. Figure 14 presents the technological scheme of manufacture the elements of this type of drive, and the special devices, which are necessary. The manufacturing method is appropriately to the manufacturing of globoid worms with the CONE method [4],.

The helical worm precision is influenced by the fixing precision of the hob's teeth, of the tool's edges, and of the devices used.

Since now we achieved only the worm wheel with attached teeth. The teeth were realized by casting, and were finishing with the helical worm hob (figure 15).

Figure 16 presents the helical worm – internal teeth worm wheel drive.

CONCLUSIONS

- The internal worm gearings are made up of an ellipsoid worm and an internal teething worm wheel. These

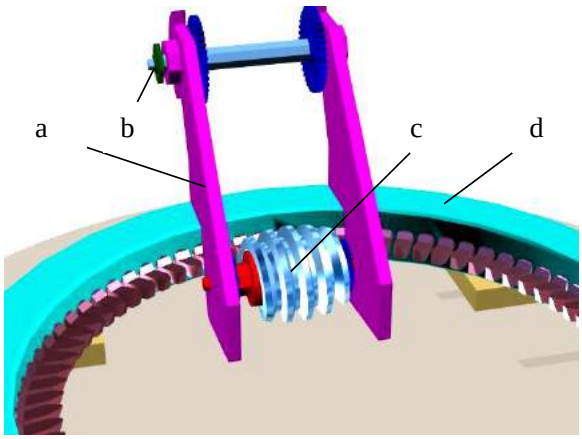


Figure 14. The technological scheme of the drive: a – arm device, b – tool axis, c – semi product of helical worm d – multicutter device [4]

gearings, especially those with perpendicular axes, can be named reverse globoid worm gearings or anti-globoid, as they have similar characteristics.

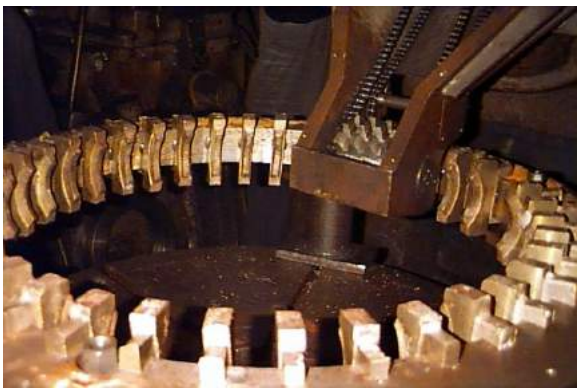


Figure 15. The finish manufacturing of the internal teeth worm wheel [4]

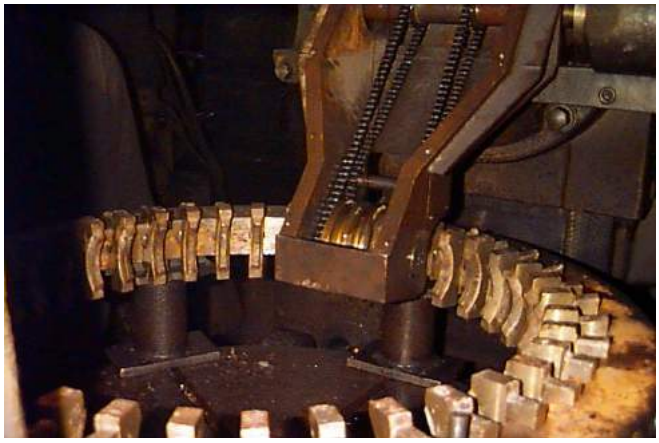


Figure 16. Helical worm – internal teeth worm wheel drive

- The angle between the worm axes and of the worm wheel can range between 0º and 90º. It is even advantageous for the angle to be other than 90º, thus not considering the problem of worm bearing.
- For the time being we consider both the worm and the helical worm hob with ruled profiles, but theoretically their profile can be generated by any curve. For processing, we used two special devices. By there aid a processing, which we could call of anti Cone type, occurred.
- The next step is the determination of geometrical parameters for the worm hob.

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Contact person

Prof. Dr. Eng. Gábor László PÁY, Ph.D., University of Nyíregyháza, Hungary, 4400 Nyíregyháza, Kótaji St. 9-11, e-mail: Pay.Gabor@nye.hu

Barometer for Identifying and Measuring Economic and Financial Risks

Călin D. POP[1] - Vasile BÎRLE[2] – Nicolae UNGUREANU[3]*

Abstract: *Small and medium enterprises are increasingly exposed to new types of risks due to the recent globalization. The survival rate of an SME depends in most cases on the efficiency of the management process. There are several factors that could have a negative effect on the profitability, security and stability of the business. The objective of the research is to obtain a practical working tool for SMEs, under the name of barometer for identifying and measuring economic and financial risks – thus improving the management process. The research is a methodological one, of predictive and stimulating type, oriented towards explanation and practical applicability. The idea started from the urgent need for management to identify at a reasonable time the areas of economic and financial risk, from which the disruptive factors of economic activities start – considering the fact that, unlike corporations, SMEs do not posses their own arsenal in terms of resources (financial, human, logistical, etc.) which leads to their increased vulnerability. The goal of this practical tool is to increase the survival rate of SMEs and therefore its profit.*

Keywords: *SME, management, financial risks, barometer.*

1 INTRODUCTION

RISKS HAVE PLAYED A DECISIVE ROLE IN COMPANIES FROM THE MOMENT OF THEIR ESTABLISHMENT AND MANIFEST THEMSELVES IN A MULTITUDE OF FORMS. THE WORLD ECONOMY, AND ESPECIALLY SMEs, OPERATE IN A VOLATILE AND OSCILATING MARKETS, WITCH CAUSES THEM TO REGISTER MORE OR LESS SIGNIFICANT FLUCTUATIONS, FROM ONE PERIOD TO ANOTHER. THE BATTLE FOUGHT BY LARGE CORPORATIONS FOR CONTROL OF RESOURCE MARKETS ARE NOT WITHOUT COLLATERAL AMONG SMEs, WHOS EXPOSURE IS BECOMING INCREASINGLY RISKY. THE RISK FACTORS GENERATED BY THE BEHAVIOR OF THE MARKETS HAVE A REDUCE PREDICTIVE CAPACITY, SO THAT THE UNCERTAINTY INFLUENCES THE DECISIONS IN SMEs, AT EVERY MOMENT OF THEIR ACTIVITY.

2. The general context from which the need to build a tool for identification and risk assessment emerges

The multitude of risks that generate a constant pressure on the decision-making system in SMEs, can be summarized in at least three important (often defining) directions, which refer to: realization of salable goods and services, recovering advanced resources and making a profit and last but not least, the sustainability of the business. The three directions represent the areas from which the risks for SMEs arise, all under a dome of uncertainties, more or less controllable, easier or harder to anticipate.

From this perspective, management needs a control and decision-making tool that shows the direction, amplitude and strength of risks so that the decision-making process is fast, efficient and generates effects of maintaining microeconomic balances.

Whatever the angle or stages of the systemic approach to economic activities, this process is inextricably linked to market mechanisms, more than managers would like, especially in SMEs.

In order for the decision to be valid and to produce the expected effects, the management needs a tool, a mechanism through which to identify the direction of action of the risk factors. The tool is useful either before starting actions or during their development.

3. The premises of the research considered in the construction of the risk identification and measurement barometer

The working tool for SME managers was entitled: Barometer for Identifying and Measuring Economic and Financial Risks.

The objective of the research is to obtain a practical working tool, with applicability at the level of SMEs, under the name of economic barometer for measuring the pressure under which risk factors act, through adjustments of economic and financial indicators.

The idea of building an economic barometer started from:

- the urgent need for management to identify at a reasonable time the areas of economic and financial risk, from which the disruptive factors of economic activities start;
- the requirement to measure the force with which the economic and financial risk factors act in order to adapt their correction decisions to the created situation,
- the need to assess when the risk factors will produce the maximum effects so that the decisions are made in a timely manner;
- measuring the speed of reaction of the internal system to the managerial decisions, respectively, the period in which the correction decisions will produce their expected effects.

The research is a methodological one, of predictive and stimulating type, oriented towards explanation and practical applicability.

The proposed solution was verified on a number of five SMEs in the manufacturing industry fully confirming the assumptions underlying the construction

of the barometer for the identification and assessment of economic and financial risks.

3.1. The directions of investigation considered in the construction of the barometer

The results obtained from the construction of the barometer, as well as the tests performed, allow us the following statements:
- the barometer, considered as a tool for identifying and assessing risks of an economic and financial nature, is applicable to value-added enterprises;
- the indicators used have the property to level the economic phenomenon so that the size or complexity of the activities carried out does not influence the quality of the results;
- the barometer can be used both in the sphere of production of goods and in that of the provision of services, provided that the matrix vectors are adapted to the specifics of the economic activity carried out;
- the model has as main purpose the determination of the economic and financial health of the economic units, moment from which the risks can produce unexpected effects;
- the barometer allows the identification of systemic and local dysfunctions in economic and financial flows;
- as a result, the barometer shows the manager the financial position in which he is on a certain point in a time gap.

The information base used is represented by the economic and financial-accounting information at a desired reference moment.

At the base of the construction of the risk identification and measurement barometer we considered a package of rules, principles and elements, such as:
- defining the package of relevant indicators, specific to the economic-financial analysis of diagnostic type;
- calculation of indicators at time "T" considered as a starting point (initially) to determine the state of economic equilibrium of the economic unit;
- establishing a score from 0 to 25 points, through which it will be observed the degree of deviation from the equilibrium state, respectively, whether the financial health condition of the economic unit is good or not;
- an economic unit may collect a score between 0 and 100, falling within one of the intervals for establishing the financial health status;
- the above reasoning will be continued for the T + n periods, as more information and working data are accumulated. In dynamics, one can calculate a score related to the evolution of economic and financial health by comparing the results obtained in the current period compared to those in previous periods.
- an overview will be obtained of the direction from which the risks come but also of the direction towards which the economic and financial activity of the economic unit is directed;
- the management, based on the information obtained, will have the possibility to operate the management levers for making economic and financial adjustments so that the equilibrium state is restored in the shortest possible time;
- the decisions that the management will take will be sufficiently argued so that the uncertainties turn into calculable and determinable risks, and the risks can be assumed or even annihilated.

3.2. Selection criteria of the indicators used in the construction of the barometer

The indicators considered important in the action of diagnosing the economic and financial health as well as the equilibrium conditions on the same fields, were chosen on the following criteria, respectively, to:
- has a high capacity to level the economic phenomenon;
- be determined on the basis of accessible and meaningful primary information, such as: turnover, profit, receivables, current assets, capital, etc.
- reflects the economic situation at a given time;
- provides structural information on the entire economic phenomenon (general activity of the economic unit).

In relation to the specifics of the economic activities to which it is addressed but also to the management requirements, the above criteria can be developed or restricted.

4. Static indicators used to build the risk identification barometer

The choice of indicators and the establishment of parameters that reveal the equilibrium states - those in which the risk factors are minimal as a force for action - was made in accordance with the requirements and criteria stated above. The indicators used in the construction of the barometer for identifying and measuring economic and financial risks are the following: economic profitability, liquidity, degree of indebtedness and receivables turnover rate.

4.1. Economic profitability

In general, profitability shows the ability of an economic unit to generate profit, a capacity that is dependent on: the object of activity, the volume and quality of production or services, the level of unit costs, management performance, etc. Profitability can be measured in multiple ways and each calculation formula will show a specific hypothesis for measuring the efficiency of the activity carried out in a certain period of time.

Within the barometer, the profitability will be calculated by reporting the profit obtained to the Turnover. For a better representation, the percentage calculation will be used, so the ratio will be multiplied by 100. Through this operation we aim to see:
- what percentage of the turnover achieved in a certain period of time represents the net profit that the management can direct to finance various actions;
- net profit is a lever of immediate and free intervention and is considered as the main source of financing development;
- if the management is oriented towards making a profit, it will certainly be concerned with the development of the activity.

Profitability also means the ability of the economic unit to meet its competitive objectives, to be a presence on the specific market and to recover its advanced resources by collecting the price of economic goods and services.

In the construction of the barometer, the determination of the values that can be attributed to the economic units was sought, in relation to the quantities obtained for the profitability indicator. The scores were placed on 4 levels; maximum, medium, low and minimum, as shown in the following table:

Table 1. Economic profitability

Scoring obtained	max. 25 points	average 15 points	low 5 points	min. 0 points
if the profitability is:	>=15	5	1	<= 0

If a return value greater than or equal to 15 is obtained, a maximum of 25 points may be awarded. This means that more than 15% of turnover is represented by profit. Such a level of profitability only reveals an ideal situation, therefore it will be given the maximum score.

In order for a certain situation to be considered "average", it is necessary that the rate of return be 5, in which case it is awarded 15 points.

The economic unit that obtains a value of the profitability indicator between 5 and 15, the score is obtained linearly, this being a point on the right located between the two extreme points, the points having the coordinates (15,25), respectively (5,15).

The equation of the line determined by two points is calculated by the formula:

$$(Y-Y0) / (Y1-Y0) = (X-X0) / (X1-X0)$$
$$(Y-15) / (25-15) = (X-5) / (15-5)$$
$$(Y-15) / 10 = (X-5) / 10$$
$$Y-15 = X-5$$
$$Y = X + 10$$

Thus, exemplifying, for a value of the profitability indicator of 10, the score obtained is 20 and for 7 it is 17, and so on.

Following the above reasoning and establishing that, for a profitability value of 1, 5 points are awarded, for the interval (1, .., 5), the values on the line Y = (5X + 5) / 2 are sought. Thus, for the value 4 12.5 points are obtained and for 3 10 points are obtained, etc.

If the economic unit records losses, then the profitability will be negative and the corresponding score will be zero. At the same time, for a value of the indicator between 0 and 1, the score will be searched on the right Y = 5X

For a rate of return of 0.5, the score will be 2.5 and for 0.2 the score will be 1 etc.

4.2. Liquidity

In the most general sense, liquidity reflects the general ability of an economic unit to meet its due obligations. Specifically, it is about the property of the patrimonial elements to be transformed into money, in a very short term, so that the obligations can be honored.

The liquidity indicator is a signal criterion for the occurrence and action of risks exogenous to the system (economic unit). Therefore, it is necessary to establish the share of the asset in liquid form, in the cash accounts but also the part of the asset that can be easily and quickly converted into cash (stocks, receivables).

The calculation formula of the liquidity indicator is as follows: the value of current assets is related to the value of short-term debts.

In the construction of the identification barometer and risk measurement, the assigned values are: maximum, medium, low and minimum. This breakdown was made in order to establish the scores that can be assigned to the economic units, depending on the values obtained for liquidity and in accordance with those for the profitability indicator presented above.

The liquidity values and the scores for those values are detailed in the following table:

Table 2. Liquidity

Scoring obtained	max. 25 points	average 15 points	low 5 points	min. 0 points
if the liquidity is:	>=2	1,5	1	0

For a value of the liquidity indicator higher than 2, the maximum score is given, being in the most favorable situation. Two more intermediate values were established according to the table above, and for the intervals between them the equations of the line which is Y = 20X - 15 were calculated, both for the interval (1,5, .., 2) and for the interval (1, .. 1.5).

As examples from these intervals, we can take the values of 1.7, for which 19 points are obtained or 1.25, for which 10 points are obtained.

Values between 0 and 1 will receive low scores, suggesting that short-term debt is higher than available current assets, assets that can be used to settle them.

The line on which the points on this interval are found has the equation Y = 5X, for a value of the indicator of 0.5, situation in which 2.5 points are obtained and for 0.2 1 point is obtained, etc.

4.3. Degree of indebtedness

The degree of indebtedness is a general indicator that is calculated as a ratio between total debt and total assets. The result obtained shows the proportion of financing of assets from sources other than their own, such as: loans, suppliers, debts to the state, debts to employees, suppliers, etc. The indicator is the inverse of the patrimonial solvency and can have values less than or equal to 1.

The indicator reflects the degree of financial autonomy of the economic unit. In this context, he shows the limit from the risk factors of loss of financial autonomy are active. In economic practice these limits are different depending on the fields of activity, the degree of horizontal integration and the size of the specific market.

In general, financial practice supports a maximum indebtedness rate between 0.40 and 0.60, the optimum being a value as close as possible to 0.4 or even lower. At a level of 0.80, the situation becomes alarming, the economic unit operating "on debt", and being dependent on external sources of financing.

As a way of calculating this indicator we chose to use a ratio between the value of total debts and the amount between debts and equity, which represents the total liabilities. This method of calculation can also be used, because the value of total assets is equal to the total value of liabilities. In order to obtain a percentage result, the ratio will be multiplied by 100. The general interpretation is that, it is determined what percentage of the assets of the economic unit are represented by debts (external financing).

The scores given to the value of the indicator called degree of indebtedness, within the risk identification and measurement barometer (of financial autonomy, in the case of this indicator), are the following:

Table 3. Degree of indebtedness

Scoring obtained	max. 25 points	average 15 points	low 5 points	min. 0 points
if the degree of indebtedness is:	<=40	50	60	>= 80

As presented above, for a value of indebtedness equal to or less than 40, the maximum score will be obtained, and for a value equal to 50, 15 points will be awarded. The line between these two points has the equation Y = 65-X.

For example: for the value of the debt degree indicator equal to 45, 20 points will be awarded. For a value of the indicator equal to 60, 5 points are received and for values located in the range (50, .., 60) the points are also searched on the right Y = 65-X. For example: for the degree of indebtedness equal to 55, 10 points are obtained.

For values of the indebtedness indicator of over 80 percentage points, the situation becomes alarming. Therefore, any value in the range (80, .., 100) will be given a score of 0.

For the interval 60, .., 80, we have the equation of the line Y = (80-X) / 4. For example: for a value of the indebtedness indicator of 70 we obtain 2.5 points, for the value of 64 4 points result and for the value of 76 a single point is received, etc.

4.4. Receivables turnover rate

Receivables are those current assets that will become liquid at the time of their payment by the beneficiaries of economic goods and services.

The turnover rate of receivables is in fact the ability of an economic unit to collect the value of goods sold or services provided to business partners.

Given that our model follows the rotation speed of each month, we will use the turnover obtained during this period. Therefore, it is necessary to divide the value of this indicator by 12 in order to be able to fit in the safety intervals used for the other indicators considered in the construction of the risk identification and measurement barometer.

The scores assigned to the values recorded by the "rotational speed" indicator are exemplified in the following table:

Table 4. Receivables turnover rate

Scoring obtained	max. 25 points	average 15 points	low 5 points	min. 0 points
if the receivables turnover rate is:	<=30 days	60 days	90 days	>= 120 days

From the table above it can be seen that, for a speed of rotation of receivables of less than 30 days, the maximum score will be received.

At a value of 60 days we find ourselves in an average situation, for which 15 points are obtained. Between the two values of the indicator (30 and 60), the scores are taken from the right Y = (105-X) / 3. Thus, for a value of 45 days, the points received are 20. It is observed that the same slope is kept for the right corresponding to the next interval which leads us to a small value of the score of 5, assigned to the value of 90 days, a interval.

It is considered that the level of the indicator “speed of debt collection” higher than 120 days is critical. First of all, for everything that exceeds this value, the economic unit will receive 0 points. For the interval (90, .., 120), the scores will be on the right Y = (120-X) / 6 (for example, for 100 days we have 3.33 points, for 114 days we get one point, etc.).

The barometer, as it was designed and made, is easy to use by managers, even if they do not have advanced economic training. It is enough to know and use excel software.

The table model that the user can use to determine indicators and scores, both for the static state of affairs at a given time) and for the dynamic evolution, is as follows:

Table 5. Barometer input data

Period	***Fiscal value***	***Economic profit***	***Circulating assests***	***Total debts***	***Curent debts***	***Claims***	***Net assests***	***Salary expenses***
January								
February								
March								
April								
May								
June								

For the accuracy of the results, it is preferable that the input data be entered without decimals.

The calculation algorithm will determine each indicator with two decimals and the scores with two decimals.

5. How to use the identification barometer and risk assessment

The ease of use of the risk identification and measurement barometer consists mainly in the fact that, at the end of a period (month, week or even a day), a unit value (score) can be obtained at the level of each indicator.

For the accuracy of the results, it is preferable that the input data be entered without decimals.

After entering the basic information, the input data, the working algorithm will provide the value of the indicators that constitute the signaling criteria for the risks of economic and financial imbalances.

6. Case Study. Verification of how the risk identification and measurement barometer works

For example, this chapter presents the situation for six months in one of the economic units in the processing industry (value added), as follows:

Table 6. Example input data

Period	***Fiscal value***	***Economic profit***	***Circulating assests***	***Total debts***	***Curent debts***	***Claims***	***Equity***	***Salary expenses***
January	43.638	3.541.129	11.342.914	11.438.109	6.014.899	13.941.740	15.523.927	432.571
February	148.644	3.954.935	14.367.263	13.381.036	9.301.741	14.090.385	18.250.641	445.535
March	187.210	4.073.043	13.102.722	13.434.681	7.945.972	14.277.595	18.255.976	430.556
April	-4.406	3.175.878	13.518.574	14.017.397	8.101.180	14.273.190	18.853.299	429.553
May	91.859	3.435.289	14.315.617	14.679.721	8.571.249	14.365.049	19.455.242	428.824
June	196.360	3.896.989	14.981.221	15.062.807	8.541.514	14.561.409	19.806.973	425.246

The static values of the indicators from the current period were determined according to the calculation formulas presented, resulting in the following information that will be taken as support for the calculation of scores, as follows: presented are the following:

Table 7. Example - the value of benchmarks

Month	Econo-mic profit	Liquidity	Degree of indebted-ness	Recivables turnover rate
1	1,23	0,99	52,68	51,67
2	3,76	1,07	56,43	71,54
3	4,60	0,98	56,11	59,34
4	-0,14	0,96	56,91	77,59
5	2,67	0,98	57,53	75,89
6	5,04	0,99	57,63	66,67

Once determined the values of the indicators both in the static format (current month) and on the dynamic evolution, the barometer will allocate the scores of each indicator, as follows:

Table 8. Example - scores obtained on benchmarks

MONTH	Econo-mic profit	Liqui-dity	Degree of indeb-tedness	Reci-vables turn-over rate	Total current score
1	5.58	4.96	12.32	17.78	40.63
2	11.90	6.47	8.57	11.15	38.09
3	13.99	4.88	8.89	15.22	42.97
4	0.00	4.82	8.09	9.14	22.05
5	9.18	4.88	7.47	9.70	31.24
6	15.04	4.97	7.37	12.78	40.16

Following the application of the reasoning described in the previous chapters, add the score obtained in the current month which can record values between 0 and 100, and check the place or situation in which it falls, at intervals:

a. **score> = 60**

If the total score is over an interval of more than 60, it can be estimated that the economic unit is in a position of economic and financial equilibrium, with minimal risks to act on the activity carried out. Therefore, this size indicates a favorable situation.

After the static analysis of the scores obtained during the period under analysis, the scores related to the dynamic evolution of the indicators are verified. If scores below 15 are found in the dynamic evolution of an indicator, this is the signal that there are certain risks. If there are scores below 5 in the dynamic evolution, it means that there have been significant decreases in one or more of the indicators. And in this case it is considered that there may be some alarm signals, although if the absolute value of the indicators is good.

b. **score on the range 40 -60**; Medium situation, with minimal risks but which must be taken into account due to the fact that in the near future, if those conditions in which it manifests itself are perpetuated, the risks may increase.

c. **score on the interval 20-40**; An unfavorable situation in which economic and financial risks can turn into systemic risks, generating effects that are difficult to overcome through corrective decisions. In such situations, radical, structural measures are required, which are often expensive and have a lower chance of success.

d. **score <20**; Critical situation and the management is forced to adopt some decisions with action in the depth of the economic system it leads or those decisions that prepare the exit of the economic unit from the market.

Remarks:

- those indicators that obtain high values reflect the economic or financial areas and have substantiated equilibrium states, which indicates a positive evolution of economic activity;
- indicators with low values represent those signal criteria that show the occurrence of risks of loss of balance and their value denotes the force with which they act on economic or financial activity;
- in both cases, for a better substantiation of the directions and the force of action of the risks, it is necessary to analyze the warnings from the previous periods to see if the corrective decisions taken previously generated the expected effects, respectively, led to the improvement or not the situation;
- it is important for the user to pay due attention to the deviations from the equilibrium line of each of the indicators that make up the barometer.

7. CONCLUSIONS

The equilibrium states for the whole economic activity or its components are under the action of risk factors. Losing balance means slippage, sometimes difficult to stop with economic and financial effects increasingly difficult to anticipate. In this sense, once the signal is received that a certain balance is compromised, the interventions can be operative with real possibilities to put the whole economic activity back on the correct line of evolution.

The barometer allows the identification of systemic and local dysfunctions in economic and financial flows from the first moments of the action of risk factors. The barometer shows the manager the financial position in which he is at a given moment, in which point of the equilibrium states as well as the quantitative dimension of the deviations from the equilibrium state.

The ability to continue working in sustainability conditions is a major desideratum of management in SMEs, perhaps most importantly, above the need for profit. This is because markets are experiencing significant changes from one period to another increasingly difficult to anticipate.

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Authors addresses

[1] *Călin D. POP, Phd ec., Technical University of Cluj-Napoca, Baia Mare, Maramureș, str. Dr. Victor Babes nr. 62 A, Maramureș, phone: 0744588470, e-mail: calindpop@gmail.com*

[2] *Vasile BÎRLE, Conf. dr. univ. ec., Technical University of Cluj-Napoca, Baia Mare, Maramureș, str. Dr. Victor Babes nr. 62 A, Maramureș, phone: 0748233280, e-mail: vasile.birle@yahoo.com*

[3] *Nicolae UNGUREANU, Professor dr. univ. eng. (coordinating teacher), Technical University of Cluj-Napoca, Baia Mare, Maramureș, str. Dr. Victor Babes nr. 62 A, Maramureș, phone: 0745298976, e-mail: nicolae.ungureanu@cunbm.utcluj.ro*

Contact person

[*] *Călin D. POP, Phd ec., Technical University of Cluj-Napoca, Baia Mare, Maramureș, str. Dr. Victor Babes nr. 62 A, Maramureș, phone: 0744588470, e-mail: calindpop@gmail.com*

A theoretical-application model to improve management tools for SMEs

Pop Călin Dumitru[1,*], Drenţa Raul Florentin [2] , Ungureanu NicolaeStelian [3]

Abstract: *In the European Union are registered approximately 20 million small and medium enterprises with a share of 99% of all companies (Internal Market I. E., 2018). Romania ranks 17th in the European Union in terms of the total added value of small and medium enterprises and the last place after the number of active SMEs, according to a study conducted by the Post-Privatization Foundation (2017) P. Drucker (DRUCKER, 1999) said that "small businesses are the main catalyst for economic growth." Small businesses contribute intensely to the achievement of the fundamental objectives of any national economy, becoming the "driving forces" of economic and social progress. Entrepreneurial Risk Management is a valuable management tool that helps companies achieve their goals - Thomas H. Stanton (T.H., 2017). Risk identification is an action that must be done on a regular basis as part of the process of establishing risk management in businesses.*

Keywords: risks, assessment tools, risk management

1 INTRODUCTION

Risk management is typically placed in the hands of owner-managers in SMEs, and there are no structural linkages between planning and risk management. Furthermore, the new entrepreneur, and not alone, devotes his finances to acts that help to maximize earnings, and only in the event of significant losses, seeks to cover them with a gradual shift of funds, which is frequently late, leading to bankruptcy.

Based on statistical data on SMEs in Romania, we believe it is necessary and relevant to develop a theoretical model for improving management tools for Small and Medium Enterprises by addressing organizational risks in an integrated management system with which to make a regular diagnosis at low cost and in a short time, which will contribute to their survival rate as well as the improvement of the management system and with profitable economic results.

Although the management procedures of big and small and medium firms are comparable in general, both groups employ the same managerial traits (forecasting, organization, coordination-training, decision, and control) (MRGIAN, 2001). Small and medium-sized businesses, unlike large corporations, lack a full arsenal of strategic weapons and the ability to change managers; small businesses, which are frequently run by the owner-manager, risk failure if they follow their own ideologies and operational practices, and access to external financing can be difficult. The enterprise (BRESSY, G., and KONKUYT, C., 2014) is a production, service, or commerce economic unit.

An enterprise is any type of independent patrimonial economic activity permitted to conduct actions and deeds of trade in order to gain profit by manufacturing material things and selling them on the market or by providing services under competitive circumstances, as defined by the laws in effect. SME's (micro, small, and medium-sized companies) make up 99 percent of all firms in the EU. They account for two-thirds of private-sector jobs, more than half of total added value produced by EU enterprises (European, 2018), and are an important driver of growth, innovation, and social integration.

Small and medium enterprises contribute to economic growth - there is a positive correlation between the level of development of the small and medium enterprise sector and an economy's GDP (WELSH, J., A. WHITE, J., F., and DOWELL, P., 1981), contribute to the reduction of unemployment and increase of the living standard - it provides jobs, and, last but not least, it acts as a market stabilizer due to its quick reaction to changes (NICOLESCU, O., 2008)

In Romania, public policy acknowledges the importance of SMEs, and there are a variety of support instruments available, both directly through national and European grants and indirectly through the development of a favorable regulatory framework (AIPPIMM) and ongoing assessment. - White Paper on Romanian SMEs (the only scientific paper analyzing the economic environment in Romania, which has included statistical data, analysis, and information relevant to the business environment since 2002 - the date of publication of the first paper), through a competition organized by the National Council of Small Private Enterprises and The Middle of Romania.

However, once a SME is established, its survival probability is largely dependent on the management process' performance, considering that around half of them are controlled by a single individual. Managerial quality, bad finance, incoherent human resource management, a lack of processes and internal control systems, and a lack of sufficient IT systems are the factors that define the economic regression or even bankruptcy of these businesses under comparable circumstances and over time.

The importance of small and medium-sized firms in both developing and established nations cannot be overstated, and their existence and survival is a key concern for policymakers and scholars alike. ; numerous SMEs fail within a year of their founding.

The high degree of turnover given to personnel, the lack of staff credentials, IT risk, market fluctuations, and image erosion are among the most serious difficulties encountered by SMEs (Alpa, et al. 2005). Due to the high level of risk and insufficient degree of profitability associated with SMEs, they have difficulty

securing financing (St-Pierre, J., & Bahri, M., 2006). (International Trade Center, 2009).

The key issues mentioned in the literature as difficulties faced by SMEs include: insufficient or inadequate training of the employer-manager, and poor decision-making skills as a result of lack of training in the absence of large-scale strategic instruments; and the cash required by the firm (whether it is insufficient or difficult to access or unprofitable).

2 RISKS OF SMALL AND MEDIUM-SIZED ENTERPRISES

Most people want to avoid risk, however, the economy as a whole encourages businesses to take risks. Business operations, the activities of extracting capital from one source to another, literally mean taking risks for higher profits.

Managing risk brings competition and innovation. Thus, risks are issues that require structured management plans, to be understood, prepared and improved.

In the explanatory dictionary of the Romanian language, risk in a general sense is defined as the possibility of reaching a danger, of having to face a trouble or of suffering a damage; possible danger. - from fr. risk (Explanatory dictionary of the Romanian language). In most economic publications, the risk refers to the negative deviation from the plan (Maylor, 2010).

In the financial field, risk is related to the risk of an investment or loan (Encyclopedia Britannica).

In general, risk is defined as the possibility that future income may be different from that expected to be obtained. In other words, "the risk represents the variability of income under the influence of the environment, implying the eventuality of an unfavorable event." (Ionescu, 2005) In every enterprise we are dealing with risk management, but not always in a completely transparent, repeatable or permanent way that supports the decision-making process. The purpose of risk management is to ensure that the company or enterprise using the system does so in a cost-effective manner, and that the risk management process consists of a number of well-defined steps. The objective of risk management is to support the decision-making process, due to a better understanding of risk and its impact on society itself.

The management system represents the coherent set of elements, materialized in principles, methods, techniques, decision-making, organizational and informational procedures, through which the modeling and exercise in a specific manner is ensured, of all or most of the functions of the management process for a company. , as a whole, or for its main components, in order to increase economic profitability (Pride, WM, Hughes, RJ and Kapoor, JR., 1991).

Risk management offers the following benefits:

- A risk-based approach enables companies to respond more flexibly to current market disturbances, being able to effectively serve their customers, whose requirements are constantly changing in a constantly evolving business market;
- Companies that respond first to new circumstances, become market leaders in the medium or long term;
- Companies are seen according to the current level of risk and how they are managed;
- Companies must be aware of the continuous changes in the market;
- Risk management and internal control tools can be used to manage changes in the company.

Table 1. Common Types of Business Risks (David, L. Olson & Desheng, D. Wu, 2008)

External environment	Business strategies and policies	Execution process
Competitors Legal regulatory framework Natural disasters Medical costs / trends in use Customer expectations	Strategy and innovation Capital allocation Business / product portfolio Organization chart Organization policies	Planning Processes / technology Technological implementation and continuity Suppliers / partner trust Customer satisfaction Compliance with regulations and confidentiality Intellectual capital ¢ Integration for change
People	Analysis & reporting	Technology & data
Leadership Skills and competencies Adaptability Communication Performance criteria Responsibility Fraud and abuse	Performance Management Budgeting / Financial Planning Accounting / Tax Information External Reports and Disclosures Pricing / Profit Market Intelligence Contractual Commitments	Technological and architectural infrastructure Relevance and integrity of data Integrity of data processing Technological reliability Security of information systems

Risk management is a process of identifying, analyzing and responding to the risks to which an organization is exposed. By exposing the organization is meant the analysis of the internal and external environment in which it operates.

Moreover, risk management involves:

- risk identification,
- qualitative and quantitative risk assessment

- development and implementation of a risk response plan,
- risk monitoring,
- identification of new risk-generating situations, and
- development of an environment conducive to insurance risk communication.

3 SMALL AND MEDIUM-SIZED BUSINESS RISK MANAGEMENT

ERM (Enterprise Risk Management) refers to the strategies and procedures that businesses employ to manage risks and seize opportunities in order to achieve their objectives. ERM is a risk management framework that entails recognizing events or conditions that are important to the organization's objectives (risks and opportunities), analyzing them in terms of probability and size of effect, and implementing a response strategy and monitoring procedure. Business businesses safeguard and produce value for stakeholders such as owners, workers, consumers, regulators, and society at large by proactively detecting and addressing risks and opportunities.

There are several key ERM models, each of which describes a method for detecting, assessing, responding to, and monitoring the company's risks and opportunities, both internally and internationally.

We chose to focus on COSO ERM and ISO 31000 since they are the most widely used and disputed ERM models in the literature. At the same time, they will be the cornerstones of the article's major topic, the construction of a theoretical model for developing management tools for SMEs.

3.1 Comparative analysis COSO ERM and ISO 31000: 2018

Risk determination, risk treatment, and frequent risk monitoring are all emphasized in the COSO ERM standard and ISO 31000. The capacity to analyze and modify risks is the key commonality between the two types, as dangers are continually developing.

If the primary goal of COSO is financial reporting, the first step, according to ISO 31000, is to establish risk management and its implications, which include risk identification, risk criteria design, and decision-making.

The following are some of the similar components of the two types of enterprise risk management (ERM):

- ERM should make achieving goals easier. ERM permits the identification and management of related uncertainties for all types of businesses;
- ERM should be customized to the context of the organization;
- The support provided by the company's management for the success of risk management efforts ERM is a continual process, not a one-time event.
- The importance of stakeholders in ERM initiatives
- The importance of understanding the internal and external context / factors;
- The importance of the correct designation of authorities and responsibilities throughout the organization for the effective implementation of ERM;
- The importance of identifying events that may affect the organization's objectives as part of identifying risks;
- The importance of identifying events that may affect the organization's objectives as part of identifying risks
- Identifying occurrences with both negative and positive repercussions should be part of the risk assessment process.
- When a risk can give rise to other risks or is closely linked to other risks, organizations should consider multiple risk identification techniques.
- The treatment of a risk can be effective for several risks. distinct evaluations / independent reviews of hazards and risk remedies are critical

The major difference between the two frameworks, ISO and Coso is found below:

Table 2. Differentiations between ISO and COSO

ISO 31000	- The risk includes events with positive and / or negative consequences.
COSO	- Only occurrences with negative outcomes are classified as risks; - Events with positive consequences are classified as opportunities and are excluded from the risk assessment.

For example, under the ISO 31000 framework, a large concentration of resource providers in a single geographic region is a risk, while in the COSO framework, this is an opportunity and is not included in the risk assessment.

The ISO 31000 standard does not cover the analysis of inherent risks; instead, it only covers the study of residual risk, whereas COSO covers both inherent and residual risks.

Another significant variation in terminology is that risk assessment in ISO 31000: 2018 refers to risk identification and includes risk analysis and assessment, whereas risk assessment in COSO ERM refers to risk analysis and risk assessment. Under the COSO framework, risk identification and risk assessment are two separate procedures.

In terms of risk probability analysis, COSO incorporates event-level probability analysis, ISO 31000 suggests consequence-level probability analysis, and the Manual HB 436: 2013: risk management recommendations (Australia, 2013) promotes event-level and consequence-level probability analysis.

4 PROPOSAL OF TOOLS USED FOR RISK MANAGEMENT

Entrepreneurial Risk Management is a valuable management tool that helps companies achieve their goals - Thomas H. Stanton (T.H., 2017).

Risk identification is an action that must be done on a regular basis as part of the process of establishing risk management in businesses. Different approaches may be used to identify the risk:

- Checklists with possible risk sources (anticipated outcomes, design and execution mistakes and omissions, environmental conditions, cost estimates, execution deadlines, and so on)
- Archive record analysis to detect reoccurring issues Use of directly involved staff's experience (leaders of sections and teams)
- The appointment of a person in charge of recognizing externally imposed hazards (essential changes in legislation, economic changes, technology, etc.)

Small and medium-sized businesses are vulnerable to a wide range of hazards due to their size and operations.

In terms of risk management, small and medium businesses have a tendency to overlook the dangers that their activities entail, as well as their role and relevance in formulating corporate strategy (Jaynes, 2002).

The cost of implementing a risk management system in an organization (enterprise) is high, and it is primarily dependent on how unanticipated occurrences are managed. Internal or external risks might be detected at the project or product level, or hazards that demand various techniques and skills, depending on the company's profile.

Risk matrices are used to assess how hazards may effect a firm, a project, a program, or expenses, independent of their profile.

In this context, we propose a functional matrix (fig.1) as a theoretical model for enhancing management tools for SMEs, with the goal of answering the question: "What are the key risks that might impede the company (SME) from meeting its objectives?"

The risk assessment matrix, also known as the functional matrix - management tool, is a risk assessment approach that emphasizes two aspects: Consequence: the impact of a risk and the potential negative repercussions; Probability is the likelihood of a danger occurring.

To place a risk in the risk assessment matrix, we must first give a level of appreciation to its effects and probabilities, which will define the chart's proper placement. The following categories will be used: Consequences:

- insignificant: risks that have no real negative consequences or pose no significant threat to the organization or project;
- minor: risks that have a small potential for negative consequences but will not have a significant impact on overall success;
- moderate: risks that could have negative consequences and pose a moderate threat to the project or organization;
- critical: risks that have significant negative consequences and will have a significant impact on overall success; These are the most serious dangers.

Probabilities:

- Unlikely: very rare hazards with a slim chance of manifesting;
- Rare: comparatively uncommon risks with a tiny chance of manifesting;
- Occasional: more common risks with a 50/50 chance of manifesting; probable: dangers with a high likelihood of manifesting;
- Categorical hazards are those that are practically guaranteed to occur.

The greatest ranking is given to hazards that have significant negative repercussions and are extremely likely to occur; the lowest ranking is given to dangers with little impact and likelihood. To assist identify the risks that provide the greatest general (and hence priority) concerns, risk rankings incorporate impact (consequence) and probability evaluations.

The rankings fall into four broad and colorful categories:

- low: the consequences of the risk are minor and unlikely to occur. These types of risks are generally ignored and colored in shades of green;
- medium: risks to occur, with slightly more serious consequences. If possible, measures should be taken to prevent the occurrence of medium risks, but they are not a priority and should not significantly affect the organization or success of the project and are represented in yellow;
- high: serious risks, with significant consequences and likely to occur. They must be prioritized and require a short-term response, colored with the code orange;
- extreme: catastrophic risks that have serious consequences and are very likely to occur.

Extreme risks are the highest priority and require an immediate response, as they can threaten the success of the organization or project. They are colored red.

Table 3. template risk assessment matrix - risk level

	LOW	**MEDIUM**	**HIGH**	EX-TREME
RISK LEVEL	Series 1-1, 1- 2, 1-3, 2-1, 2-2 and 3-1 Acceptable	Series: 1-4, 1- 5, 2-3, 3-2, 4-1 and 5-1 Reasonable	Series: 2-4, 2-5, 3-3, 3-4, 4-2, 4-3 and 5-2 Unacce-ptable	Series: 3-5, 4-4, 4-5, 5-3, 5-4 and 5-5 Intole-rable
	can be ignored	the activity can continue	mitigation interve ntion	Maxi-mum priority

We can create a risk response plan to avoid or resolve concerns that are "high" or "extreme" once the risks have been identified; we may not be accountable for risks that are "low" or "medium."

We can gain a better understanding of the dangers:

1. Generally acceptable (GA): hazards have a low impact and/or are unlikely to occur in the region of the chart labeled "low." The risks in this area do not constitute a direct danger to the project or organization, and some may even be overlooked;
2. Reasonably (MR): is an acceptable risk category that includes the "low" and "medium" categorization regions. The hazards in this area of the matrix are bearable or do not pose a serious threat; thus, the activity can continue without immediate intervention.
3. UU stands for "usually unacceptable" and refers to the section of the graph where the danger is "high" or "extreme." The hazards in this area are detrimental, very likely to occur, and would put the project or organization at danger. These are the most pressing issues that must be addressed right away.

The functional matrix will assist management (contractor) in identifying and quantifying the risks to which the organization is exposed, as well as determining when interventions are required.

Figures big size

Fig. 1. Risk assessment matrix

		CONSEQUENCES				
		UNSIGNIFICANT	MINOR	MODERATE	CRITICAL	CATAS-TROPHIC
		does not pose a significant threat	potential negative consequences, insignificant impact	considerable negative consequences, significant impact	Substantial negative consequences and significant	extreme negative consequences, top priority
PROBABILITY	UNLIKELY	LOW	LOW	LOW	MEDIUM	MEDIUM
	extremely rare, almost no probability of occurrence	1 - 1	1 - 2	1 - 3	1 - 4	1 - 5
	RARE	LOW	LOW	MEDIUM	HIGH	HIGH
	unusual, but with a small chance of manifestation	2 - 1	2 - 2	2 - 3	2 - 4	2 - 5
	OCCASIONAL	LOW	MEDIUM	HIGH	HIGH	EXTREM
	typical, with a chance of occurrence of 50/50	3-1	3-2	3-3	3-4	3-5
	LIKELY	MEDIUM	HIGH	HIGH	EXTREM	EXTREM
	likely to occur	4 - 1	4 - 2	4 - 3	4 - 4	4 - 5
	CATEGORY	MEDIUM	HIGH	EXTREM	EXTREM	EXTREM
	it is almost certain	5 - 1	5 - 2	5 - 3	5 - 4	5 - 5

5 CONCLUSIONS

Risk management is a scientific discipline that contributes significantly to the support of decision-making in practice.

There are basic ideas, philosophies, and methodologies in place, and they are evolving.

Furthermore, risk management is essential for safeguarding a company's capital and comprehending threats so that they may be effectively assumed. In fact, many businesses opt to eliminate risk. While this strategy provides complete protection against particular losses, it also restricts earnings.

The COSO ERM and ISO 31000 models' key aims are risk setting, risk management, and frequent risk monitoring, and they serve as the theoretical framework for enhancing management tools for SMEs. Both COSO and ISO define the term "objective" in the context of risk definition, facilitating the identification and management of associated uncertainties for all types of organizations, emphasizing the importance of understanding the context / internal and external factors, the importance of identifying events that may affect the organization's objectives, the importance of risk monitoring and risk treatments implemented, and so on.

By classifying and prioritizing risks through a graph utilizing combinations of effects and probabilities, the risk matrix will assist management - the entrepreneur in recognizing big risks that might destabilize the firm and achieve objectives. At the same time, it is a tool that helps managers make decisions by recommending a risk response plan for the discovered and evaluated risks, which might include things like avoidance, reduction, alternative actions, acceptance, transfer, risk sharing, and so on.

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Authors addresses

[1] Pop Călin Dumitru Tehnical University of Cluj Napoca, North University Center of Baia Mare, Victor Babeş street, no.62 A,,

2. DRENŢA Raul Florentin, Tehnical University of Cluj Napoca, North University Center of Baia Mare, Victor Babeş street, no.62 A, raul.drenta@utcluj.cunbm.ro

3. UNGUREANU Nicolae, Tehnical University of Cluj Napoca, North University Center of Baia Mare, Victor Babeş street, no.62 A,, nicolae.ungureanu@utcluj.cunbm.ro

Contact person

* *[1]Drenţa Raul Florentin, drd. ing., ec.,Tehnical University of Cluj Napoca, North University Center of Baia Mare, Victor Babeş street, no.62 A, +40745688591, e-mail raul.drenta@cunbm.utcluj.ro*

Review of refrigerants

Robert Sánta

Abstract: *The refrigerants must be consistent with a number of requirements: thermodynamic, chemical, health, economy and, last but not least, ecological requirements. There is no refrigerant that fully meets the listed requirements. In the selection of refrigerating fluids, in addition to low GWP consideration, gases with better energy characteristics should be preferred because of their limiting characteristics. The study confirms that all new alternative gases are better regarding their lower GWP values. Although they have some differences in terms of energy parameters, it can be stated that R1234yf, R1234ze and R444B refrigerants can be good alternatives to R134a, R404A, R410A and R22, respectively.*

Keywords: Refrigerant, criteria, environment, application, lubricant

1 INTRODUCTION

A refrigerant is chemical compound that is used as the heat carrier, which changes from gas to liquid and then back to gas in the refrigeration cycle. The first refrigerant used was ether, employed by Perkins in his hand operated vapour compression machine. In the earlier days, ethyl chloride C2H5Cl was used as a refrigerant which soon gave to ammonia as early as in 1875. At about the same time, sulphur dioxide SO2 in 1874, methyl chloride CH3Cl in 1878 and carbon dioxide CO2 in 1881, found application as refrigerants. During 1910-30 many new refrigerants, such as N2O3, CH4, C2H6, C2H4, C3H8 were employed for medium and low temperature refrigeration. Hydrocarbons were, however, found extremely inflammable. Dichloromethane CH2Cl2, dichloroethylene C2H2Cl2 and monobromomethane CH3Br were used as refrigerants for centrifugal machine. A great breakthrough occurred in the field of refrigeration with the development of Freons (trade name) in 1930s by E.I. du Pont de Nemours and CO. Freons are a series of fluorinated hydrocarbons, generally known as fluorocarbons derived from methane, ethane etc.as bases.

Fig. 1. History of refrigerants [1]

2 REQUIREMENTS FOR REFRIGERANTS

In principle, any liquid or liquid mixture which can be evaporated at the desired low temperatures and liquefied within well-manageable pressure and temperature limits or can be evaporated at the desired low temperature can be used as refrigerant. Within this, it is a natural basic requirement that the freezing point and critical point of the material used as refrigerant fall outside the operating temperature range. However, the mode of operation, design and operating conditions of refrigeration equipment impose many additional thermodynamic, chemical physiological and environmental requirements on the refrigerant, so that the range of materials that can be used as refrigerant is greatly reduced. Moreover, it should even be noted that there is in fact no "ideal" refrigerant that fully meets all criteria.

The „ideal" properties for a refrigerant [2]:

- A high latent heat of vaporization

- A high density of suction gas
- Non-corrosive, non-toxic and non-flammable
- Critical temperature and triple point outside the working range
- Compatibility with component materials and lubricating oil
- Reasonable working pressures (not too high, or below atmospheric pressure)
- High dielectric strength (for compressors with integral motors)
- Low cost
- Ease of leak detection
- Environmentally friendly

Most refrigerants commonly used today are classifiled into four types:

- Chlorofluorocarbons (CFCs)
- Hydrochlorofluorocarbons (HCFCS)
- Hydrofluorocarbons (HFCs)
- Refrigerant blends (azeotropic and zeotropic).

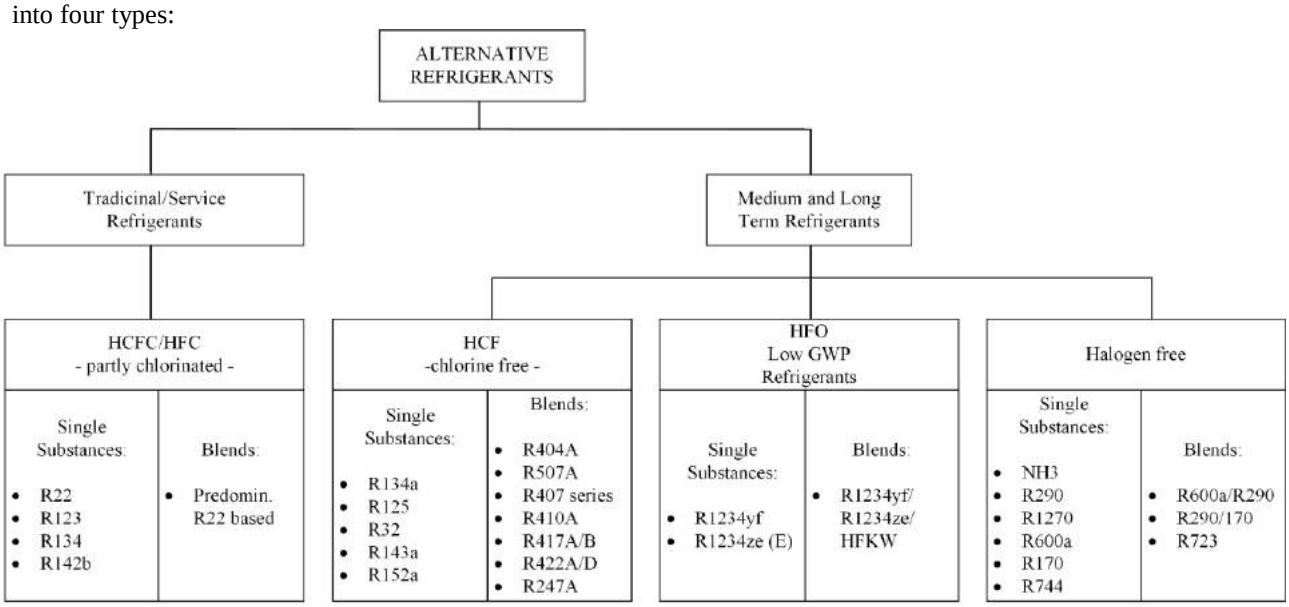

Fig. 2. Classification of refrigerants

Hydrochlorofluorocarbons (HCFCs) are molecules composed of methane or ethane in combination with a halogen. This makes up a new molecule that is considered to be partially halogenated. Once released into the atmosphere, they decompose rapidly, making them much less harmful to ozone than CFC refrigerants.
Hydrofluorocarbons (HFCs) include such refrigerants as R134a and R23. They are different from chlorofluorocarbons since they contain one or more hydrogen atoms and no chlorine atoms. HFCs are considered to have zero potential for ozone depletion. They have only a slight effect on global warming, thus, they are merely a compromise solution.
HFO refrigerants are hydrofluoroolefins, i.e., fluorinated hydrocarbons that have a double bond between carbon atoms at least one site in the molecule. They are rapidly flammable compounds in the atmosphere with zero ODP and very low GWP values (class A2) and will therefore be able to meet the ecological requirements of the future. A further advantage is that they can be used with minor modifications to equipment using HFC medium, which facilitates the transition.

Natural organic refrigerants were not discovered recently, although they were swept away by the "freon wave" for a while. As a counterpoint to their excellent refrigeration properties, they are highly flammable, making their use mandatory. Nevertheless, they were back among the refrigerants in use due to their favorable ecological characteristics.

3 ENVIRONMENTAL ASPECTS (ODP, GWP, TEWI)

The past few decades have seen many different refrigerants in the market. Scientific results from the last 15-20 years have shown that some refrigerants are harmful to the environment. Decisive features of refrigerants were their environmental compatibility and their impact on the ozone layer or global warming [3].

3.1 Ozone Depletion Potential – ODP

The biggest environmental effect is the destruction of the ozone layer by the chemical gases. Decrease or removal of this layer which functions as a filter against harmful

ultraviolet rays can damage life on earth profoundly. After the exploration of the damage caused on the ozone layer by chlorine-based gases, removal of this type of gases has been planned with Montreal Protocol. The ODP of R11 is by definition 1.0.

3.2 Global Warming Potential – GWP

The GWP describes the contribution to the greenhouse effect relative to CO_2 =1.0. Indication of the time horizon is required. The calculation of GWP values over a time horizon of 100 years is most common.
The TEWI (Total Equivalent Warming Impact) takes the sum of direct (global warming potential of a substance) and indirect (contribution of the CO2 emissions which result from energy consumption for operation of the plant) emissions of greenhouse gases. TEWI is not a product-specific indication but rather relates to a system (plant). The refrigerant emissions are almost zero here, i.e. the direct GWP share is negligible [4].
The method of calculating TEWI is provided below:

$$TEWI = GWP\ (direct, refrigerant\ leaks\ incl.EOL) + GWP\ (indirect, operation)$$

$$TEWI = (GWP \cdot m \cdot L_{annual} \cdot n) + GWP \cdot m \cdot (1 - a_{recovery})) + (E_{annual} \cdot \beta \cdot n)$$

where,
GWP - Refrigerant Global Warming Potential (equivalent to CO2) [kg CO_2/kg refrigerant]
L - Annual leakage rate [kg/year]
n - System operating life time [years]
m - Refrigerant charge [kg]
α - Recycling factor [%]
E - Annual energy consumption [kWh/year]
β - CO_2 emissions on energy generation [kg CO_2/kWh]

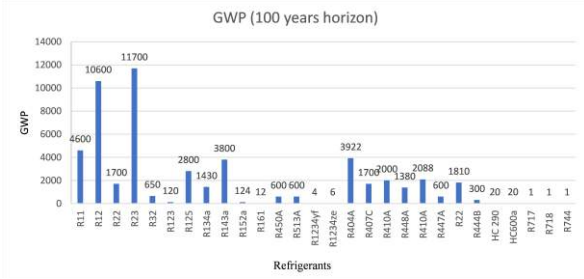

Fig. 3. Environmental data of same refrigerants

Table 1. Applications of refrigerants

4 REFRIGERANT APPLICATIONS

Some popular refrigerant applications are shown Table 1. One type of refrigerant may be used in a number of applications. Several items are considered in the selection of the refrigerants [5]:

- The system capacity, governed by the refrigerant boiling point.
- The volume of the vapor pumped to provide the necessary refrigeration.
- The latent heat of the refrigerant.
- The operating temperatures required.
- The size of the equipment.

Refrigerants	Range	Applications
R134a	Medium temperature	• Automotive, for air conditioning units in all new generation cars • Air conditioning - commercial and industrial, air conditioning in public transport (passenger trains and buses) - domestic, domestic air conditioning units • Refrigeration - commercial and industrial, refrigerated counters, cold rooms, centrifugal refrigeration systems, ice makers, refrigeration systems for the processing industry, chillers - domestic, domestic refrigerators • Thermal hydraulics, heat pumps [6], [7]. • Refrigerated transports
R404A HFC blend	High temperature applications	• Refrigeration - commercial, refrigerated counters, cold rooms, display units, ice makers, refrigerated vending machines, refrigerated warehouses, ice skating rinks - industrial, refrigeration systems for the processing industry, chillers - domestic, freezers and domestic refrigerators • Refrigerated transports
R407 A	Medium-low temperature applications	• Refrigeration - commercial, refrigerated counters and cold rooms, refrigerated vending machines, ice makers, refrigerated warehouses, ice skating rinks, display units

		- industrial, refrigeration systems for the processing industry, chillers (having a high glide, they must not be used in chillers that have a flooding evaporator) - domestic, freezers and domestic refrigerators • Refrigerated transports
R410A – HFC blend	High temperature applications	• Air conditioning [11] - residential and commercial, small air conditioners and for domestic and commercial heat pumps, air conditioning in public transport (passenger trains and buses) - industrial, air conditioning for the processing industry
R 1234yf	Low- and medium-temperature	• Automotive - air conditioning equipment for new type of vehicles • Refrigeration -domestic, domestic refrigerators, heat pump [8], [10]
R600a - isobutane	High temperature	• Refrigeration - commercial, refrigerated counters, cold rooms, commercial display units, ice makers, refrigerated vending machines, refrigerated warehouses - domestic, freezers and domestic refrigerators
R717 NH3	low and medium temperature	• Refrigeration - commercial, refrigerated counters, cold rooms, display units, ice makers, refrigerated vending machines, refrigerated warehouses, ice skating rinks - industrial, refrigeration systems for the processing industry

5 HEALTH AND SAFETY

When dealing with any refrigerant, personal safety and the safety of others are vitally important. The risks associated with the use of refrigerants in refrigeration and air-conditioning equipment can include toxicity, flammability, asphyxiation, and physical hazards. Although refrigerants can pose one or more of these risks,
system design, engineering controls, and other techniques mitigate this risk for the use of refrigerant in various types of equipment.
Figure 4 show the refrigerant safety group classification from ANSI/ASHRAE Standard 34-2010 (ANSI/ASHRAE 2010); this classification was made based on toxicity and flammability [9].

- Class 1: refrigerants exhibit no flame propagation when tested for flammability in air at 60°C and 101.3 kPa.
- Class 2 (lower flammability): refrigerants exhibit low flammability (LFL > 0.10 kg/m3) when tested for flammability in air at 60 °C and 101.3 kPa and have a low heat of combustion (Δhc < 19,000 kJ/kg).
- Class 3 (higher flammability): refrigerants exhibit high flammability (LFL ≤ 0.10 kg/m3) when tested for flammability at 60 °C and 101.3 kPa or have a high heat of combustion (Δhc ≥ 19,000 kJ/kg).

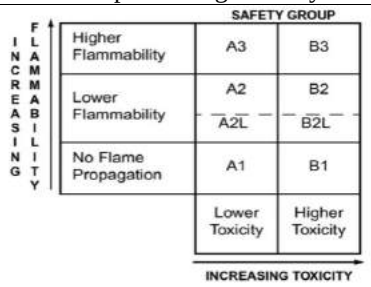

Fig. 4. Refrigerant's safety group classification (ANSI/ASHRAE 2010) [9]

6 REFRIGERATION OIL

Oil circulates through the system with the refrigerant. Oil provides lubrication and cools the compressors moving parts. Because it is mixed with the refrigerant, a refrigerant oil must have certain properties. The major lubricant characteristics are lubricity, stability, materials compatibility, mutual solubility with refrigerant, viscosity, and, finally, foamability. The lubricity or capability of a lubricant to provide adequate lubrication to compressor moving parts is the essential role of the lubricant in a compressor. In the past, so-called naphthenic mineral oils and synthetic alkylbenzenes were preferred. For systems with CFC and HCFC refrigerants (for example R22) and hydrocarbons, they are very favourable with regard to solubility and miscibility. On the other hand, owing to their low polarity, they are insufficiently miscible with the highly polar HFC and HFO refrigerants and are therefore not properly and sufficiently drawn into the refrigeration cycle. Therefore, new lubricants with appropriate solubility/miscibility have been developed for systems with HFC and HFO refrigerants. These are oils based on polyol ester (POE) and polyalkylene glycol (PAG).

Table 2. Overview lubricants [2]

Refrigerants	Traditional oils				New lubricants			
	Mineral oil (MO)	Alkylbenzene (AB)	Mineral oil + alkylbenzene	Poly-alpha-olefin PAO	Polyol ester (POE)	Polyvinyl ether (PVE)	Polyglycol (PAG)	Hydrocracked mineral oil
(H)CFC	good	good	good	limit	limit	not suitable	not suitable	not suitable
HFC + blends	not suitable	limit	not suitable	not suitable	good	good	limit	not suitable
HFC/HC blends	dependant on system	dependant on system	dependant on system	not suitable	good	good	not suitable	not suitable
HFO+ HFO/HC blends	not suitable	not suitable	not suitable	not suitable	good	good	not suitable	not suitable
Hydrocarbons	good	limit	Limit	good	good	not suitable	limit	not suitable
NH3, R723	good	limit	Limit	good	not suitable	not suitable	limit	good

7 CONCLUSIONS

In this study compared the GWP values, validity, safety requirements, and refrigerant-oil pairings of refrigerants. It can be concluded that there is no refrigerant that fully meets the listed requirements. The conditions and requirements need to be examined on a case-by-case basis in order to select the most suitable, most favorable material from the materials that can be used as a refrigerant. Due to the very large number of tasks and requirements, manufacturers have developed a wide variety of refrigerants.

Most recently, mainly due to environmental regulations, a lot of new refrigerants and blends have appeared or are under development. On the other hand, the renaissance and rediscovery of known but marginalized refrigerants are taking place today.

Old, naturally occurring refrigerants have come to the fore, as well as old-new refrigerants and mixtures that do not damage stratospheric ozone and do not increase the greenhouse effect.

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Author addresses

Robert, Santa, University of Dunaújváros, Táncsics Mihály 1/A, santar@uniduna.hu

Maintenance of underground power lines

***Anamaria Manuela Savu**[*] - Nicolae Stelian Ungureanu*[*]**

Abstract: *Electricity networks are a set of energy infrastructure, more or less available for directing electricity from power plants to consumers.*
It consists of power lines located and operated at different voltage levels, interconnected with each other in power stations. Power stations are used to switch from one voltage to another by means of transformers.
An electricity network must also dynamically manage the whole production - transport - energy consumption, putting in place control elements designed to ensure the stability of the whole.
The name of the underground power lines is often found in the electrical connection offers under the abbreviation LES. They are also called underground electrical networks. These are electrical networks whose voltage is less than 1 KV.
Underground power lines, depending on their destination, can be classified into:
1). Power lines (networks) for electricity distribution. These networks are used for both direct current and alternating current, high, medium or low voltage. Underground power lines are usually executed for voltages lower than 35 KV.
2). Teletransmission networks - used telephony, telex, clock, radio, fire warning, etc.
3). Power lines (networks) for control and command - used for measurement, signaling and protection in automation systems. They are also used in the remote operation of some elements from the urban household installations or located at a great distance inside a consumer.
Underground electrical networks also have many features specific to the location, which can be:
- Directly in the ground;
- in invisible or visitable channels;
- in the basements of buildings;
- in river, river, lake, fresh or salt water;
- in the underground galleries;
- in an environment with very varied temperatures.
In all cases, the underground power lines are made of cables and accessories for junctions, branches and connections to electrical panels.

Keywords: electrical networks, underground power lines, power lines, maintenance, maintenance times, overhaul of power lines.

1 INTRODUCTION: **Objective:**

Maintenance refers to the technical and organizational actions carried out on the components of the structure, installation and capacity of an energy distribution system.

Underground power lines offer many significant advantages for OHL (overhead power lines):

- are easier to operate;

- ensure greater operational safety and have a high degree of aesthetics.

However, they have significant disadvantages: correcting a malfunction is much more complex and expensive.

Maintenance of electricity distribution systems is done through a traditional approach through corrective maintenance: repairs, replacement of leaking elements, additions with combustible materials, intervention after the damage has occurred - production flow is affected - repair costs are added economic losses from own production, or a modern approach: predictive-preventive maintenance, actions are taken in a planned manner to maintain the optimal level of performance of the system leading to optimal costs.

1.1 Preventive operations - planned or corrective after the accident, have the following definitions:

Preventive maintenance - reduces the risk of a sudden defect and is achieved by replacement parts of parts subject to wear, adjustment, operation, cleaning, etc., including all planned overhauls and repairs.

Corrective post-breakdown maintenance - consists of repairs to replace items that have failed, additions with consumables.

In the perspective of sustainable and sustainable development, respectively of long-term creation of acceptable working and living conditions, in a clean and healthy environment, the issue of safe provision of urban utilities, including the importance of electricity cannot be overstated. The safe operation of the energy distribution system is essential. The distribution of electricity is largely determined by the reliability of electrical installations. In urban areas, the distribution of electricity is done preferentially through underground power lines. In most cases, the primary causes of damage to electrical installations are due to the degradation ("aging") of power cables related to undrground power lines. Degradation of underground cables and aging of their insulation are processes that take place under the synergistic action of stressors given,

on the one hand, by working circumstances (firstly, voltage; working currents and transits, and on the other hand, by the environmental conditions in which the cable is laid (soil aggressiveness: salinity, microbiological load, humidity, dispersion currents generated by urban transport systems on rails powered by cc shocks and vibrations produced by road transport, etc. Due to damage that may occur in the electrical installations the corrective maintenance is carried out that involves repairs, interventions, verifications and is classified according to the following types of works:

- Repair works with a high degree of complexity which implies the non-modification of the initial technology restoring the technical condition, the efficiency of the installations at a level close to the one at the beginning of the life.

- Repairs of energy equipment that are carried out in workshops to maintain availability, reliability in their operation.

- Deforestation - they ensure the maintenance of safety corridors for energy installations

Corrective maintenance work is required following incidents and aims to restore electrical installations to the state of operation and supply of electricity to consumers.

Accidental works that are of greater magnitude, as a result of calamities and special weather phenomena.

Maintenance has the following specific times:

- actual maintenance time;

- actual corrective maintenance time;

- the effective time of preventive maintenance;

- the actual maintenance time observed;

- estimated actual maintenance time;

- the actual planned maintenance time;

- availability;

Brief description of these maintenance times:

- actual maintenance time - is the time during which repairs are performed manually or automatically on a device, they do not include the waiting time allocated to the work of the device in material waiting repairs, etc., instead it includes inherent times, necessary, application of prescribed maintenance methods;

- actual corrective maintenance time - in which corrective maintenance actions are performed, which do not include the waiting time and the time required for repair;

- the effective time of preventive maintenance - expresses the part of the actual maintenance time in which preventive maintenance actions are performed, during this time the waiting time and the time necessary for the maintenance action are not included;

-the observed actual maintenance time is the ratio between the sum of the actual times and the total number of maintenance actions.

Estimated actual maintenance time - is determined by the value or limit values of the given credit interval and based on the same data as the average observed actual maintenance time of the nominally identical devices. The expected average effective maintenance time is calculated for a device taking into account the following reliability indicators, estimated, extrapolated, predicted and the estimated average effective maintenance time of its components, as well as the indication of calculation methods, data sources and technical assumptions. and statistics.

Availability - represents the probability of the device performing the function at a given time, or the probability at a time interval.

Distribution systems - electricity is a basic component of the entire power chain, the problems of reliability of distribution systems are key issues of electricity that require special attention in the analytical calculation of the optimal level of reliability of distribution systems and power supply electricity consumption. The factors that influence the operating regime of the distribution systems and can be aligned are the following: - the predominant specific features of the components of these systems; - the needs submitted in relation to the level of reliability of electricity supply by the respective consumers; - the connection schemes of the respective elements in relation to the system as a whole; - technical and economic requirements before the distribution systems as a whole;

- the socio-economic and climatic-geographical conditions of the region in which the system is located.

The optimization of the distribution system and the security of the electricity supply is a technical-economic problem, the solution must be ensured based on the criterion of minimizing the expenses incurred. In this process, the cost of the damages suffered, both the consumer and the supplier, is very important.

1.1.1 The experimental part:

Overhaul of underground power lines with voltages up to 35 kV. This operation requires disconnecting the cables. The following are performed during the overhaul:
- Preventive test with high voltage for cables over 1 kV;

- Checking the tightness of the terminal boxes, and for those provided with a filling hole, additions can be made, if necessary, with insulating mass or oil;
- Checking the condition of the insulation in phases and restoring it, if possible degradations are found;
- Checking the condition of the conductors' slippers and grounding slippers, of the contact surfaces and, if necessary, the soldering is restored and the contact surfaces are cleaned;
- The condition of the terminal boxes with insulators is erased and checked;
- Clean the cable ducts and check the condition of the protective metal covers;
- Repaired concrete slabs on cable ducts are replaced;
- The layers of anticorrosive and fire-retardant paint are restored;
- Check the support connections of the cables and the support parts to the terminal boxes in the cells.

If, in the case of overhauls, certain defects are found that cannot be remedied on these occasions (for example, terminal boxes that lose insulating mass, cables with advanced corrosion), they will be signaled and retained for scheduling repairs.

Repair of underground power lines with voltages up to 35 kV.

The cables are repaired after identifying the defective place and generally consists of the following operations:

- Replacing the terminal boxes that lose the insulating mass;
- Repair of defective terminal boxes, either during operation or during tests;
- Replacing the defective cable portions and executing the respective junction sleeves; - undoing and restoring some defective junction sleeves, and at low voltage and those of derivation.

Below are some of the characteristic cable line repair activities, which are more common in operation.

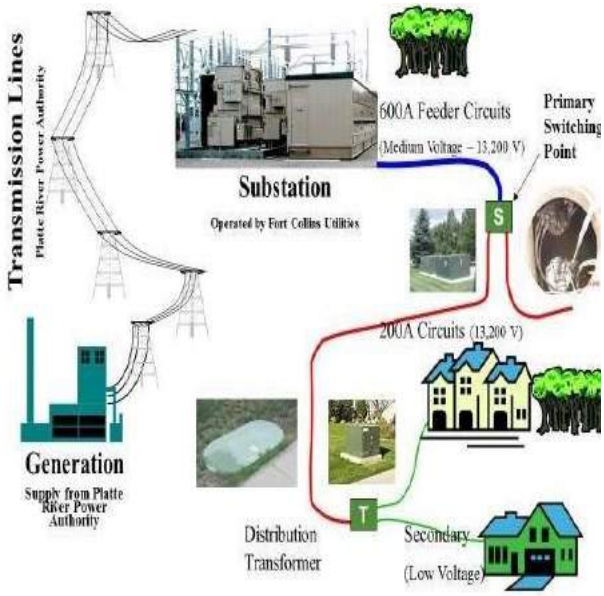

Fig. 1. Basic electric system overview

Worksheet

• Periodic voltage checks (phase and line) at the consumer end of the SLE;

• Periodic checks of the SLE load by measuring current intensities;

• Control of insulation resistance especially after periods of SLE overload

• Control of the electrical resistance of the cable conductors;

• Troubleshooting (replacement of burnt fuses, restoration of contacts, insulation of columns)

• Repair of cables, sleeves, terminals, etc

• Maintenance of distribution boxes

• Identification of the cable route

• Defect detection

• Check the cable cover

• Check the end sleeves

Fig. 2. Underground electrical transmission lines

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Authors addresses

Anamaria Manuela Savu[*] *- Nicolae Stelian Ungureanu*[*]

Contact person

[*]*Savu, Anamaria, institution:Technical University of Cluj-Napoca - North University Center of Baia Mare, street Victoriei, no76.,City:Baia Mare, e-mail: savu.a.m7@gmail.com*

Principles and objectives of management related to maintenance activity

Anamaria Manuela Savu, Nicolae Stelian Ungureanu**

Abstract *Maintenance refers to the technical and organizational actions carried out on the components of the structure, installation and capacity of an electricity distribution system that is used and which are performed to maintain and restore the technical standards necessary to achieve the objectives for which they were created. The definition highlights the importance of the level of reliability for a given system that can change by the nature of the operations to which the system is subjected.*
The current stage of industrial and economic development in which our country is and in accordance with European Union standards, is a necessity for specialists in the energy, technical and electronic fields in the acquisition and efficient application of the notions of maintenance and maintainability.
The main purpose of maintenance systems in both industrial and energy environments is to keep machines, machinery and equipment in working order and they are based on the logical structuring of works based on many criteria:
- resources
- means
-data processing
- lower maintenance, repair and storage costs;
- the requirement to reduce unintentional breaks by preventing permanent damage, disturbances and wear and so on.
The principles of the maintenance activity to be observed are the following:
Increasing operational safety in accordance with the objectives of reliability, safety and operation, protection of personnel and the environment in accordance with relevant standards, based on cost-effectiveness;
The maintenance of the distribution systems will be carried out on the basis of maintenance insurance programs;
Early detection of damage is done by applying preventive maintenance programs and within it, with priority, surveillance and predictive maintenance programs.
The management staff has the duty to coordinate the maintenance activities following the achievement of the following objectives:
Establishing a new strategy for maintaining and applying the stated principles;
A different technique for approaching problems. New requirements to be met, the resources allocated to each electricity distribution system of the maintenance program, which must correspond to the significance it has for operational safety, personnel safety, environmental protection or the fulfillment of other particular criteria;
The necessary resources must be made available in time.The effectiveness of the maintenance insurance program should be evaluated following the results.
Situations in which the requirements of the maintenance programs or the prescribed standards for the maintenance works are not observed, are identified by the personnel involved and communicated to the management for follow-up and the disposition of the solution.
The allocated budgets will be justified on the basis of the maintenance requirements, and the maintenance expenses will be associated to each specific activity carried out, ensuring the necessary conditions for their reporting to the competent authority.
Keywords: principles of maintenance activity, ensuring maintenance, organization, administration, maintenance objectives, coordination of activities.

1. INTRODUCTION: RESPONSIBILITIES IN THE MAINTENANCE OF DISTRIBUTION SYSTEMS

Maintenance activities will be allocated according to each hierarchical level:

Updating the strategy underlying the expansion of maintenance operations;

Implementing the guiding principles for establishing maintenance and training activities;

Ensuring compliance with the provisions of this Regulation and their implementation;

Creating budgets for maintenance tasks, as well as monitoring and reporting expenses;

Adapting the financial-accounting system of the enterprise to properly represent the structure of the chosen maintenance program;
Evaluation of maintenance insurance programs submitted by contracting maintenance companies;

Maintaining in good maintenance conditions the distribution systems due to the assurance of the contracts concluded with the maintenance enterprises, the achievement of the designed lifetime and the maintenance of safe conditions for the development of the operation;

Providing data on the performance achieved in the maintenance activity, in accordance with the requirements contained in the specialized procedure;

1.1 Maintenance program requirements

Maintenance insurance will include:
The requirements of the maintenance program can be applied distinctly, based on the function and significance that each system plays in operation, to the safety of people and the environment, the level of risk involved and the specific maintenance history of each system;
The process of planning, planning and coordinating maintenance operations:
Provide data on budget and maintenance expenses in accordance with the requirements contained. In order to maintain the electricity distribution systems in accordance with the established objectives and to reduce the outstanding works to a controllable level, a good provision of resources is necessary;

Ensuring maintenance is done by monitoring, reviewing, analyzing efficiency and controlling the effective application;

Creating and maintaining databases on the state of distribution systems and the results of multidisciplinary inspections made by specialists, managing the situation of maintenance works by preparing and supporting reports on the state of electricity distribution systems;

Reporting data on the performance of the maintenance activity in accordance with the criteria presented in the specific process;

Providing data on budget and maintenance costs in accordance with the criteria of the procedure;

Updating and issuing maintenance-specific rules, methods and instructions.
Responsibility and authority are assigned to each level of management within the companies engaged in guaranteeing and / or performing maintenance operations.
Management systems that maintain control over maintenance operations, monitor and evaluate the effectiveness of the maintenance program and collect the necessary field data to change measures to assess and correct any problems with electricity distribution systems;

Indicators and criteria used to evaluate the results of maintenance operations of the distribution system, as well as the performance of maintenance employees;
The application and assurance of a maintenance program will be done mainly through preventive maintenance techniques, surveillance and predictive maintenance on distribution systems, with priority over those important in ensuring a reliable and safe operation by establishing whether degradation processes take place and detecting and addressing any wear and tear that affects the performance, safety or maintenance of energy capacity.

1.1.1 Organizing and planning activities

Ensuring a high level of performance in maintenance activities requires from the management of the organization of responsible electricity distribution systems, the following actions:
setting high standards, strategies and quality objectives to be achieved;
well-implemented training programs to have a professional and ultra-qualified staff;
communication, objectives, strategy and standards of the work of the implementing staff, taking into account the long-term planning and scheduling of activities and the provision of sufficient resources;
evaluation of the execution performances of the works and coordination of the maintenance activities with the operation activity and with that of other departments,
from the execution and supervision staff assuming the responsibility for the quality of the executed works.

Fig. 1. Types of maintenance

1.1.2 Organization, administration and training of staff

Ensuring an organizational structure and trained and qualified personnel for the execution of maintenance programs.

In this regard:
Clear establishment and organization, with well-defined lines of authority, responsibility and reporting;
Determine communication requirements and establish links with other organizations involved;
Provide an adequate number of competent managerial, supervisory and executive staff who are properly trained to perform the necessary maintenance tasks.
The department that carries out maintenance activities for a certain energy objective is

responsible for the physical condition of the distribution systems.

Maintenance must propose a good strategy and implement clear objectives that must be specified in writing and brought to the attention of all maintenance personnel, the maintenance activity must be carried out in the manner necessary to achieve these objectives.

Maintenance objectives should include, but are not limited to:

- timely planning and execution of works;
- reducing the maintenance effort required during planned and unplanned downtime;
- reduction of execution errors and shutdown times of installations and equipment;
- reducing the number of activity restorations;
- taking appropriate measures for the proper functioning of the system.

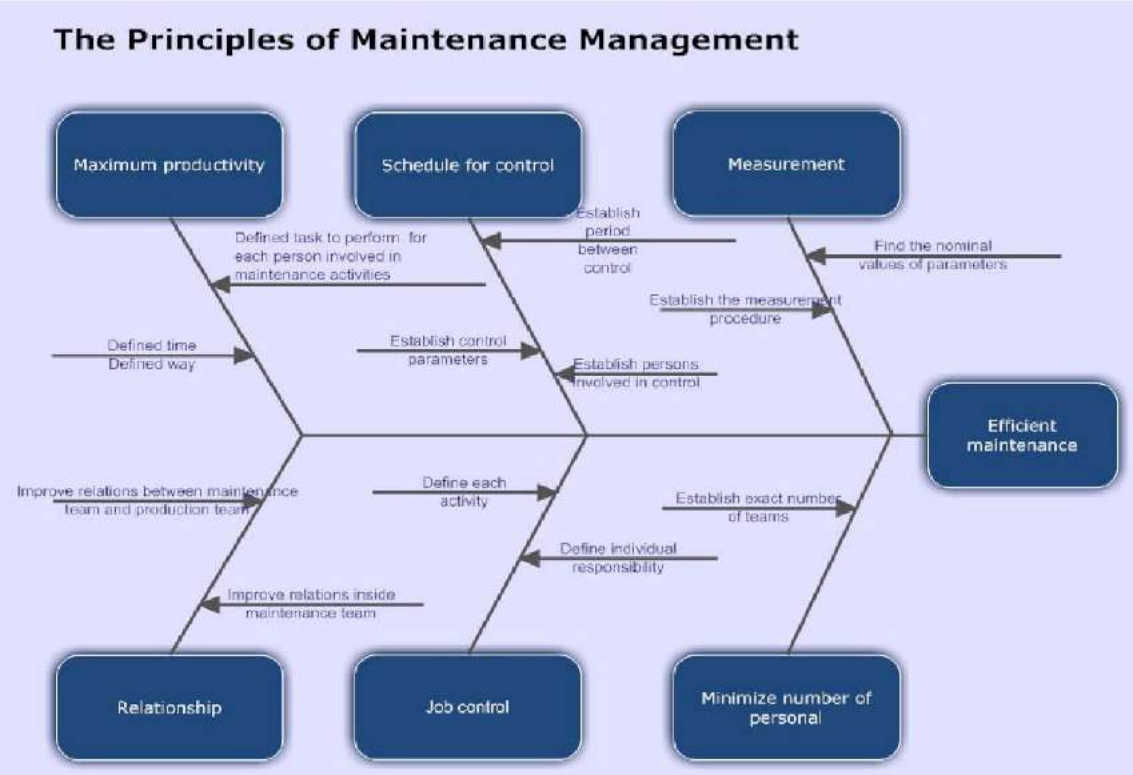

Fig. 2. The principles of maintenance management

1.1.3 Planning, scheduling and coordinating activities

To ensure the planning, scheduling and coordination of maintenance operations, the maintenance program must use an efficient system.

It also ensures that tasks are completed on time, improving maintenance efficiency.

In the case of complex objectives that involve rigor in setting priorities and judicious use of planned downtime, more specialized groups may be needed. On the contrary, in the case of small objectives, these maintenance tasks may be the responsibility of a single person in the management of the maintenance department.

The specific maintenance plan shall include the total number of maintenance operations required, as well as a summary of the major scheduled maintenance actions. The plan will also include a summary of actions to address long-term maintenance needs.

Using the formal method of planning and estimating activities, defining logistical support, permits to be granted, checkpoints, work processes and consumables, as well as establishing the overall volume of activities and planning the tasks and steps required to complete them. The schedule created for maintenance operations that take place during scheduled shutdowns must allow for their completion and verification, as well as provide management with the information necessary to manage

all activities that take place during this time. There are many organizations that perform maintenance tasks. Ensuring good coordination is done by:
- obtaining authorization to carry out activities such as fire work permit, radioactive work permit, closed access permit and live work permit, as well as acceptance of the external organizations involved, such as acceptance of the SEN Dispatcher for decommissioning production capacity or electricity transmission.
- organizing activities at meetings attended by representatives of each maintenance discipline and departments involved: operation, labor protection, quality control, radiation protection, technical assistance, warehouses, etc.

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Authors addresses
Anamaria Manuela Savu[*] - *Nicolae Stelian Ungureanu*[*]

Contact person
[**]*Savu, Anamaria, institution*:*Technical University of Cluj-Napoca - North University Center of Baia Mare, street Victoriei, no76.,City:Baia Mare, e-mail: savu.a.m7@gmail.com*

Effect of granulated power plant fly ash on hairy vetch (*Vicia villosa* Roth.) biomass yield

Béla Szabó[1,*] – Edit Krajnyák Kosztyuné[1] – Csaba Varga[1] – László Simon[1] – Katalin Oláh Irinyiné[1] – Judit Csabai[1]

Abstract: *In the demonstration garden of the University of Nyíregyháza, we set up a greenhouse experiment in 2020 with a highly perspective material for the use of granulated power plant fly ash (GFA). Due to its favourable pH, macro, meso and microelement content, the use of the material is particularly justified in the soils of Nyírség having poor nutrient and water management. The experiments were carried out with one of the dominant plants of the University's Scientific Workshop, the hairy vetch. In addition to measuring the below-ground and above-ground biomass of the plants, the number of Rhizobium nodules was also measured.*

Keywords: *hairy vetch, acidic sandy soil, root nodule, biomass yield, granulated power plant fly ash (GFA)*

1 INTRODUCTION

Today's arable crop production differs remarkably in all its agrotechnical elements from the industrial farming of the recent past. This problem is even more pronounced in poorly productive acidic sandy soils, where the unilateral and excessive use of nitrogen and the soil-destroying effects of herbicides are even more highlighted. This is mainly due to poor soil water management and low organic matter content. Any method or process that can be used for nutrient management is particularly important to farmers. Green manure crops are receiving increasing attention. The most valuable green manure crops are the legumes, which not only provide a significant amount of organic matter to the soil, but also enrich the upper soil layer with remarkable amount of nitrogen through the Rhizobium bacteria that live symbiotically with their roots. The majority of legume green manure plants are valuable fodder crops because of their high protein content and favourable amino acid composition (KOSZTYUNÉ KRAJNYÁK, 2021).

Among the green manure crops that can be grown on the acidic sandy soils of Nyírség, the hairy vetch (Vicia villosa Roth.) occupies a prominent place, because it can be grown successfully under increasingly extreme weather conditions.

Brown and colleagues (1993) found that hairy vetch which is a green manure crop is frequently used as a cover crop. It uses up only small amount of water and fixes nitrogen from the air. Therefore, as a previous crop is able to significantly increase the maize yield both in conventional and in no-tillage systems. Miko and colleagues (2012) found that biomass yield of green manure plants and their positive effect on soil fertility, under unfavourable ecological conditions, can be increased by adding 50 kg/ha nitrogen. Newly incorporation of green manure plants causes inadequate off-spring and slow early developing of after-crop. Therefore, 4-6 weeks should be kept between the incorporation and sowing. (WESTSIK 1936, BALLENEGGER and colleagues 1936). Kahnt (1986) recommended the green manure application to farms where cereals are prevalent in crop rotation; nitrogen fertilizing is not intended or not possible. Green manure plant could be divided into two groups, papilionaceous and all the others. Papilionaceous are applied owing to nitrogen fixing ability of symbionta Rhizobium species while the others are applied due to their other favourable agronomic properties.

According to Dobránszki (2002) green yield of hairy vetch could be 25-45 t/ha, while its seed yield could be 500-800 kg/ha. Szabóné (2002) pointed out that hairy vetch is able to produce great amount of green yield in low fertile soil even in early spring. Seed yield potentially could be 1.5-2.0 t/ha, at farm level it is 0.4-0.5 t/ha. As for green yield 25-30 t/ha is reachable. Gondola and Szabóné (2010) reported that hairy vetch sowing seed has a good export market. Its green yield ranges from 25 to 45 t/ha, its seed yield is about 500-800 kg/ha depending on supporting plant and cropping year.

It tolerates dry soils with low precipitation in autumn, has excellent winter hardiness, regenerates quickly under favourable early spring weather conditions and has high biomass production (KOSZTYUNÉ KRAJNYÁK and colleagues 2020).

In the last decades, fertilization has become the most common method for plant nutrient supply. With the rise in the cost of fertilizers and soil improvers, the importance of other materials, agricultural or forestry by-products, which can be used for nutrient supplementation and soil improvement in crop production, has increased. These include fly ash, a by-product of power plants.

The Romans were already aware of the importance of wood as a nutrient management material, although no literature has survived. The first written references to it date from the late 1700s. In the early 1800s, Justus von Liebig, the father of nutrient replenishment, also dealt with ash. Domestic studies were first published in the late 1800s (BENCZE 1893). The author examines the nutrient composition and potential uses of acacia ash for nutrient supply. From a silvicultural point of view, Csiha and colleagues (2007) investigated the properties of wood ash in several experiments. Tóth and colleagues (2012) and Marozsán (2009) also looked at the role of ash in the nutrient supply of plants. Tóth (2021) mainly focused on the effects of granulated wood ash on plant tissues. From a

domestic researchers Füzesi has studied the topic in most detail, investigating the effects of wood ash plot experiments (FÜZESI-KOVÁCS 2011; 2012, FÜZESI and colleagues 2013; 2015). The above experiments usually report the yield-enhancing effect of the substance. Wood ash also improves soil properties.

Our study is focused on the phenological analysis of the early development of the hairy vetch grown on acidic sandy soils. We investigated the effect of granulated power plant fly ash (GFA) on the early development of the hairy vetch in an open air plot experiment. The main objectives of our work were the following:

- Measurement of plant height and root length
- Clounting of Rhizobium nodules on the main and lateral roots.
- Measuring of Above-ground and below-ground.

2 MATERIAL AND METHODS

Our study was carried out in an open air pot experiment in 4 replicates. Pots were lowered into the ground and filled with soil from the Training Farm of University of Nyíregyháza. Planting was done on 20th September 2020. 20 seeds were placed in each pot. 2 dkg of GFA was applied to each pot at sowing. Nutrient content and pH of GFA is presented in Table 1.

Table 1. Total nutrient content and pH of GFA

Nitrogen (mg/kg)	792
Phosphorus (mg/kg)	10591
Potassium (mg/kg)	32614
Calcium (mg/kg)	135943
Magnesium (mg/kg)	11717
pH-KCl	11.41

Source: Szabó Béla

Almost all elemental contents of the tested material correspond to the average values given in the literature. (It should be noted here that the international literature describes the elemental content of wood ash in a very wide range.) The nitrogen content is negligible from a nutrient management point of view. The phosphorus content of the material is around 1 % while the potassium content exceeds 3 %. The calcium content is remarkable at 13.5 % and the magnesium content is also notable at above 1 %. The pH of the ash was 11.4.

Table 2 shows the soil test results, which reflects poor water management and low fertility soils of the Nyírség. The data also clearly show that this is light, acidic sandy soil.

Table 2. Soil test results (2020))

Parameter	Value
Sampling depth (cm)	0-30
pH-KCl (-)	4.22
Soil plasticity according to Arany (K_A)	27
Total watersoluble salt (m/m%)	<0.02
$CaCO_3$ (m/m%)	<0.1
Humus content (%)	1.14
NO_3^--N+NO_2^-N (mg/kg)	17.9
SO_4^{2-}-S (mg/kg)	<50
Mg (mg/kg)	81,1
P_2O_5 (mg/kg)	169
K_2O (mg/kg)	321
Na (mg/kg)	56,5
Zn (mg/kg)	0,87
Cu (mg/kg)	1,18
Mn (mg/kg)	56,1

Source: Hungarian Horticultural Propagation Material Non-profit Ltd.

The experimental plant was the Hungvillosa cultivar of hairy vetch, bred in Kisvárda. Lazányi (1994) found that Hungary's ecological conditions give good opportunities to vetch seed production. As excellent green yield was reached with cultivar "Kisvárdai" in Germany, its sowing seed has a good market. This cultivar due to its favourable agronomic properties was registered in Germany under the mane of "Hungvillosa" in 1980. It has a long, thin and moderately hairy shoot system. The leaves are hairy and elongated. It has medium cluster size and a dark violet-blue flower pair. The pods are broad, flat and elongated in shape, with a yellowish-brown colour indicating the maturity of the pods. The seeds are greyish black and rounded, weighing 30-35 g per thousand seeds. The growing period is 240-260 days. When combined with cereals (e.g. rye, triticale), it is an excellent green fodder, which can also be silageable. Its tillering capacity and winter hardiness are excellent.

Harvesting was done on 8th December 2020. The pots were lifted out and the plants were removed. The plant samples were taken to the Plant Production Laboratory of the University of Nyíregyháza, where the roots were washed. During the test 10 plants were randomly selected. Phenological measurements were made on the plants, plant height and root length were

measured. Number of root nodules were also counted either on main or on lateral root.

The root was detached from the stem to measure the below- and above-ground biomass.

3 RESULTS

In our study, we measured plant height and root length in an open air plot experiment in the early phenophase of the cultivar Hungvillosa. Rhizobium nodules were counted on main and lateral roots. Our study also included measurements of below-ground and above-ground biomass mass. Both the traps and the temperature conditions developed favorably in the post-sowing period. A rapid germination process took place after sowing of the hairy vetch seeds. The initial development of the young plant stock was slow shoot development accelerates more in spring. Plants treated with GFA developed better than untreated ones. GFA treated plants was more than 3 cm taller than untreated plants. (Figure 1).

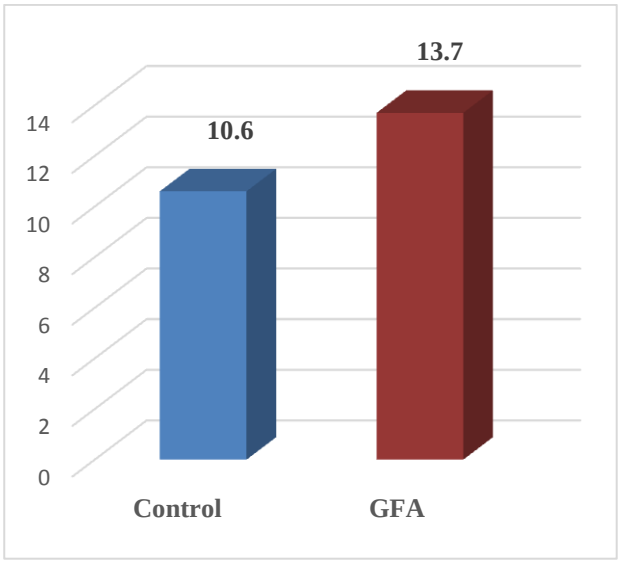

Fig. 1. Plant height (cm)
Source: Szabó Béla

During the autumn-winter period, the roots develop almost exclusively, the above-ground parts develop only slowly producing low green mass. Its long, spindle-shaped main root, from which rich lateral roots branch off with root nodules at the end. The root mass itself is 30-35% of that of the fully developed plant. At harvest, the length of the main root can reach 150-180 cm. Because it has many lateral roots, it is extremely well able to penetrate the upper (20-25 cm) soil layer.

Longer roots were measured in plants treated with GFA (Figure 2).

While the root length of the control plants averaged 25 cm, that of GFA treated plkants was more than 32 cm. This is a significant difference in root growth. We did not measure the length of the lateral roots here, but we observed that the total root system of the plant showed a significant increase. This was also demonstrated by measuring underground biomass masses.

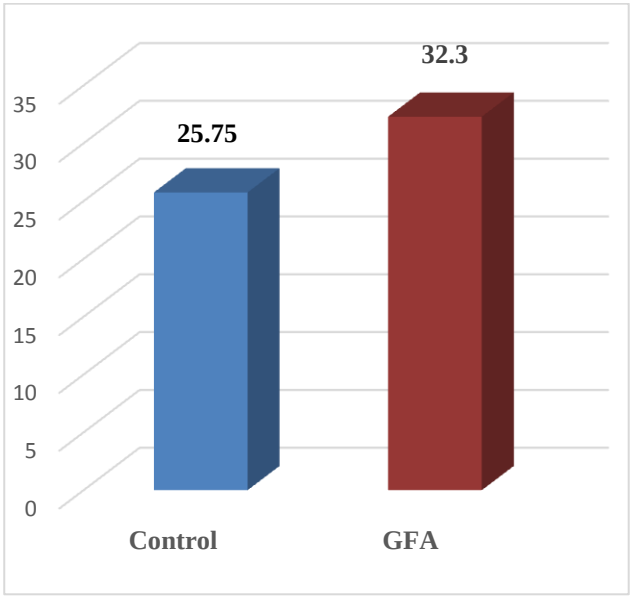

Fig. 2. Root length (cm)
Source: Szabó Béla

We also counted the number of Rhizobium nodules. In plants treated with GFA, with 5 more nodules were detected on the main root than in control plants (Figure 3). An average of 11.5 nodules were found on control plants. In GFA-treated culture vessels, this value increased significantly. Here, the average number of nodules on the main root was 16.5.

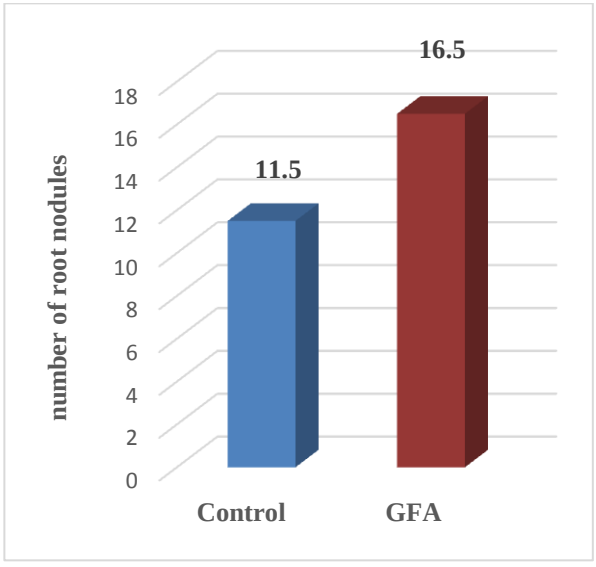

Fig. 3. Number of nodules on main root
Source: Szabó Béla

The spindle-shaped main root develops long, densely branched lateral roots with a large number of root nodules (Figure 4). In plants treated with GFA, more than 14 nodules were formed on the lateral roots. Plants in the control plot produced far fewer root nodules.

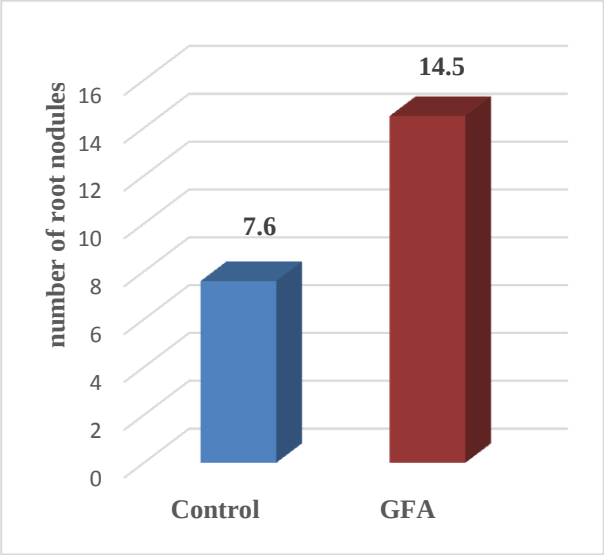

Fig. 4. Number of nodules on lateral roots
Source: Szabó Béla

Looking at the whole root system, plants treated with GFA developed with 60% more nodules than untreated ones (Figure 5). Our studies did not cover the measurement of the nitrogen uptake effect, but we can hypothesize that the increased number of nodules has a positive effect on nitrogen uptake. It is likely that the alkalinising effect of GFA had a beneficial effect on soil life in the acidic soil.

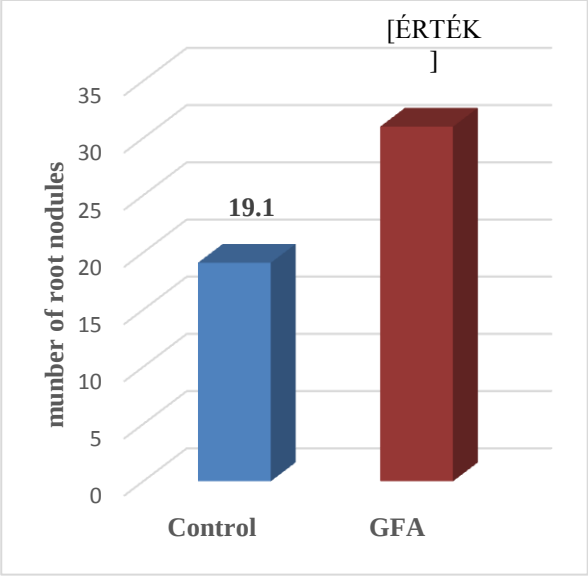

Fig. 5. Number of root nodules
Source: Szabó Béla

Hairy vetch produces remarkable amount of green mass in the spring. The plant develops many leaves and long stem. Based on data from the early development stage, we measured a higher above ground biomass for GFA treatment.

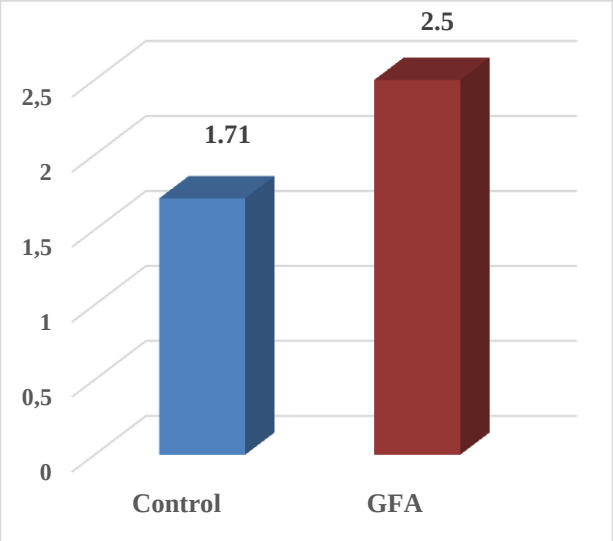

Fig. 6. Above-ground biomass (g) of hairy vetch
Source: Szabó Béla

Below-ground biomass was also measured. GFA treatment increased the root mass. As it could be show in Figure 7 root mass was higher with 0.5 g due to GFA treatment.

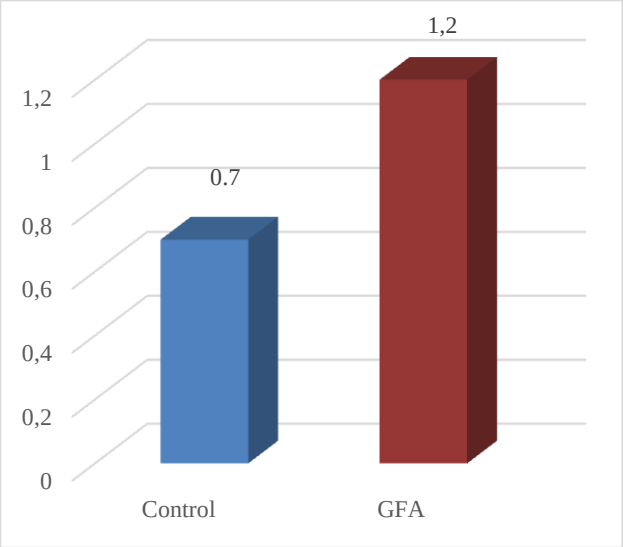

Fig. 7. Below-ground biomass (g) of hairy vetch
Source: Szabó Béla

4 CONCLUSION

The effect of GFA on plants was more pronounced in our plot experiment. The plant height, root length, number of root nodules, below-ground and above-ground increased significantly due to GFA application. As for hairy vetch GFA had a positive impact ont he above mentioned parameters.

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Authors addresses

[1]*Béla, Szabó, PhD, University of Nyíregyháza, Sóstói 31/b szabo.bela@nye.hu*

[1]*Edit, Kosztyuné Krajnyák, University of Nyíregyháza, Sóstói 31/b*

[1] *Csaba, Varga PhD, University of Nyíregyháza, Sóstói 31/b*

[1]*László, Simon, PhD, University of Nyíregyháza, Sóstói 31/b*

[1]*Katalin, Oláh Irinyiné, PhD, University of Nyíregyháza, Sóstói 31/b*

[1]*Judit, Csabai , PhD, University of Nyíregyháza, Sóstói 31/b*

Contact person

**1 Béla, Szabó, PhD, University of Nyíregyháza, Sóstói 31/b szabo.bela@nye.hu*

Accelerating to industry: experiences in development and implementation of cooperative and dual education models in higher education

Ferenc Szigeti[1] - Gergely Dezső[2,] - László Sikolya[3] - Gábor Páy[4]*

Abstract: *Cooperative education embrace a wide range of models at different levels of educational systems. In higher education it aims linking between skill development of students with demand for qualified manpower of companies. Key idea is that being involved in daily life at a company is an effective environment for speed up and deepen of learning practical knowledge, getting realistic experiences and empowering so-called soft skills. Additionally apprenticeship may bring together prospective engineers with their possible future employer decreasing significantly the risk of unemployment at one side and lack of expected white collar workers at other side. In this paper we share experiences of six years in development, implementation and operation of two different cooperative model in higher education. First one is dual education at University of Nyíregyháza in five fields of study. Second one is a short period cooperative form of completive education.*

Keywords: dual education, pedagogy, engineering education, cooperative education, higher education

1 INTRODUCTION

In the past concept of dual education (work integrated learning) was primarily present in vocational training in high schools. Basic idea is that an educational institution and a company carry out program of training in a cooperative way. Students spend their time partly either in the school or in the factory, where they became more and more involved in work. This mode of learning linked directly knowledge with applications so ensuring that practical skills of students developed to the level required in the industry.

Nowadays higher education, especially on fields of engineering, economics and other studies tend to introduce cooperative forms of education. This reflects to claim of industrial stakeholders for white collar workers who are able to organize and coordinate practical work. Cooperative education is a collective noun of several type of education. In higher education this may involve a short-term completive apprentice program and a fully parallel type of education, the so-called dual education.

Legal regulation of cooperative forms of higher education stands at different levels in countries of Europe. Germany, France can be regarded as motherland of such kind of higher education with old and tried out rules of law. In Hungary definition of dual higher education was coded in law 2011. CCIV. as followings: "*dual training: a form of training in the technical, informatics, agricultural, natural sciences, health sciences or economics bachelor's degree program, in the social work bachelor's degree program, or in the master's degree program in the listed field, in which the vocational training and output requirements are defined, full-time, containing special description of schedule, methods, evaluation of knowledge, and takes place at an organization qualified by Dual Education Council*" [5]. Arrangement and codification of further rules took place between 2012 and 2015 in Hungary. There are countries in Europe, where legal background of dual higher education is under development, like Spain [3].

Introducing dual education led to new relationships between vocational education and training (VET) and higher education (HE). On the one hand there is a real danger of VET and HE get in a competitive situation because HE may substitute VET dual education. On the second hand a synergy can be formed between HE and VET by dual study programs. [4]

Dual education was analyzed from the viewpoint of outcome, that is how all three parties, student, university and company benefits from it. It is shown out that all of them may be a winner of this form of education. Primary aim of the whole process to have skilled graduated people with considerable industrial experience, strengthened soft-skills and having appropriate attitude of working at a company. Industrial partners reflected that students participated in their program in most cases reach that level, and they are willing to offer a job for this students. Students report on how much additional knowledge they get, how they are involved in and learn teamwork, and usually how they get support in academic studies from their mentors. Benefit for universities is being able to announce a really effective, marketable and attractive form of education, developing their link with actors competitive area. [6,7]

Balance between theoretical and practical knowledge is a vivid question. Learning practical skills may help in engagement of students and industrial companies. However oversimplification in view of this complex process may lead to neglection of cognitive skills like basic vocational knowledge, in other words classroom instruction. Weakness on cognitive side of educacion may significantly decrease the flexible applicability of skills and ability for continuing education, which is important for continuous employability in circumstances of rapidly changing technologies in industry. [2]

In dual education special methods needed to be applied for evaluation of students skills. Experiences show that multiple ways are recommended, involving oral and written forms, especially a presentation at partner company. This kind of monitoring and evaluation opens up opportunities for developing soft skills of student even by evaluation process itself, personalized and effective feedback from all three direction that is

student-company, student-university (in case a representative of university takes part in presentation), company-university. [1]

University of Nyíregyháza released dual form of education in 2015. We reported our first experiences about structural questions, program development and methodology [7,8,9]. Now we can look back on sfive academic years. In this paper we introduce how dual education at University of Nyíregyháza advanced and how it contributed to preparedness of students, human resources of partner companies and educational offer of the university.

2 DUAL EDUCATIONAL PROGRAMS AND STUDENTS

General aims and features of dual educational programs what applied also at University of Nyíregyháza are followings:

- academic education is provided by the university and practical training is organized at premises of partner company,
- students receive scholarsip during the whole duration of training, what is 3.5 years, that is 7 semesters,
- academic and practical knowledge is united at workplace,
- employee competences like autonomy in labour, creativity, problem solving skills, project view, teamwork, professional communication, speaking foreign language, presentation techniques are consciously developed,
- students acquire routine in handling materials, tools and applying technologies,
- since students trained in dual form of education gain substantial professional experience beyond academic curriculum, they have much more chance on labour market.

Implementation and development of dual education at University of Nyíregyháza can be featured by two key set of data: fields of study involved in dual education and number of students.

Figure 1. demonstrates time schedule of dual education at University of Nyíregyháza. This is a template what can be handled flexibly.

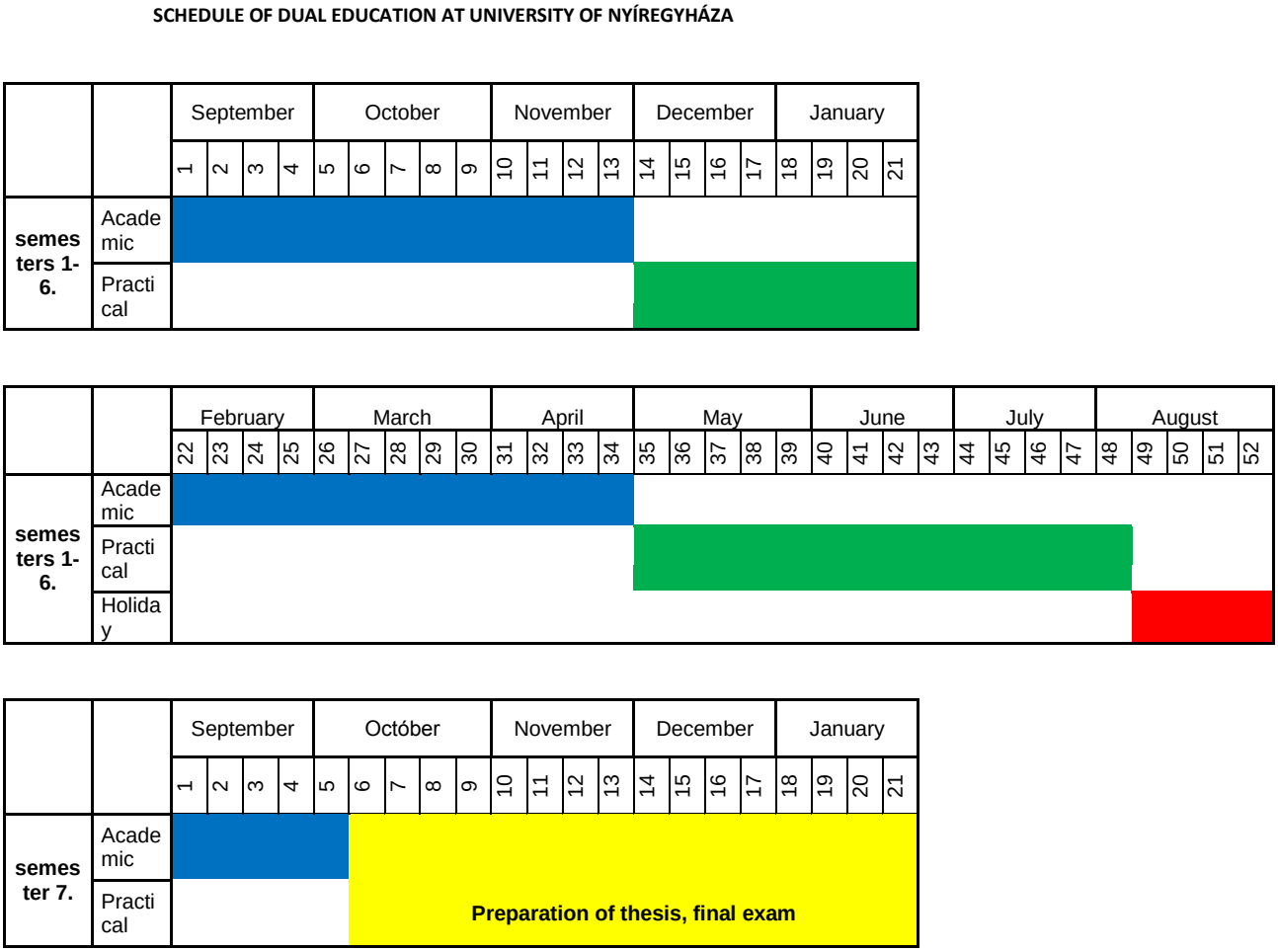

Fig. 1. Time schedule of dual education at University of Nyíregyháza

Time schedule can be affected by several factors.

- According to the nature of field of study and activity of the partner company it can be required that the student visit to the plant of the company.
- In the summer planned outages and maintenances may not fall in August. So dates of holidays may change according to arrangement between student and company. But total duration of holidays must reach one month in a year.
- Conversely, company may, and usually do let students free days in exam period, when they should work at the factory anyway, so that they are able to fulfill their exams successfully.
- There are fields of study which have an active period in a certain time in a year, and then a less active period follows. An example for this is agriculture. In such cases a special time schedule is worked out by three parties, that is company, university and student in favour of fitting together academic and practical training effectively.

Table 1. presents the six fields of study and headcounts of students in the period 2015-2021. We note that there are five academic year of dual education completed, and sixth academic year is ongoing now. In the heading of Table 1. year numbers refer to academic year which started in that year, for example 2015 refers to academic year 2015-2016.

Flagship of fields of study in dual education at University of Nyíregyháza has been mechanical engineering. In 2015 this was the only programme which worked out curriculum for dual education. Main task in this period was to get in touch with possible industrial partners and put them up to conception of dual education, make them informed on legal background, financial questions, pedagogical requirements, and whole administrative procedure. It was the first test of viability of dual education. Eventually many directors, excecutives, HR and technical managers decided to expend human work and other capacities to initiating dual education at their company in cooperation with University of Nyíregyháza. It is not a secret that there were some key partners which are significant economical operators in the region, some of the worldwide. After they had good first hand experiences, they shared it with other companies, and their testimony assisted attendance of further enterprises to dual education.

In 2016 dual educational programs started to develop on two new fields of study: transportation engineering and economist in business administration and management. By this dual education was no longer restricted to engineering programs, but touched economics.

In 2018 three new fields of study attended to dual education, two of them belongs to engineering, one represents again a new discipline, computer science. these three programs were: agricultural engineering, mechanical engineer in the agriculture and food industry, computer scientist.

Number of students can be analyzed in two ways: how it changed in time, and how it distributed between programs.

Figure 2. visualizes data of Table 1.

Timeline of total number of students taking part in dual education is increasing from 2015 to 2019. Then a drop can be observed. Separated data of number of participants by fields of study show almost the same tendency.

It is observable that engineering programs give two third part of total number of students or more. According to student specific number of programs mechanical engineering is the first and economist in business administration and management has the second place, and transportation engineering is the next.

Drop from 2019 can be unequivocally interpreted as effect of epidemic. Pandemic situation influenced dual education at least in two ways. First was lack of personal contact with future students during campaigns. High school students, their teachers and parents need direct and clear information and motivation about dual education in higher education, because in Hungary most of people doesn't know about this form of studies. Second way how pandemic obstructed students in attending dual education is legal rules aiming roll back of spread of infection. Often it means that outsider persons were not allowed to enter premises of the company. In this sense students are also outsider, because they are not employees.

Communication between partners is based on three processes:

- annual meeting with representatives of partner companies and responsible persons for programs at university,
- presentation of students at the end of each semester, it takes place usually at partner's premises, and one person from the university takes part,
- regular communication between university and student both in official and personal ways.

This system ensures that

- we have up to date information on performance of dual education,
- we can improve our daily work or programs continuously if necessary,
- we can build up long term development actions according to legal changes, challenges in industry and social circumstances, experiences gathered and proposals suggested from all three steakholders, students, partner companies and university in a period.

Regular communication is a substantially important tool of maintenance and development of dual education at our university.

Table 1. Number of students attending dual education on six fields of study in the time period 2015-2021

field of study	2015	2016	2017	2018	2019	2020	2021
computer scientist	0	0	0	3	2	3	3
agricultural engineering	0	0	0	4	10	8	7
mechanical engineer in the agriculture and food industry	0	0	0	1	8	7	5
mechanical engineering	11	18	20	29	35	30	26
transportation engineering	0	1	4	8	5	5	2
economist in business administration and management	0	11	13	16	18	9	7
total number of students	11	30	37	61	78	62	50

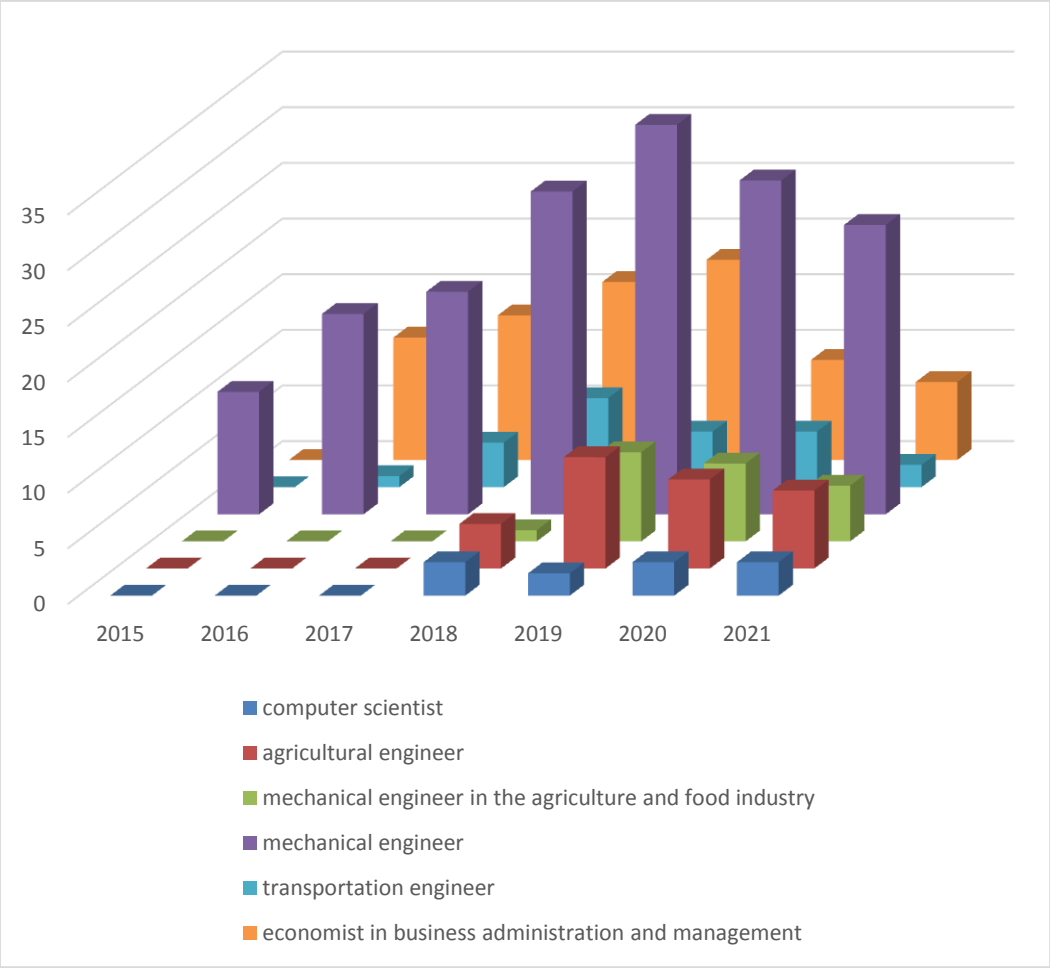

Fig. 2. Headcount of students participated in dual education on six different field of studies from year 2015 to 2021

Table 2. shows number of industrial partners of University of Nyíregyháza in dual education in 2021. Two remarks may help to understand these data.

There are partners who are interested in multiple disciplines. The larger is a company the more valid is this statement. For example a large international company interested in production applies not only engineers, but IT xperts and economists. This is why they sign a contract with the university for more dual educational programs.

Partner companies may indenture not only one students, but more. We have an example of four students started dual education at the same company in the same semester. However the opposite is also possible, a company may skip an academic year omitting entrance procedure. Companies are not obligated to take in

students. University and companies have a frame contract regarding dual education. Many times colleagues at the university have substantial role in helping students a company which fits to their needs in dual education.

Table 2. Number of industrial partners in dual education on six fields of study in the year 2021

field of study	2021
computer scientist	7
agricultural engineer	15
mechanical engineer in the agriculture and food industry	13
mechanical engineer	28
transportation engineer	11
economist in business administration and management	13
total number of industrial partners	87

3. A SHORT TIME COOPERATIVE TRAINING

Dual education is a roboust, very effective form of practice-oriented field of studies and has several advantage. It has the important feature, that students can enter this form of training only at the beginning of their university studies, that is the first semester, not later (in special cases it is possible in second semester, but that is exception). However there are some special cases when students can not attend to it. Some example for such cases are the followings:

- Advertisement of dual education can not reach in time to future students, so they don't know about it, and don't apply for it.
- At the beginning of university studies the student does not understand well enough advantages of dual education and simply does not want to attend.
- Some student have not the level of personal maturity of getting so committed to learning that they scarify so much time and work for dual education what it requires. But later they may change their mind.
- Some students understands everything, but they really decide not to involved in dual education.

And, additionally we have to take into account students, who enter dual education, but later drop out for some reason. There are a few of such students.

It implies that there is a need of a different type of cooperative education, which is shorter in time. It is called short time cooperative training, or we could say cooperative apprenticeship. Main features of it are the followings:

- Academic education takes place at the university, practical training at the company, but the latter is shorter in time.
- Prerequisites of entering this apprenticeship are at least 4 semesters fulfilled, at least 100 credit gained, and successful application to the company advertised the training.
- Duration of practice is at least 70 workdays.
- Students receive scholarship for the time of practical training.
- Students link academic and practical knowledge, develops their soft skills like in dual education, but in a shorter period.
- Students gain professional practice, so they have better employment expectations on labour market. It is possible that company, where they are apprentices employs them.

Industrial partners in this training comes from partners of dual education. We have partners who signed contract for both cooperative training namely dual education and cooperative apprenticeship.

4. CONCLUSIONS

Dual education is a successful project at University of Nyíregyháza. Further advancement of it is an objective committed to wrinting in development plan of the institution.

Competences of students can be improved, appropriate motivation may significantly accelerate personal development. Dual education strengthens motivation of students by not only financial benefits, but by inspiring working environment, several kinds of customized personal support, sense of achievement, mind with good expectations for future employment.

Dual education highly contributes to academic engineering training so that it can correspond to expectation of labour market. It means graduated students have much stronger and wider scale of skills required for successful work.

Cooperation with companies and the university has got stronger since dual education has been introduced. It extends to educational, service and research activity involving invited lectures by professionals, common theses and student's research projects, collaboration in scientific projects.

Dual and cooperative education needs to be acquainted expansively inboth student's and companie's circles.

The majority of students obtaining a degree after dual education are employed by the company where they completed their practical part of dual training, and stays in the region.

In the future we plan to develop our cooperative educational activity. Possible way of it preparing new, practice-oriented teaching materials, especially on topics come from industrial partners. Preparing visual aids may bring closer practice to students even in stage of academic training. Companies are ideal partners in creating visual aids.

5 ACKNOWLEDGEMENTS

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Here we express our thanks to industrial partners of University of Nyíregyháza, Institute of Engineering and Agriculture for their cooperation and commitment in development of dual educational models, fruitful consultations, and sharing their experiences with us.
Authors say thanks students and alumni for allowing us to follow up their studies, advancement till their graduation and their career after getting employed.

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Authors addresses

[1]*Ferenc Szigeti, professor, University of Nyíregyháza, Institute of Enfineering and Agriculture, Department of Physics and Production Engineering, H-4400 Nyíregyháza, Sóstói road 31/b, +36-42-599-400, e-mail: szigeti.ferenc@nye.hu*

[2]*Gergely Dezső, professor, University of Nyíregyháza, Institute of Enfineering and Agriculture, Department of Physics and Production Engineering, H-4400 Nyíregyháza, Sóstói road 31/b, +36-42-599-400, e-mail: dezso.gergely@nye.hu*

[3]*László Sikolya, professor, University of Nyíregyháza, Institute of Enfineering and Agriculture, Department of Transportation Engineering and Infotechnology, H-4400 Nyíregyháza, Sóstói road 31/b, +36-42-599-400, e-mail: laszlo.sikolya@nye.hu*

[4]*Gábor Páy, professor, University of Nyíregyháza, Institute of Enfineering and Agriculture, Department of Physics and Production Engineering, H-4400 Nyíregyháza, Sóstói road 31/b, +36-42-599-400, e-mail: pay.gabor@nye.hu*

Contact person

[*]*Gergely Dezső, professor, University of Nyíregyháza, Institute of Enfineering and Agriculture, Department of Physics and Production Engineering, H-4400 Nyíregyháza, Sóstói road 31/b, +36-42-599-400, e-mail: dezso.gergely@nye.hu*

Effects of potassium sorbate

Mohamed Tarek[1] - Szablocs Vigh[1] - Tarekné Judit Tilistyák[1]

Abstract: *In our recently work we determined the effect of patassium sorbate on different human cell lines in vitro. Also we investgated the quality and safety of cottage cheese based desserts with and without potassium sorbate as preservative substance. We examined the effect (microbiogical, physical and sensoral) of storage time, storage temperature, presence of potassium sorbate, and the type of coating chocolate. Our results indicated that potassium sorbate did not inhanced the examined human cancer cell viability. From our results we can also conclude that the potassium sorbate effect on citotoxity can expressed by linear equation models and the antiproliferative activity varied on the cell type employed. Our results also may be important to help dairy industries to estabilish shelf-life predictions on CCPD with and without preservation stored under different temperature conditions.From our results we can conclude that the potassium sorbate effect on citotoxity can expressed by linear equation modell and the antiproliferative activity varied on the cell type employed*

Key words: potassium sorbate, human cell lines, dairy dessert

1 INTRODUCTION

Food spoilage is a main problem for the food industry as it can make products unacceptable to the consumer, and can result in economic losses and potentially serious health hazards. Microbial spoilage develop when good manufacturing procedures are not employed (e.g. poor factory hygiene, missing or insufficient preservatives, inadequate pasteurizing temperatures, and/or use of poor quality raw materials). (Fleet, 1992; Viljoen et al., 2003; Stratford, 2006).

Microbial contamination reduces the shelf life of foods and increases the risk of food-borne illness. Dairy products represent a specific environment for the growth and selection of different microorganism species. Yeasts and mould are usually detected in high numbers in dairy products reflecting a good adaptation to a substrate rich on proteins, lipids, sugars and organic acids. In many cases, the presence of yeasts in dairy products is an indication of spoilage. Yeasts may cause blowing of packages, yeasty, bitter or fruity flavours, and colour and texture changes (Jakobsen and Narvhus, 1996).

Food preservation is one of the oldest technologies used by people due to the importance of food for our survival. Different ways and means have been found and improved for this reason (Şifa Türkoğlu, 2007).

Food-grade antimicrobial compounds, in particular sorbic derivatives, are routinely used for prolonging shelf-life and the preservation of food quality by inhibiting spoilage microorganisms (Battey et al., 2002; Papadimitriou et al., 2007). Nowadays, the sorbates are the third largest group of antimicrobial preservatives in food and pharmaceutical industries, following the parabens and benzoates whose safety is questioned by recent publications. Potassium sorbate (E202) is the potassium salt of 2,4-hexadienoic acid (sorbic acid). It is used as an antimicrobial agent not only in dairy products but also in a lot of food products. The antimicrobial action of sorbates is not well understood, yet it is considered to be basically based on the intracellular acidification of microbes (Bagar et al., 2009; Plumridge et al., 2004).

Potassium sorbate, displayed mutagenic and/or genotoxic effects that have been assessed by several authors. Contrary to the earlier findings, several studies have reported that PS is not genotoxic (P.Mpountoukas et al.,2008; Abe and Sasaki, 1977; Ishodate and Odashima, 1977, Hasegawa et al., 1984).

Consumers in the 21st century are demanding high quality foods that are free from additives, fresh tasting, microbiologically safe and with an extended shelf-life). The objective of the present study was to determine the content of potassium sorbete and microbiological contamination of different Hungarian cottage cheese based dessert (CCPD), and to investigate the effect of potassium sorbate on the poliferation of different human cell lines (Jung et al., 1992; Sasaki et al., 2002).

2 MATERIALS AND METHODS

2.1 Microbiological analysis

A sample of cottage cheese based dessert (10 g), was aseptically transferred to sterile plastic pouches and homogenized with 90 ml of 0.1% (wt/v) sterile buffered peptone water for 1 min at room temperature in a Stomacher Lab Blender. Serial decimal dilutions were prepared with sterile buffered peptone water and inoculated on growth media for the estimation microbial contamination.

Yeasts and molds. Yeasts and molds were determined using Rose Bengal Chloramphenicol Agar (RBC) (Merck) after incubation at 30 ^{o}C for 72 hour.

Enterobacteriaceae. Enterobacteriaceae were determined on Violet Red Bile Glucose Agar (VRBGA) (Merck), with overlay, and incubation at 37 ^{o}C for 24 h.

2.2 Potassium sorbates determination

The potassium sorbate contents of samples were determined by high performance liquid chromatography

(HPLC) with 250×4 mm ACE RP-18 analytical kolonna. Results eas measured at 232 nm.

2.3 Assay for antiproliferative (citotoxity) effect

The antiproliferative effect of the test samples was measured using the MTT-based colorimetric assay as described by Mosmann T. (1983). T47-D and HT-29 human cancer cell line sor NCM460 human normal cell line cells in culture medium (100 mL) were placed in a 96-well microplate at a concentration of 5-10^3/mL cells per well. After incubation at 37 ^oC in an atmosphere of (5% CO^2 in air) for 24 h, an aliquot of 20 mL of DMSO with or without solvent extract, and 180 mL of culture medium, were added to each well on the plates. After 24 h, the cells were washed with PBS twice. Then 200 mL of free serum culture medium that contained 0.5 mg/mL 3-(4,5-dimethylthiazol-2-yl) -2,5- diphenyltetrazolium bromide (MTT, Sigma Chemical Co., St. Louis, MO, USA) was added to each well. After another 4h of incubation to allow the formation of MTT formazan, DMSO (200 mL Merck, Darmstadt, Germany) was then added to dissolve the blue crystals and the absorbance was measured at 570 nm (VersaMax_ Tunable Microplate Reader, Molecular Devices, Sunnyvale, CA, USA). Citotoxity of PS on treated cell lines was expressed as % of the control (PBS or DMSO without test sample) and was calculated according to the following formula.
Citotoxity (%) =OD Cell / OD control * 100%, where OD (sample) and OD (control) represent the absorbance of the test samples and the control, respectively.

2.4 Statistical analysis

Data were subjected to analysis of variance using the SPSS25 software programme and where statistical differences were noted.

3 RESULTS

To identify the potassium sorbate content in different type of CCBD and finding relationship between sorbate content and microbial contamination we examind 7 different CCBD type (most popular) which were purched from local different supermarkets (every type were purshed and examined at two indepentet time). The core temperatures were 4.7 ± 1.2 ^oC and every product type had produced in similar time (within 7 day).

In Figure 1 we can see that the examined CCBD had sorbate content varied from 166 and 257 (mg/kg). This value is cofirm to the Hungariasn low which allowed 300 mg/kg in fermented dairy products. We did not observed high sorbate content in any samples.

We also determined the microbial contamination of examined samples. As shown in Fig. 2. we can see that total plate count were varied between 2.41 and 5.30 (log cfu/g), while yeast-mould content were varied between <10 and 2.27. Enterobacteriaseae was detected only in one sample (V sample) with (1.59 log cfu/g). In case of V sample we can see that the yeast and mould content was relatively high comparing with the other samples. May be the higine parametre and relatively lower potassium sorbate the soure.
Our results were the first results in case of determination of potassium sorbate content in CCDD in Hungary.

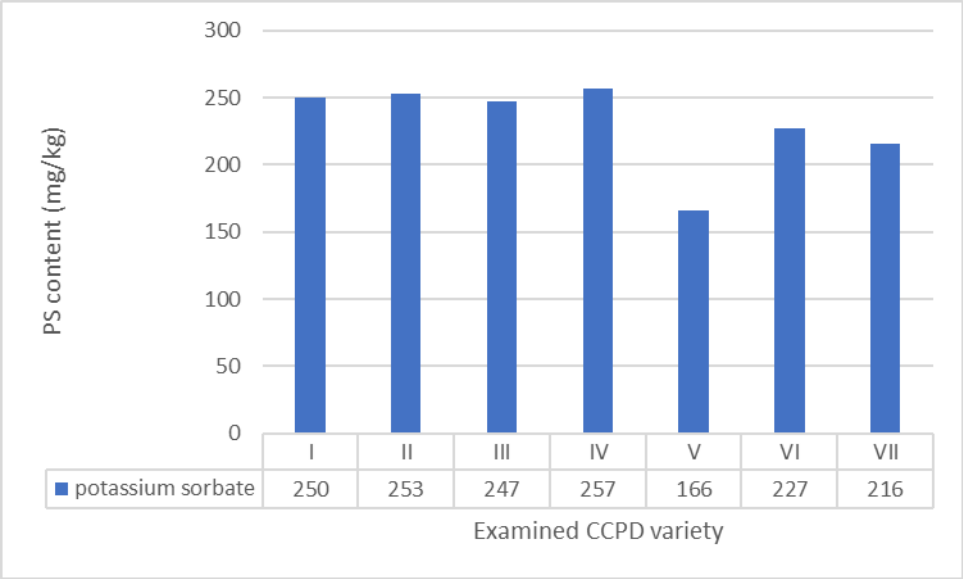

Fig.1. Potassium sorbate content of most popular cottage cheese based desserts in Hungary

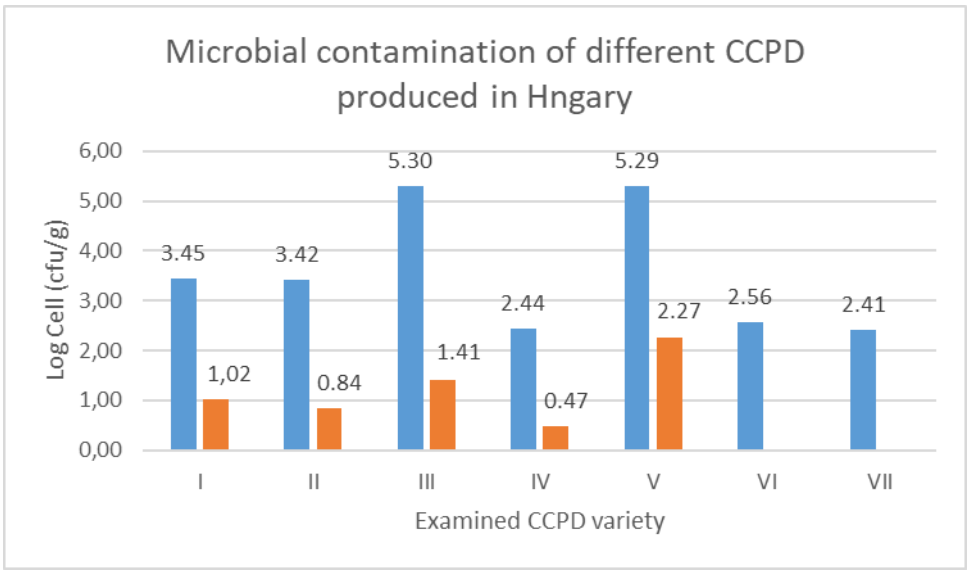

Fig 2. Microbial contamination of most popular cottage cheese based desserts in Hungary

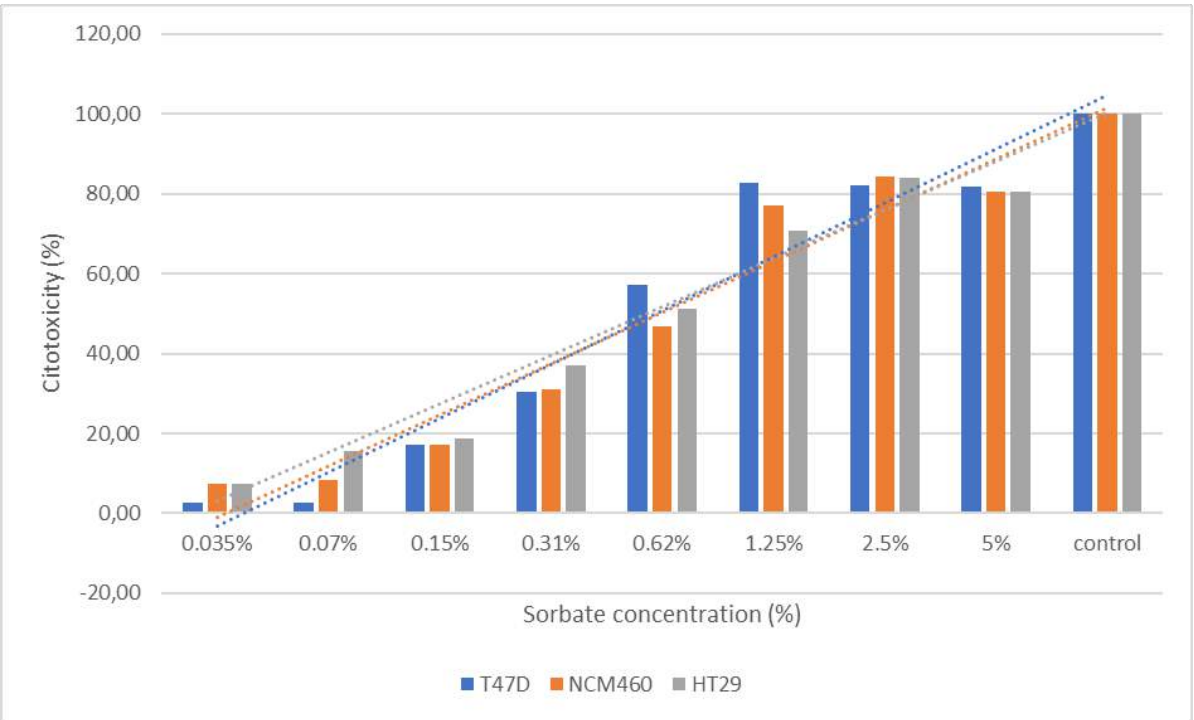

Fig 3. Citotoxicity effects on different human cell lines

3.1 Effect of potassium sorbate on the poliferation of different human cell lines

In this study, experiments were designed to examine and compare the proliferative-antiproliferative effect of different concentration of potassium sorbate on different human cell lines (T-47D, NCM460, HT-29). The results are shown in Fig. 3.

From the results we can see that potassium sorbate with concentration varied between 5% and 0.07% had significantly ($p<0.05$) antiproliferative negatív effect on all examined cell lines exepted the T47-D tumor cell line. Concentration of 0.035% only had negative effect significantly in the case of HT-29-A cell lines. This concentration occurd poliferation in the the case of TD and NC but this decrease was not significant ($p<0.05$). We can conclude also that the in vitro effect of potassium sorbate on cell viability and proliferation is a concentration- dependent. We can also conclude that PS did not increase the proliferation of any tumor cell line. We can also conclude that PS did not increase the cell increasing in any case.

From our results we can conclude that the potassium sorbate effect on citotoxity can expressed by linear equation modell (Table. 1.) and the antiproliferative activity varied on the cell type employed.

There have been many studies on the carcinogenicity and genotoxicity of potassium sorbate and the results have been negative (P. Mpountoukas et al., 2008; Dickens et al., 1968; Jung et al., 1992; Wurgler et al., 1992; Sasaki et al., 2002). On the other hand, potassium sorbate (3–4 mg/kg) was found to cause chromosomal aberrations and sister chromatid exchanges in Chinese hamster cells. Based on our and other positive results, consumers sholuld be made aware that PS should be considerd a genotoxic and mutagenic compound (Abe and Sasaki, 1977; Ishidate and Odashima, 1977).

Table. 1. Linear equations of Potassium sorbate concentration effect on citotoxicity of human cells

Cell line	Equation	R^2
T47D	y = 13.475x – 16.619	0.9403
NCM460	y = 12.784x – 13.654	0.9490
HT29	y = 12.168x – 9.1145	0.9707

The deterioration in specific sensory attributes and/ or overall quality have been used extensively in the determination of shelf-life of foods. However, the use of different sensory tests, that utilize different scales of measurements, and the product-specific reduction in sensory quality perceivedto be tolerated by consumers have resulted in the use of different cut-off points to mark end of shelf-life of foods.

To calculate the self time of produced CCBD samples we determined the growth rate of yeast- mould. The results is shown in Fig. 4.

The result shown in Fig. 5. presentes the self times od CCBD produced in factory scale. From the results we can conclude that there is no any quality risk if products storged in 6 ^{o}C. during min 87 day. In case of storage in 10 ^{o}C, we can see from the results that CCBD without adding PS had a lower self life.

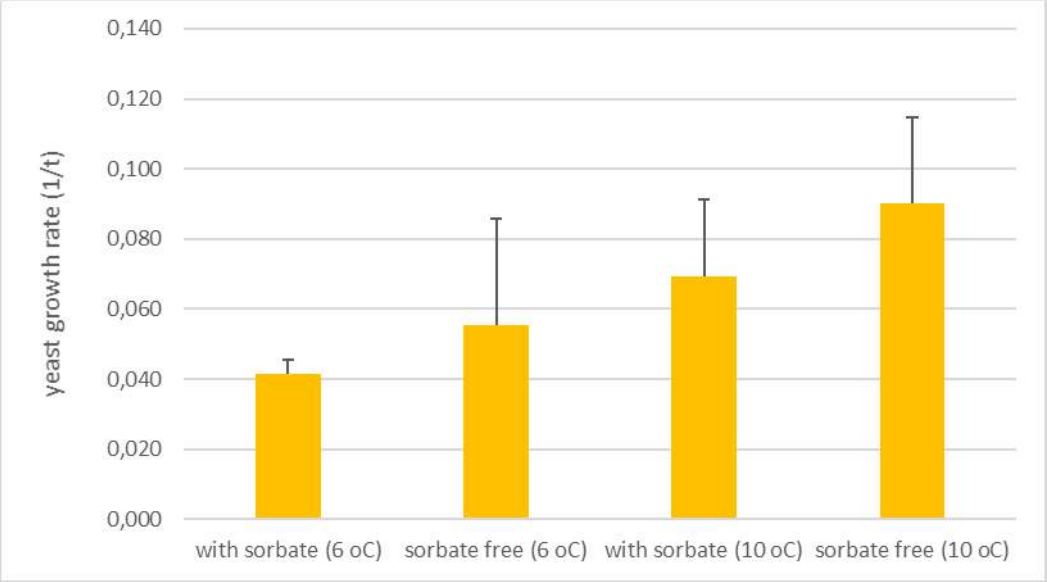

Fig. 4. Citotoxicity effects on different human cell lines

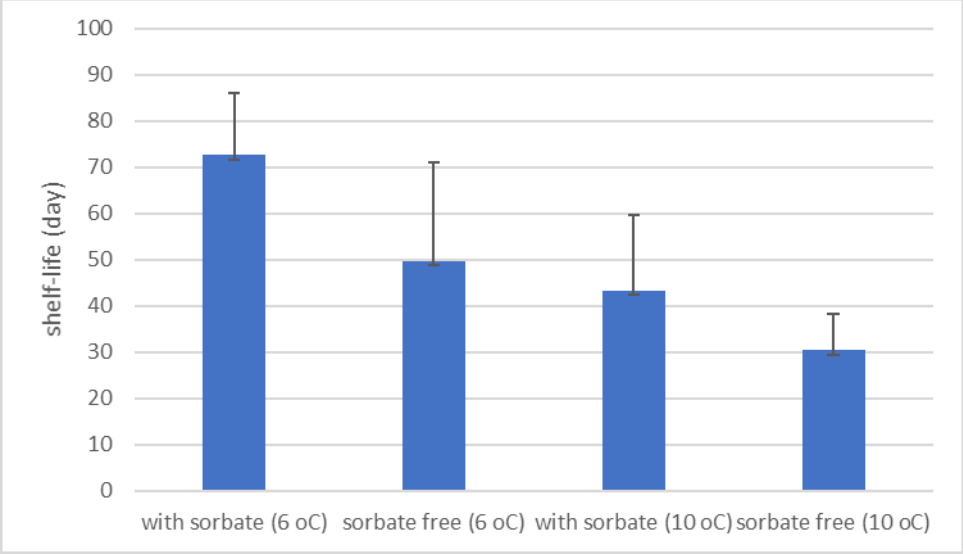

Fig. 5. Estimation of self life

4 DISCUSSIONS

Preservatives are food additives that are added to food items in order to preserve them for spoiling. The use of synthetic antimicrobial agents and chemical food preservatives is one of the oldest techniques for controlling food spoilage. Weak-acid preservatives are widely used to maintain microbial stability in foods and beverages. Potassium sorbate has long been considered a safe and non- toxic food additive. However, several studies have suggested that the chemical can actually be toxic. As well, some researchers now believe that potassium sorbate can cause a wide range of long-term health problems and side effects. Our results indicate that the in vitro effect of potassium sorbate on cell viability and proliferation is a concentration- dependent. We can also conclude that PS did not increase the proliferation of any tumor cell line. From our results we can conclude that the potassium sorbate effect on citotoxity can expressed by linear equation modell and the antiproliferative activity varied on the cell type employed.

Our recent study also suggest that the good hygiene conditions and storage in low temperature (<6 ^{o}C) do not allow yeast to growth in cottage cheese based dessert as model.

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Authors addresses

[1]*Mohamed Tarek, assistant engineer, University of Nyíregyháza, Agricultural and Molecular Research Institute, Hungary, 4400 Nyíregyháza, Kótaji St. 9-11, tarek.mohamed@nye.hu*

Contact person
[1]*Mohamed Tarek, assistant engineer, University of Nyíregyháza, Agricultural and Molecular Research Institute, Hungary, 4400 Nyíregyháza, Kótaji St. 9-11, tarek.mohamed@nye.hu*

Biscuits Fortified Through Pumpkin Seed Flour

Judit Tarek-Tilistyák[1,*] - Peter Stamusz[2]

Abstract: *Oilseed residues can be unique ingredients in bakery products, however they are still underutilized in the food industry. The aims of the present research were to produce health protective biscuits with pumpkin seed flour (PSF), and to investigate the quality and the consumer acceptance of the fortified biscuits. For the biscuit enrichment, the PSF was applied in 3 biscuit types using 4 different concentrations. PSF has a significant and special effect on the organoleptic and nutritional value of sweet biscuits. The significant texture-modifying effect of PSF was observed in the case of non-fat biscuits. Acceptance of semi fat pumpkin seed flour biscuits was the same as the control fat biscuits (linzer, ischler). Regarding all the three biscuit type, PSF enrichment were well accepted by consumers. Our results predict that PSF also has a place in industrial production, because it increases the value of the product, it is suitable for the production of successful new biscuit products with a homogeneous color and composition.*

Keywords: pumpkin seed flour, pressing residue, biscuit, functional food, dietary fiber

1 INTRODUCTION

There is a need to evaluate the by-products of juice or oil production and find cost-effective solutions for their use due to societal challenges such as more efficient management of resources: reducing waste emissions, increasing the amount of substances that can be used as food, and health-protective food.
While, due to inadequate nutrition and lifestyle, civilization diseases are increasing, e.g. obesity, hypertension, heart diseases and intestinal diseases, etc. its occurrence at a younger age, even among children. Consumption of healthy foods rich in bioactive substances and the quality of ready-to-eat foods play a key role in preventing these diseases. Healthy character is represented by colorful foods containing vegetables / fruits, because with these intake of vitamins, minerals and dietary fiber can be ensured.

One interesting subject of these challenges is pumpkin seed flour (PSF). As PSF is the residue of cold pressed pumpkin seeds, it is partially defatted, so it contains enriched all the other nutrients and bioactive components from the pumpkin seeds. Pumpkin seed has many constituents, which has health promoting effect e.g. effective against prostate enlargement [12], delays the development of hypertension [2]; cholesterol lowering effect[1]. Relieves arthritis [3] [7]; anti-cancer: human melanoma M21 inhibitor [6]; anthelmintic [10], protein isolate with high radical scavenging activity [11]. Its allergenic effect is negligible. Pumpkin seeds have an antimicrobial effect on *Klebsiella penumoniae, Acinobacter baumannii, Candida albicans* [13].
PSF's unique green color, distinctive taste and smell, and composition set it apart from other flours. It is a floury commodity, therefore obvious to use it as bakery ingredient.

Sweet biscuits are popular products for both snacks and main meals. Their main ingredient is cereals, however, they can contain a lot of sugar and fat, so it is recommended to consume little of such biscuits. Although the selection of sweet biscuits is large, they show less variation in color and taste. Their hue are mostly light, golden yellow and brown; their taste is sugary and aromatic. Cocoa and coconut flour are the most commonly applied variant regarding in taste and color. Candied fruits and oilseeds (sesame, sunflower seed, linseed) are mainly for decoration. Sweet biscuits containing oilseeds contain more dietary fiber. Recently, consumers refuse the foods containing artificial additives, especially bread (Kim et al., 2006).
No examples of biscuits with green colour or contained PSF were found in retails.
Along these thoughts, we wanted to utilize the PSF in traditional short dough biscuits (e.g. linzer) and in hard biscuits or ones with lower fat content, to make them be novel and healthy.

The aims of the present research were to study (1) the quantity of health promoting ingredients in pumpkin seed flour; and (2) the direction and the extent to the quality of biscuits change physical, chemical and organoleptic characteristics, that is due to pumpkin seed flour. The quantitative amalysis of the macronutrients of PSF (protein, fat, dietary fiber, ash) and measurements on the biscuits' color, moisture, hardness and sensory evaluation were performed.
We have shown that the PSF enriched biscuits can be new and alternative choices for health conscious consumers.

2 MATERIALS AND METHODS

2.1 Materials

Biscuit ingredients [fine wheat flour (ash content: <0,55%), margarine, sugar, baking powder, whole eggs, leavening agent] were obtained from retails. The biscuits were made on a laboratory scale.
Pumpkin seed flour were a gift from Sotiva Ltd..
Analytical grade organic solvent was bought from VWR.

2.2 Preparation of PSF enriched biscuits

Finely milled pumpkin seed flour (particle size distribution: 500 - 250 μm: 28%; < 250 μm: 72%) was added to the wheat flour in proportions of 0, 10, 20 and 30%. Biscuits with 0% PSF content served as controls.

Three biscuit types were produced: short dough biscuit (FB), low-fat biscuit (SFB), hard biscuit (NFB), so they differed in terms of fat ratio (Table 1.).

Table 1. Main ingredients' ratio of the biscuit types.

biscuit type: main ingredient	fat (FB)	semi-fat (SFB)	non-fat (NFB)
flour blend (unit)	3	3	3
margarine (unit)	2	1	0
sugar (unit)	1	1	1

Firstly the flour blend, the leavening agent (1g/125 g flour blend) and the sugar were mixed, then margarine was added. This composite was homogenized. To make the dough, tap water and 3% whole egg based on the weight of the composite were added. The volume of added water was measured during development of manual preparing of the dough, and also water binding capacity of the flourblends were taken into account. The doughs were left for rest for 10 minutes at 6 °C, then sheeted to a thickness of 3 mm, cut out with a 44 mm diameter manual cutter, and placed on a baking tray covered with silicone baking paper (Figure 1.). Baking parameters: 175°C, 10 minutes, in electric oven with air circulation. Altogether, 336 piece of biscuits were produced, average of 28 piece per composite. The baking experiment was performed without repetition. The baking parameters was validated with pre-experiment.

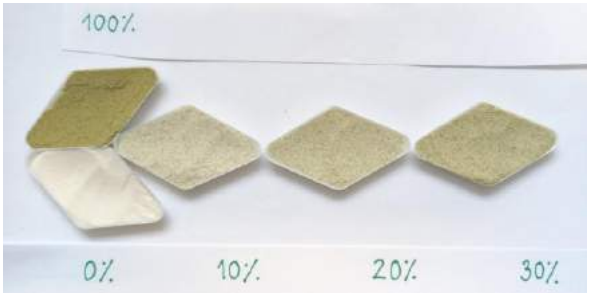

Figure 1. Flour blends containing pumpkin seed flour at different ratio.

2.3 Analysis of flour blends

The PSF were grinded in ball mill (10 sec; 3/sec; Retsch MM 200) before analysis.

Moisture content was measured with MT HG63 analyser at 103°C until constans weight.

For fat content determination, 5.0 g PSF was extracted in triplicate with 10-fold hexan for 15 minutes on shaker (Heidolph, 160 rpm).

Nitrogen content was measured on 3 mg sample weight based on Dumas method with Flash 2000 (Thermo Scientific) instrument using BBOT for calibration. The protein content was calculated using conversion factor 6.25.

Ash content was determined gravimetrically after 0.5 g sample combustion at 550°C for 5 hours.

Total dietary fibre (TDF) was determined on 1.0 g sample using Megazyme TDF assay kit, which is the simplified modification of the AACC 32 05.01 total dietary fiber (TDF) method. Total dietary fiber content of the biscuits are a calculated value from the PSF ratio, to a 2% moisture content.

2.4 Analysis of biscuits

Colour parameters were determined on the top of the biscuit with Colorlite sph 860 at D65 illuminance and 10° observation angle, on MA38 probe. Lightness, Chroma and hue angle values were used for analysis.

Hardness of the biscuits were measured with Brookfield LFRA CT3 texture analyser using compression mode, 4.5 g trigger, 3 mm deformation, TA39 probe head (2 mm diameter).

Sensory evaluation of the biscuits was carried out with the involvement of 13 judges, who scored the color, smell, taste and texture of the biscuits from 1 to 10. A product could get a maximum of 40 points, based on which we ranked the 12 biscuits. Products with the same total score got the same rank.

2.5 Statistical analysis

The experiments were performed with at least 3 replicates. The biscuits' hardness, color and organoleptic data were analyse by one way analysis of variance (ANOVA). SPSS v. 20.0 was used for statistical analysis. Tukey's test and Mann Whitney test at the 5% level for least significance were used to determine any differences in mean values between the fortified biscuits. Kramer method was used for ranking [9] Selected data are presented using box-plot method.

3 RESULTS AND DISCUSSION

3.1 Nutrient composition of PSF and enriched biscuits

The nutrient composition of pumkin seed flour is presented in Table 2. PSF has a low moisture content and can therefore be stored well for long time. It is low in fat, so it has a lower energy content and a lower proportion of unsaturated fatty acids with the beneficial physiological effects are present. The possible rancidity of pumpkin seed flour must not cause a significant change in the quality and organoleptic properties of the seed flour. The ash, protein and dietary fiber content of pumpkin seed flour are significant, suitable for enrichment with these nutrients.

The dietary fiber content of PSF enriched biscuits is significant compared to traditional, control biscuits. Regarding the in-store sweet biscuits' 4,5% fiber content, by adding at least 20% of the pumpkin seed flour to a biscuit's dough, this value can be achieved (Table 3.)

Table 2. Nutrient composition of SPF (%)

moisture	fat	protein	ash	TDF
5.5	5.0	45.1	7.1	37.5

Table 3. TDF content of PSF enriched biscuits (%)

PSF ratio: biscuit type	0%	10%	20%	30%
FB	-	1.9	3.8	5.6
SFB	-	2.3	4.6	6.9
NFB	-	3.3	6.6	9.9

3.2 Sensory properties of PSF enriched biscuits

The figure 2. shows representative pieces of 12 types of sweet biscuits enriched with PSF. This figure also shows that the enrichment of pumpkin seed flour significantly affected the color of the biscuit. A darker green color was observed with the increasing ratio of PSF. With the baking method used, a maillard reaction developed on the top of the fat and semi fat control biscuits (red colour), and in the enriched versions the biscuits were slightly reddened at the edges.
Regarding the NF biscuits, the control biscuit surface stayed white, it was underbaked , while the coloring effect of PSF revailed clearly in each ratio.The less fat content was, the more water was absorbed in the dough, thus, the moisture content of the doughs and biscuits also differed significantly. Fat biscuits had an average moisture content of 2%, semi-fat biscuits 5% and non-fat biscuits 15%.

Figure 2. Pumpkin seed flour enriched biscuits. From top to bottom; 1st row: fat biscuits, 2nd row: semi-fat biscuits, 3rd row: non-fat biscuits.From left to right: increasing ratio of PSF.

3.3 Color analysis of PSF enriched biscuits

The lightness and the chroma values of the colour parameters are shown on figure 3. and figure 4. The lightness values were in the range of 73.0-76,6 for control biscuits, 59.4-62.6 for 10% PSF, 57.0-60.2 for 20% PSF, and 52.3-54.4 for 30% PSF content.
The chroma values were in the range 23.9-28.9 for control biscuits, 18.6-27.5 for 10% PSF enrichment, 16.4-19.0 for 20% enrichment, and 11.5-16.5 for 30% enrichment.
The hue angle values were in the range of 80.0-87.8 for control biscuits, 89.7-91.2 for 10% PSF content, 90.1-91.7 for 20% PSF content and 87.6-91.4 for 30% PSF content.

The colour parameters of the biscuits were only affected by the degree of enrichment. Each 10% increase in pumpkin seed meal caused a significant change: the lightness and saturation values decreased, a darker and less intense green color were observed. The hue value did not change with the increasing ratio of the PSF. The results of the color measurement are consistent with the subjective colour analysis.

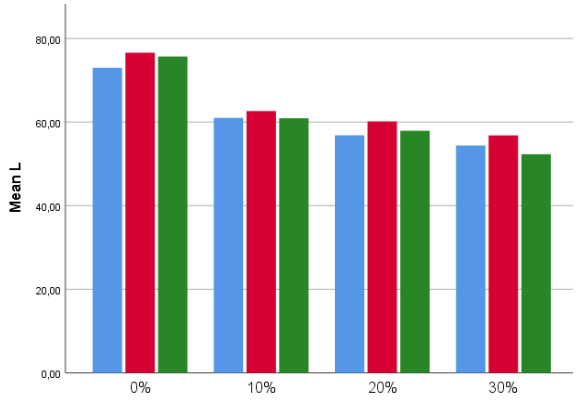

Figure 3. Lightness values of PSF enriched biscuits.

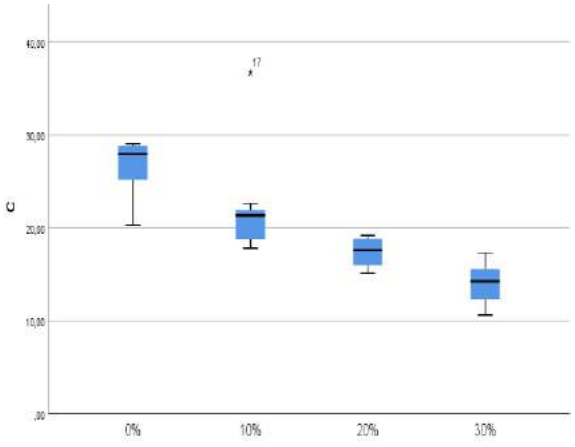

Figure 4. Chroma values of PSF enriched biscuits, with the increasing ratio from left to right.

3.4 Texture analysis of PSF enriched biscuits

The mean values of biscuits' hardness by fat content and by PSF ratio are shown on Table 4. The results are presented in gram. Hardness analysis by biscuit types are shown on figure 5. and figure 6.

Table 4. Biscuits' hardness (g)

PSF ratio	type of biscuit		
	FB	SFB	NFB
0%	553,8	707,0	508,0
10%	487,0	557,0	338,5
20%	355,0	757,0	263,1
30%	319,6	779,0	202,1

The hardness of the biscuits varied significantly depending on the type of biscuit (Figure 5.). The hardest were the semi-fat biscuits. There was no significant difference between the hardness of fat and non-fat biscuits. The higher hardness of semi fat biscuits is likely due to the combined effect of sugar and water, these ingredients have not been studied here.

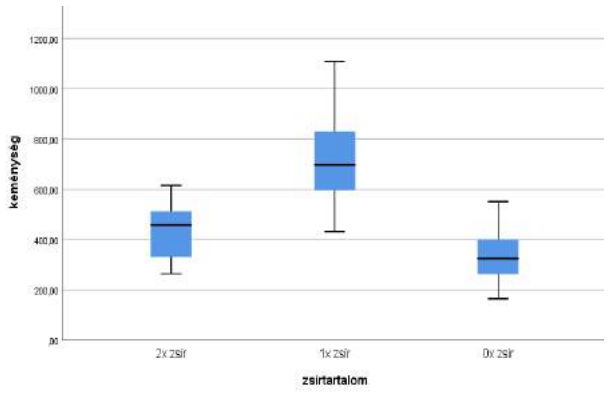

Figure 5. Hardness of biscuits by fat content (biscuit type)

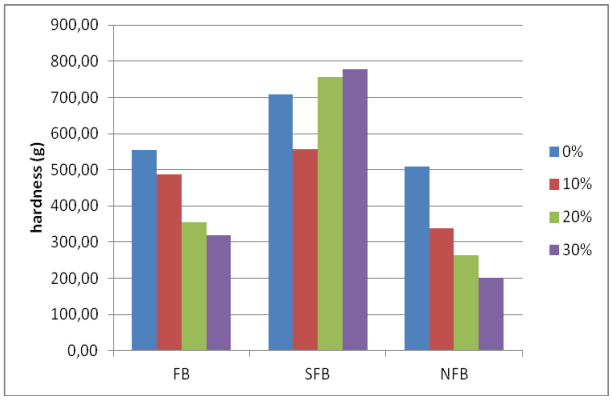

Figure 6. Hardness of biscuits by PSF ratio and by fat content

The hardness of the biscuits did not decrease statistically significantly as a result of the addition of pumpkin seed flour (Figure 6). Pumpkin seed flour addition at 30% ratio significantly increased the semi fat biscuits' hardness. Hardness altering effect of pumpkin seed flour most revailed in non fat biscuits. Non fat biscuits proved to be significantly softer with increasing pumpkin seed meal enrichment

3.5 Consumer acceptance of PSF enriched biscuits

The results of sensory evaluation are presented by analyzing the total score (Table 5, Figure 7).

Semi-fat biscuits received the biggest score, significantly better points. The least appealing products were the not-fat biscuits, among the tested ones. This is partly due to the fact that the biscuits were softer due to the higher water content, which is not typical for them.

Table 5. Means of total score. The average values of the total scores calculated on different sorting criteria.

PSF ratio	type of biscuit			mean of total score by PSF ratio
	SB	SFB	NFB	
0%	31	30	9	23
10%	20	27	15	21
20%	24	31	16	24
30%	20	30	17	22
mean of total score by type	24	30	14	-

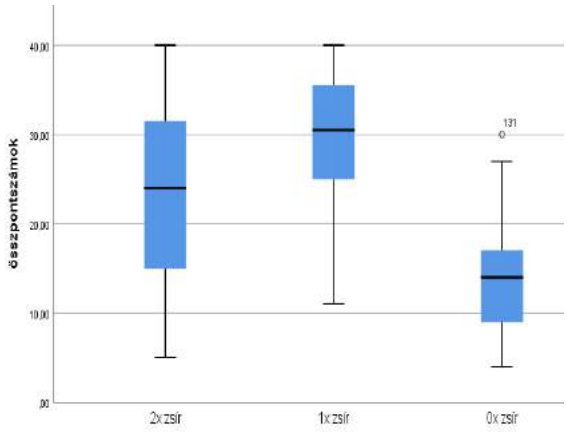

Figure 7. Consumer acceptance: total score of biscuits by fat content Y axis: total score, X axis: biscuit type (fat content); from left to right. FB, SFB, NFB.

Control biscuits (containing 0% PSF), except for control NFB, were popular products due to their traditional, customary nature, with the highest score (Figure 8). Regardless of the degree of enrichment, all the pumpkin seed flour biscuits were appealing to the reviewers, as they received half the points at any ratio. The more pumpkin seed flour contained, the more appealing the products were.

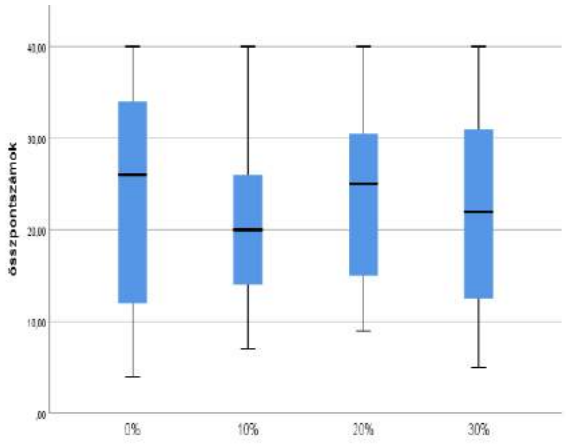

Figure 8. Consumer acceptance: total score of biscuits by pumpkin seed flour addition. Y axis: total score, X axis: PSF ratio.

Biscuits were ranked based on total scores (Figure 9). In the ranking of the biscuits, we could not single out a definite mixture as the most appealing product, because semi-fat biscuits with any fortification were as popular as control fat and semi fat biscuits. In the case of fat biscuits, the enrichment was mostly accepted in the case of 20%. Semi-fat biscuits containing 10% or 30% enrichment and all the non-fat biscuits were ranked the 3rd place. Enrichment of pumpkin seed flour had a quality-enhancing effect on non-fat biscuits, they received better points than the control non-fat biscuits

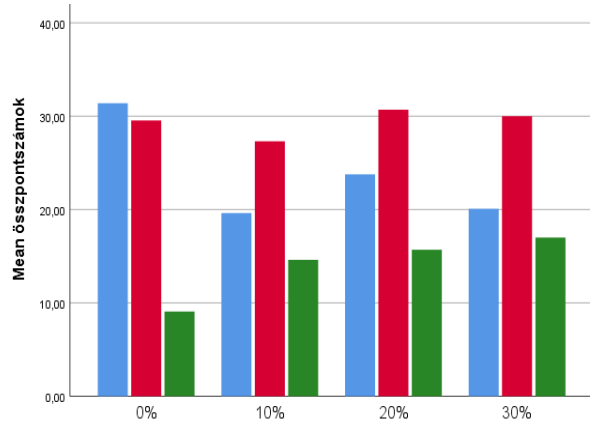

Figure 9. Total score of biscuits by PSF ratio and by fat content.

4 CONCLUSIONS

Pumpkin seed flour has a significant and special effect on the organoleptic and nutritional value of sweet biscuits.
The significant texture modifying effect of pumpkin seed flour was observed in the case of non-fat biscuits.
Regarding all three types of biscuits, PSF enrichment were well accepted by consumers. Acceptance of semi fat pumpkin seed flour biscuits was the same as control fat biscuits (linzer, ischler).

The results of our experiments predict that PSF also has a place in industrial production, because it increases the value of the product, it is suitable for the production of successful new biscuit products with a homogeneous color and composition. To improve the quality of the biscuits, it is necessary to define the quality parameters of the pumpkin seed flour, to optimize the production technology and the recipe.

Our future plans on this topic are to perform the antioxidant component studies on pumpkin seed flour and pumpkin seed flour biscuits. With regard to the shelf life, it is advisable to examine the rancidity, color stability and sensory attributes' changes of the biscuits under different storage conditions. In line with consumer trends, there is a prospect of reducing the sugar content of pumpkin seed flour biscuits and replacing gluten.

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Authors addresses

[1]*Judit, Tarek-Tilistyák, research fellow , University of Nyíregyháza, Agricultural and Molecular Research and Service Institute, 4400-H, Kótaji str., 9-11., Nyíregyháza, judit.tilistyak@gmail.com*
[2]*Peter, Stamusz, subordinate officer, Hungarian Defence Force, 4400-H, Kert köz 6., Nyíregyháza,Damjanich Barrack*

Contact person

[*]*Judit, Tarek-Tilistyák, research fellow , University of Nyíregyháza, Agricultural and Molecular Research and Service Institute, 4400-H, Kótaji str., 9-11., Nyíregyháza, +36302420247, judit.tilistyak@gmail.com*

The effect of sewage sediment containing toxic elements on the microanatomy of the leaf of *Sorghum* species

Csilla Tóth[1*] - Katalin Irinyiné Oláh[2] – László Simon[3]

Abstract: *We microanatomically examined the leaves of four species and cultivars used as test plants belonging to Sorghum genus to know how their typical micromorphometrical parameters change when they are exposed to the effects of the content of heavily contaminated toxic soil, and how the plant stress adaptation on a microanatomical level works in their case. We made epidermis imprints and cross sections out of the leaf samples. We did the micromorphometrical examinations both on the adaxial and abaxial epidermis imprints and on the cross sections. We found out that the differences we noticed are connected to the toxic element content of the plant growing medium, especially the cadmium and lead content, the copper, nickel and zinc content and the toxic element content measured in the leaves of the plant. To sum up our microanatomical examinations we can say, that out of the examined Sorghum species and cultivars, the GK Csaba cultivar of the Sudan grass species has the best adaptation abilities induced by the toxic elements (on a microanatomical level this species has the best ability to defend itself against the toxic elements).*

Keywords: *sewage sediment, toxic elements, micromorphometrical parameters, Sorghum genus, adaptation ability*

1 INTRODUCTION

There is an extensive amount of professional literature which aims the detecting and following the plant tissue changes induced by environmental stressors (toxic elements) which prove that in the case of plants grown on soil contaminated with toxic elements, the effects caused by the intake of these elements can be measured in the structural changes of the tissues and tissue systems building the vegetative organs of these plants.

Various authors write about the effects of toxic elements on the micromorphometrical parameters on the leaves. Numerous studies examine the changes of the epidermis' parameters induced by toxic elements and the properties of cross sections of the leaves.

With the microanatomical examination of the leaves of the plant it can be noted that paralell to the toxic element contamination the thickness of the leaf lamina significantly decreases, and a change is noticable in the extent of the intercellular pathways and also in the organization of the cells (BINI, 2012; DA SILVA DE JESUS et al., 2016; GOSTIN, 2009). The authors also note a change in the thickness of the leaf lamina, the height and width of the cells building the upper epidermis, the size of the stomas and a change in the value of the stoma density. SRIGHAR et al. (2005) also point out that according to their examination, paralell to the increase of the Zn concentration the thickness of the epidermis' decreases and the extent of the intercellular pathways also decreases. Just like many other authors, GOSTIN (2009) also talks about the filling by dark coloured content parts in the cells building the mesophyllum (affecting both the palisad and spongy parenchyma cells). All authors chemically classify these fillings as phenolic type compounds.

DA SILVA DE JESUS et at. (2016) in addition to the above mention the xylem structure damage caused by heavy metal contamination. According to their examinations done on leaves, the size of the cells building up the parenchima decreases but their number increases. The cuticle layer on the epidermis cells is the speciality of the epidermis of the sprout. The compound groups of the cuticle are the cutin and different waxes. The waxes can form an individual layer on the surface of the cuticle, appearing in the form of an epicuticular wax layer. The role of this layer is to moderate the water loss (cuticular transpiration) through the cuticle. The species of the *Sorghum* genus have a characteristically thick cuticle and an epicultural wax layer, which protects the cuticle. It is known, that the thickness of the cuticle and the wax layer protecting the cuticle is strongly affected by abiotic (and also is by the drought (LIU et al., 2014), UV radiation (LONG et al., 2003), soil contaminated with heavy metal (PUNNURI et al., 2017)), and biotic stress (BERNAYS et al., 1983; JENKS et al., 1994). This cuticle and wax layer has an important role in controlling the water supply, reducing transpiration, enhancing the stomatic regulation of the loss of water (BLUM, 1975). The structure and morphology of the epicuticular wax is a good indicator of the health of the plant (NEINHUIS ÉS BARTHLOTT 1998). The degradation of the waxy cuticule itself as a primary protection has serious consequences regarding the physiological functions of the plant (e.g. transpiration, stoma function).

It is also known, that with cadmium contamination, a growth in the thickness of the epicuticular wax layer is experienced. This can be explained with the reduction of the surface/interface of the epidermis cells caused by cadmium stress, which can lead to a reduction of the leaf area/surface. Due to these changes, the same amount of epicuticular wax layer covers a smaller surface, which increases the amount of wax on the same area (KHUDSAR et al. (2001)). The plants become resistant to further cadmium stress (unstable water supply) with the growing thickness of the epicuticular wax layer.

GOMES et al. (2011) state, that the accumulation of heavy metals and pollutants in the cell wall, which is practically chosen by the plant as an alternative solution to defend itself from the translocation of heavy metal/ polluting to the photosynthetic apparatus, is partly

realized in the growth of the thickness of the leaf epidermis.

The bulliform cells have an important role in transpirational control, especially with limited moisture content. Their cell walls closer to the leaf surface are significantly thinner than the cell walls perpendicular to the surface and the cell wall close to the meristematic cells. In times of durable drought, with the general water loss of the plant, the water content of the bulliform cells also decreases. This way, a turgor decrease is generated – thanks to the unequal cell walls - which results in the bulliform cells having their inner surface collapsed, bending the leaf surface with this. It was found, that the size of the bulliform cells is in correlation with the heavy metal accomulation, especially with the cadmium content of the soil (HAMEED et al., 2012; GOMES et al., 2011). The heavy metals make the water management of the plants unstable, and in arid conditions the bigger number and size of bulliform cells are a more effective form of defensive in the perspective of water loss.

In the case of plants grown on contaminated soil, with the growth of pollutants in the soil and their increasing accumulation into the plant, results in the leaf lamina thickness decreasing. The thinning of the leaf lamina thickness is caused by the expansion of the leaf mesophyll cells and through this, the thinning of the mesophyll layer. With increasing contamination (Cd, Cu, Pb), the size of the mesophyll cells decreases, and so does the extension of the intercellular passages between them (SRIGHAR et al., 2005; MELO et al., 2007).

One of the charactheristics of the tolerance of the plants against the toxic level of heavy metals is that they try to accumulate the heavy metals on such a tissue-level, where is no photosynthesis, and the transport of photosynthetical intermediers among tissues and in the plant is not hinder or impaired. During their adaptation to the altered environmental circumstances, the cells building up the mechanical tissues (sclerenchyma, collenchyma), which are either dead or their cell walls are significantly thicker than they used to be, store the heavy metals in their cell walls, making their cell walls even thicker this way, increasing the extension of the tissues made by them and other different tissues in the plant (VOLLENWEIDER et al., 2006) – moderating the toxic effects of heavy metals. (Of course this means, that in these tissues the heavy metal concentration is much higher. But also, the heavy metal concentration minimizes by the tissues, which have a role in assimilation.)

The cadmium-stress/heavy metal stress increases the stoma number of each surface (CHARDONNENS et al., 1998; BARYLA et al., 2001; SHI and CAI, 2009). The translocation of Cd in the sprout is stimulated by transpiration (SALT et al., 1995), with less water supply and with the increasing transpiration it moves relatively fast towards the leaves, and then accumulates in them, causing significant micromorphometrical differences.

GOSTIN (2009) also points out the decrease in the size of the stomas, but parallel to that the increase of the stoma density value is noticeable. Through the increasing number of stomas, the cadmium concentration has a huge influence on the water supply of the plant, because the increased number of stomas, when the water absorption is hinder, can cause an increased transpiration, so in arid circumstances, the plant shows symptoms of water shortage, and its water supply can get unstable (SANITA DI TOPPI et al., 1999; COSTA and MOREL, 1994) – later we will discuss that as an effect of Cd, as the result of the adaptational process, the size of stomas decreases and will play a role in controlling the transpiration. By optimal water supply the increased number of stomas is not a problem, because it can be proved, that with these ecological circumstances the Cd can reduce the opening of stomas even in nanomolar concentration. (Examination in the case of *Arabidopsis thaliana*, *Vicia faba* and *Commelina communis* - PERFUS-BARBEOCH et al. 2002). The closure of stomas can also cause an increased water supply. For example, the water content of different tissues of a cucumber treated with cadimum shows differences compared to the control. The water content of the roots decreased, but the water content of the leaves increased – on every individual surface (LÁNG et al. 1998, SÁRVÁRI et al. 1999).

According to some sources, there is also a significant Pb concentration in xylem sap (ZÁRAY et al. 1997), which means that the transpiration also helps the accumulation in the leaves, just like the cadmium. The lead accumulating in the leaves can cause similar structural changes in the microanatomy of the leaf like the cadmium.

When the stomatic density increases, the size of stomas decrease (MELO et al., 2007). When the stomatic density increases, it is supposed to help take up the CO_2 needed for the photosynthesis, and the reduction of the size of the stomas is supposed to prevent an excessive water loss. This adaptational process is the answer of the plants to a heavy metal toxicity, with which the plant tries to survive the toxic effects of the soil contaminated with heavy metal on it physiological process. This adaptational step is logical, because the water absorption of the root depends on the extent of the transpiration through the leaf, and by keeping the vaporization high, the water absorption increases and so does the concentraion of metal absorbed with water, which have a toxic effect.

The cadmium harms the membrane structures, breaks down the components of chloroplast membrane lipid and protein, decreases the effectiveness of photosynthesis by changing the chlorophyll a/b ratio and by obstructing the key enyzmes of the Calvin cycle (STIBOROVA et al., 1986; DROPPA and HORVÁTH, 1990). The Mg^{2+} ion in the chlorophyll can change to Cd^{2+}, which makes the quantum exploitation of the photosynthetical system less effective (SANTOS et al., 2010).

In order to follow the possible effects of the toxic element stress, we microanatomically examined four species and cultivars belonging to the *Sorghum* genus (*Sorghum bicolor* (L.) *Moench x Sorghum sudanense* (*piper) Stapf. cv.* GK Csaba, *Sorghum sudanense (piper)*

Stapf. cv. Akklimat, *Sorghum bicolor (L.) Moench. cv.* GK Balázs, *Sorghum bicolor (L.) Moench. cv.* Róna 1).

2 MATERIAL AND METHODS

By growing the four cultivars belonging to *Sorghum* genus in growing pots we wanted to examine the microanatomical reaction of the plants in an environment contaminated with toxic elements (*Sorghum bicolor* (L.) *Moench x Sorghum sudanense (piper) Stapf. cv.* GK Csaba, *Sorghum sudanense (piper) Stapf.* cv. Akklimat, *Sorghum bicolor (L.) Moench. cv.* GK Balázs, *Sorghum bicolor (L.) Moench. cv*. Róna 1).

To do so, we installed an experiment with light room and growing pots in the University of Nyíregyháza with soil slightly contaminated with toxic elements from Debrecen Lovász-zug (in which the chorme and cadmium concentration in the top soil is above the limit stated in the 6/2009. (IV.14.) KvVM-EüM-FVM joint regulation (TŐZSÉR, 2018)). The soil used for the experiment with the growing pots was used earlier as a ground cover used during the recultivation of a lagoon system used for wastewater oxidation, post-sedimentation and desiccation, its genetical type cannot be defined.

For the experiment we used 12 plastic growing pots with a 16 cm diameter and 12,5 cm height, we filled up each with 1500 gramms of air dry control soil through a 2 mm sieve and also 12 control vessels with a mixture of air dry control soil and a 10 m/m% air dry sewage sludge.

Our anatomical researches covered the micromorphologycal and micromorphometrical examination of the cross section of the leaf and the inner and outer structure of the epidermis. For our hisological examination we got our samples from the widest part of intact, healthy, developed leaves (5th leaf from above) After collecting these we stored the samples in the Strasburger-Fleming preservative mixture (96% ethanol: 99,5%-os glycerin: destilled water = 1: 1: 1 ratio mixture).

We cut the cross sections of the leaves with a razor blade and we examined them using an Olympus light microscope. We coloured the preparations with a 0,2% aqueous solution of toluidine blue. On the coloured preparations we examined the following parameters: (METCALFE, 1960; ELLIS, 1976, 1979): thickness of adaxial epidermis (µm); thickness of abaxial epidermis (µm); epicuticular wax thickness of adaxial epidermis (µm); epicuticular wax thickness of abaxial epidermis (µm); number of bulliform cells (numb./mm^2); bulliform cells width (µm); bulliform cells height (µm); mesophyll thickness (µm); vascular bundle height (µm); vascular bundle width (µm); distance between vascular bundles (µm); thickness of adaxial subepidermal sclerenchyma caps (µm); thickness of abaxial subepidermal sclerenchyma caps (µm).

We made the epidermis imprints using the method of HILU and RANDALL (1984), and GARDNER et al. (1995) and we examined them using ELAGÖZ et al.'s. (2006) method. We made imprints of the upper and lower side of the leaf lamina using transparent nail polish and after the nail polish dried, we made photgraphs of the imprints under a microscope.

We examined the structure of the epidermis following the instructions by METCALFE (1960) and ELLIS (1976, 1979), used for diagnostic stamps of the skin tissue of grasses. We made the following micromorphometrical measurements on both the adaxial and abaxial side of the epidermis imprints: thickness of costal zone (µm); cell rows number of costal zone (numb.); cells's lenght of costal zone (µm); cell's width of costal zone (µm); frequency of silica bodies of costal zone (numb./mm^2); thickness of intercostal zone (µm); cell rows number of intercostal zone (numb.); cells's lenght of intercostal zone (µm); cell's width of intercostal zone (µm) ; frequency of silica bodies of intercostal zone (numb./mm^2); stomatic density (numb./mm^2); width of stomatal complex (µm); lenght of stomatal complex (µm).

The measurements and the counting of the stomas was done with an Olympus (BX51 type) light microscope, in 10x20 zoom. Both the cross sections and the epidermis imprints were photographed in a 10x20 and 10x40 zoom. We archived the photographs digitally with a OLYMPUS camera. We repeated the examination of all the quantitative characteristic 60 times and we avarged the measurements.

3 RESULTS

3.1 General microanatomic description of the examined plant species

The results of the leaf-microanatomical examinaton of the four plant species used as test plants, the sudan grass (*Sorghum bicolor (L.) Moench x Sorghum sudanense (piper) Stapf. cv*. GK Csaba, *Sorghum sudanense (piper) Stapf. cv.* Akklimat), and the silage sorghum (*Sorghum bicolor (L.) Moench. cv.* GK Balázs, *Sorghum bicolor (L.) Moench. cv.* Róna 1) are the following:

All four plants have a homogeneous isolateral, amphystomatous leaf, which is typical for the specie of the Poaceae family (Fig. 1.). The leaves show the typical Kranz-anatomy of the species with C4 photosynthesis. Not only a parenchymal bundle sheath (contains chloroplasts without granum) but also a mesophyllum sheath organized from radial cells (rich in chloroplasts with granum) is attached to the vascular boundles. In the leaf mesophyll the presence of the sclerenchyma tissue is decisive, which is present attached to vascular boundles, in a form of wider-more narrow ribs attaching the veins to the adaxial or abaxial side of the epidermis. The bulliform cells are present in the between vessel zones of the adaxial epidermis, their task is in the coiling up of leaf caused by the lack of moisture, decreasing the evaporator surface.

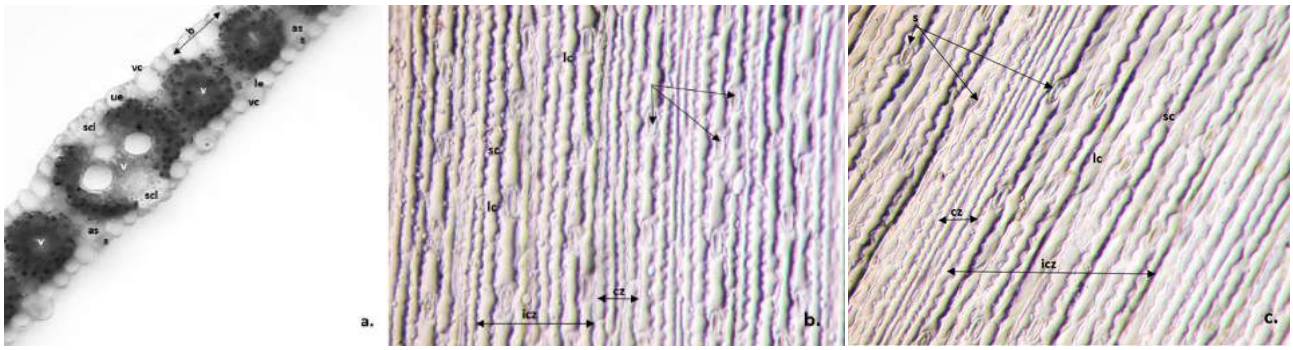


Fig. 1. The homogenous isolateral leaf typical for the Sorghum genus with Kranz anatomy (a.), lower (b.) and upper epidermis (c.) (Sorghum bicolor (L.) Moench x Sorghum sudanense (piper) Stapf. cv. GK Csaba)
b: bulliform cells, ue: upper epidermis, le: lower epidermis, s: stomatal complex, as: air space, v: vascular bounle, scl: sclerenchyma, cz: costal zone; icz: intercostal zone; lc: long cell; sc: short cell; s: stoma

The epidermis consits of costal and intercostal zones (Fig. 1.). The cells building up both zones shows a great varity in types, forms, sizes and distribution. The typical components of the epidermis are long cells and short cells. In the case of the two examined species the presence of the short cells is not decisive. The cell walls of the long cells are anticline (curvy, straight, transient type, etc.), the type of the end wall of the cells is perpendicular to the longitudinal axis

The short cell has two types, the silica bodies and the para cells. In the silica bodies usually diatoms are formed, caused by the silicium-dioxide enrichment. In the para cells there is usually suberin. The phytoliths can be put into the following types according to METCALFE's (1960) system: dumbbell, nodular, cross-shaped. In the costal zones they are present in organized rows alone, or in pair with a para cells or a trichomas.

The stoma complexes are paracytic types, they consist of dumbbell shaped guard cells and two laterally placed, triangle shaped subsidiary cells and they are mesomorph. They are integrated between the skin tissue cells in the intercostal zones, on both sides of the bulliform cells, both on the adaxial and abaxial sides. The appendixes of the epidermis are the trichotomes (microhairs, macrohairs and spike hairs) and the papillae. The papillae are in the long cells in the intercostal zones.

The costal zones mainly consist of long cells, and they are varied with some short cells (hard cells, para cells, hair cells) on both sides.

There is a difference between the micromorphometrical characteristics of the adaxial and abaxial epidermis: the row of cells building up the costal zone, the size of the long cells and the frequency of the silica bodies. The costal zones are thinner on the adaxial epidermis, the anticline walls of the long cells are straight on the adaxial epidermis and on the abaxial epidermis they are wavy. The long cells on the adaxial side are usually longer than the ones on the abaxial side.

The micromorphometrical qualities of the intercostal zones are different on the adaxial and abaxial epidermis. This is caused by the bulliform cells between the epidermis cells on the adaxial side, and in the case of the abaxial epidermis it is caused by the presence of the stoma complexes. The cells of the intercostal zone are usually wider then the ones of the costal zone.

3.2 Results of micromorphometrical examination of the tested plants - effect of sewage sediment containing toxic elements on the microanatomy of the leaf

After the micromorphometrical examination of the tested plants used in the growing pot experiment, it can be said that in the case of the control samples, the epicuticular wax layer of the epidermis of the surface shows a reduction, pointing in the direction of sorghum GK - Balázs (5.02 µm), sorghum – Róna 1 (4.95 µm), Sudan grass – Akklimat (4.8 µm), Sudan grass – GK Csaba (4.5 µm). The thickness of the epicuticular wax layer of the lower epidermis is the highest in the case of the Akklimat species (4.2 µ). In the case of most plants tested, the growth of thickness of the epicuticular wax layer was experienced, when they were affected by the sewage sediment from Debrecen – Lovász-zug. (Table 1., 2.).

The treatment only had an effect in the case of the Akklimat species (Sudan grass), which had a growth in the thickness of the epidermis of the surface and awry after the treatment with the sewage sediment from Lovász-zug: in the case of the upper epidermis from 20 µm to 20.2 µm, in the case of the lower epidermis from 15 µm to 15.4 µm. In the case of the Róna 1 (silage sorghum species), the opposite of the expected tendencies happened: in the case of the lower epidermis, the reduction of the thickness was noticable (from 15 µm to 12.5). The growth of the thickness of the epidermis layers was not noticable by most of the tested plants, there were other mutations in the case of the cells, which are parts of the epidermis: the length and width of the cells got reduced in the case of the long cells of costal and intercostal cell rows (Table 1 – 2.).

It was found, that the size of the bulliform cells is in correalation with the heavy metal accomulation, especially with the cadmium content of the soil (HAMEED et al., 2012; GOMES et al., 2011). A growth in the sizes of the bulliform cells was noticable by all four plants tested, when they were treated with the sewage sediment form Lovász-zug, which has a high heavy metal content. The GK Balázs (silage sorghum species) showed the biggest change in size, the width of the bulliform cells increased from 82.1 µm to 88.5 µm without altering the number of bulliform cells (22 number/mm^2).

Table 1. The change of the microanatomical parameters of the leaf cross-section of Sorghum bicolor (L.) Moench. cv. GK Balázs and Sorghum bicolor (L.) Moench. cv. Róna

		Sorghum bicolor (L.) Moench. cv. GK Balázs		*Sorghum bicolor (L.) Moench.* cv. Róna 1	
		Control	Sewage sediment	Control	Sewage sediment
The element content of the plant samples (mg/kg)	Cd	0.629	0.640	0.547	0.558
	Pb	0.133	0.134	0.139	0.142
	Cu	11.3	11,9	10.3	10.1
	Ni	1.01	1,00	0.526	0.569
	Zn	128	130	117	115
Adaxial epidermis (µm)		15	15	15	15
Abaxial epidermis (µm)		20	20	15	12.5
Epicuticular wax thickness of adaxial epidermis (µm)		5.02	5.25	4.95	5.12
Epicuticular wax thickness of abaxial epidermis (µm)		4.0	4.12	4.0	4.09
Number of bulliform cells (numb./mm^2)		22	22	23	23
Bulliform cells width (µm)		82.1	88.5	78.5	80
Bulliform cells height (µm)		37	39	30	28.5
Mesophyll thickness (µm)		75.5	78.3	85	62.5
Vascular bundle height (µm)		66.3	66.3	69	70
Vascular bundle width (µm)		66	66	68	68
Distance between vascular bundles (µm)		15	13	13	12
Adaxial sclerenchyma (µm)		6.9	7.1	6.5	7.1
Abaxial sclerenchyma (µm)		14.5	15.3	13.9	16.3
Stomatic density of adaxial epidermis (numb./mm^2)		72	75	66	51
Stomatic density of abaxial epidermis (numb./mm^2)		76	90	135	99
Stoma width /stoma width with subsidiary cells (µm) – upper epid.		12.57/27.05	12.05/25.9	13.02/27.85	14.63/29.43
Stoma width /stoma width with subsidiary cells (µm) – lower epid.		14,63/29,43	13,20/28,12	14,63/29,43	13,20/28,12
Stoma lenght (µm) – upper epidermis		35.51	33.42	32.58	30.45
Stoma lenght (µm) – lower epidermis		30.58	31.53	29.88	29.03
Cell rows number of costal zone in adaxial epidermis (numb.)		6	6	5	5
Long cells's lenght of costal zone in adaxial epidermis (µm)		80-145	81-138	80-147	81-137
Long cell's width of costal zone in adaxial epidermis (µm)		7-32	7-29	7-30	7-28
Frequency of silica bodies of costal zone in adaxial epidermis		10-17	10-15	10-15	10-13
Cell rows number of costal zone in abaxial edpidermis (numb.)		6	6	6	6
Long cells's lenght of costal zone in aaxial epidermis (µm)		62-120	58-118	60-115	58-110
Long cell's width of costal zone in abaxial epidermis (µm)		12-20	10-18	12-18	10-16
Frequency of silica bodies of costal zone in adaxial epidermis		<2	<2	<2	<2
Cell rows number of intercostal zone in adaxial epidermis (numb.)		4	4	4	4
Long cells's lenght of intercostal zone in adaxial epidermis (µm)		22-68	22-68	20-58	20-55
Long cell's width of intercostal zone in adaxial epidermis (µm)		15-22	13-19	15-20	13-17
Frequency of silica bodies of intercostal zone in adaxial epidermis		minimal	minimal	minimal	minimal
Cell rows number of intercostal zone in abaxial epidermis (numb.)		3	3	3	3
Long cells's lenght of intercostal zone in abaxial epidermis (µm)		68-115	65-110	60-115	60-110
Long cell's width of intercostal zone in abaxial epidermis (µm)		10-12	10-12	10-12	10-12
Frequency of silica bodies of intercostal zone in abaxial epidermis		minimal	minimal	minimal	minimal

Table 2. The change of the microanatomical parameters of the leaf cross-section of Sorghum bicolor (L.) Moench x Sorghum sudanense (piper) Stapf. cv. GK Csaba and Sorghum sudanense (piper) Stapf. cv. Akklimat,

		Sorghum bicolor (L.) Moench x Sorghum sudanense (piper) Stapf. cv. GK Csaba		*Sorghum sudanense (piper) Stapf.* cv. Akklimat	
		Control	Sewage sediment	Control	Sewage sediment
The element content of the plant samples (mg/kg)	Cd	0.638	0.623	0.387	0.369
	Pb	0.175	0.164	0.199	0.201
	Cu	8.55	8.54	8.17	7.44
	Ni	0.755	0.788	0.875	0.886
	Zn	93.6	94.4	98.1	97.0
Adaxial epidermis (µm)		10	10	20	20.2
Abaxial epidermis (µm)		15	15	15	15.4
Epicuticular wax thickness of adaxial epidermis (µm)		4.5	4.58	4.8	4.9
Epicuticular wax thickness of abaxial epidermis (µm)		3.9	4.2	4.2	4.4
Number of bulliform cells (numb./mm^2)		25	25	28	28
Bulliform cells width (µm)		75	75,2	80	80.3
Bulliform cells height (µm)		35	35.5	75	72
Mesophyll thickness (µm)		70	68	80	78
Vascular bundle height (µm)		75	75	85	84,5
Vascular bundle width (µm)		65	65	65	65
Distance between vascular bundles (µm)		28	27	23	30
Adaxial sclerenchyma (µm)		5.3	5.5	4.9	5.3
Abaxial sclerenchyma (µm)		16.5	16.8	15.8	16.2
Stomatic density of adaxial epidermis (numb./mm^2)		69	78	66	72
Stomatic density of abaxial epidermis (numb./mm^2)		63	71	122	125
Stoma width /stoma width with subsidiary cells (µm) – upper epid.		11.2/22.05	10.87/21.45	13.21/28.15	12.55/26.8
Stoma width /stoma width with subsidiary cells (µm) – lower epid.		12.43/24.23	12.02/23.98	13.85/26.40	12.70/26.20
Stoma lenght (µm) – upper epidermis		30.06	29.02	27.50	25.40
Stoma lenght (µm) – lower epidermis		35.05	33.00	28.80	27.23
Cell rows number of costal zone in adaxial epidermis (numb.)		6	6	5	5
Long cells's lenght of costal zone in adaxial epidermis (µm)		69-135	70-130	70-140	71-135
Long cell's width of costal zone in adaxial epidermis (µm)		5-25	5-25	5-27	5-25
Frequency of silica bodies of costal zone in adaxial epidermis		2-7	2-7	5-9	2-5
Cell rows number of costal zone in abaxial edpidermis (numb.)		6	6	5	5
Long cells's lenght of costal zone in aaxial epidermis (µm)		52-115	48-102	58-120	50-110
Long cell's width of costal zone in abaxial epidermis (µm)		8-15	5-13	9-12	8-12
Frequency of silica bodies of costal zone in adaxial epidermis		-	-	-	-
Cell rows number of intercostal zone in adaxial epidermis (numb.)		4	4	4 6	6
Long cells's lenght of intercostal zone in adaxial epidermis (µm)		20-55	15-45	21-57	20-55
Long cell's width of intercostal zone in adaxial epidermis (µm)		10-17	10-13	12-21	10-18
Frequency of silica bodies of intercostal zone in adaxial epidermis		<2	<2	<2	<2
Cell rows number of intercostal zone in abaxial epidermis (numb.)		3	3	3	3
Long cells's lenght of intercostal zone in abaxial epidermis (µm)		60-95	60-192	65-98	60-95
Long cell's width of intercostal zone in abaxial epidermis (µm)		7-11	7-11	7-12	7-12
Frequency of silica bodies of intercostal zone in abaxial epidermis		minimal	minimal	minimal	minimal

The increase was also significant in the case of Róna 1 species (the width of the bulliform cells increased as an effect of the treatment from an average of 78.5 µm to 80 µm).

Among the examined species, the Akklimat (Sudan grass) had the most bulliform cells, where the number of cells (28 number/mm^2) and also the height of the cells (75 µm) was three time above average, considering the other three plants tested. In this case, the growth in size of the cell was less significant (the size of the bulliform cells increased from 80 µm to 80.3 µm in total). There wasn't a significant growth in the case of the GK Csaba (Sudan grass) either. Heavy metals make the water content of the plants less stable, the more and bigger bulliform cells appearing in arid circumstances are a much more efficient defense again water loss (GOMES ET AL., 2011).

In our growing pot experiment, the sewage sediment application caused the most significant reduction in the mesophyll-thickness by the Róna 1 species, where the avarage thickness of the leaf mesophyll decreased from 85 µm to 62.5 µm in the case of the tested plants treated with sewage sediment (Table 1.). A reduction in the expansion of the mesophyll layer was also noticable in the case of Akklimat and GK Csaba species, both of their mesophyll thickness decreased by 2 µm, as compared to the contorl plants (Table 2.). The opposite of the expected tendencies happened, in the case of the GK Balázs a slight growth in the thickness of the mesophyll layer was detected.

The treatments had no effect on the lenght of leaf vascular boundle in the case of GK Csaba (Sudan grass) and GK Balázs (silage sorghum). In the case of the Róna 1 (silage sorghum) species there was a slight growth in the length of the veins, and a slight reduction in the case of Akklimat cultivar (Table 1. and Table 2.).

There was no noticable difference caused by the treatment in the width of leaf vascular boundles by any of the tested plants. There was no reduction in the size of the mesophyll cells building a wreath and the bundle-sheath in Kranz anatomy. The 10% sewage sediment used in the experiment must have been not enough to get the adaptational process started, with which the plant could stop the heavy metal translocation (heavy metal translocate in xylem) in the direction of the mesophyll cells containing grana chloroplast. (The lack of the adaptational process can cause a degradation on the membrane structure of the chloroplasts in the mesophyll cells, not letting the light-dependent reactions in photosynthesis happen.)

The thickness of the subepidermal sclerenchyma caps bonding the vascular bundle to the leaf epidermis has shown a significant growth compared to the control plants. The most significant change is expansion was in the thickness of the lower subepidermal sclerenchyma caps by every species examined. (Table 1. and Table 2.). In the case of the Róna 1 (silage sorghum) the growth was bigger than by the other three plants combined - its thickness increased from 13.9 µm to 16.3 µm. The sclerenchyma bundle on the surface also increased its thickness in the case of this species (control: 6.5 µm, treated: 7.1 µm) (Fig. 2.).

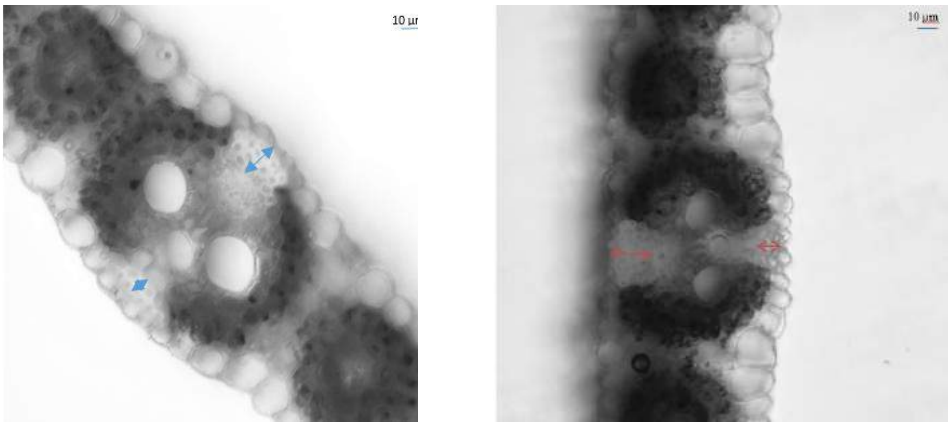


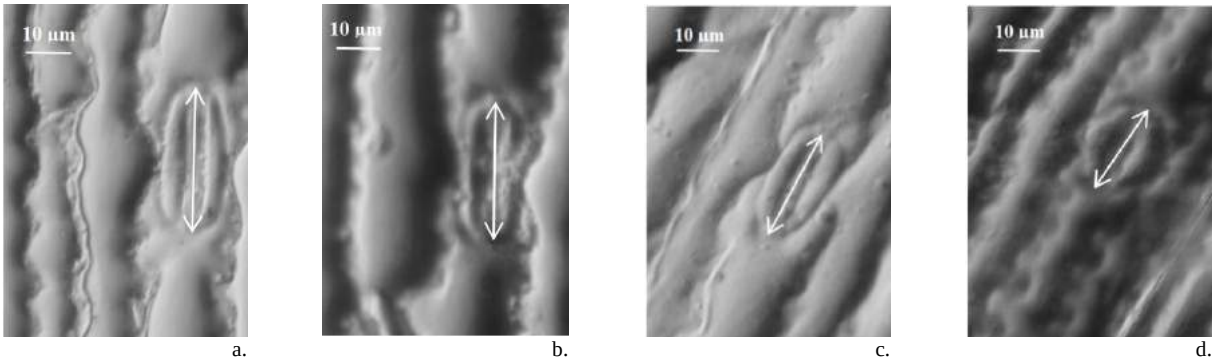
Fig. 2. The change of the thickness of the upper sclerenchyma bundle in the case of control and treated sorghum with sewage sediment (Róna 1)

The part of the examination, which concentrated on the element content of the plants revealed, that the Sudan grass cultivars are better at accumulating copper, both species tested accumulate nickel nearly the same way, but cadmium, lead and zinc are accumulated better by the silage sorghum cultivars.

The translocation of Cd in the stem is stimulated by transpiration (SALT ET AL., 1995), with less water supply and with the increasing transpiration it moves relatively fast towards the leaves, and then accumulates in them, causing significant micrmomorphometrical differences. Our measurement data confirm those statements, which say that cadmium stress/heavy metal stress increases the number of stoma on a given surface. (CHARDONNENS ET AL., 1998; BARYLA ET AL., 2001; SHI ÉS CAI, 2009). This tendency was also noticable with the 10% sewage sediment, although it was not that characteristic. In the case of the Sudan grass cultivars, on the upper epidermis of the GK Csaba the number of stomas increased from 78 number/mm^2 to 83 number/mm^2, on the lower epidermis the number of stoma increased from 82 to 89 number/mm^2. In the case of the Akklimat cultivar there was a significant difference between the measurments on the upper and

lower epidermis, considering the lower epidermis the number of stomas was extremly high even in the case of the control samples (122 number/mm^2). In the case of this species, the treatment didn't increase the number of stomas significantly (Table 2.). In the case of Róna 1 (silage sorghum cultivar), the intensity of stomatal density (135 number/mm^2) in lower epidermis, was very high by control plants, just like by the Akklimat. This number decreased to 99 number/mm^2 after the treatment (Table 1.).

Our results show that the reduction in the size of the stomas is more significant in the case of the upper epidermis (Fig. 3.): in the case of the Sudan grass cultivars the length of the stoma decreased from an average of 32.45 µm to 32.02 µm on the upper epidermis, by the samples treated with sewage sediment. Silage sorghum cultivars changed in the most characteristic way: the by the control plants we measured 35.58 µm, and by the samples treated sewage sediment the same number was reduced to 33.45 µm. (By examining the element content, it can be said, that the silage sorghum cultivars accumulates cadmium, lead and zinc better than Sudan grass cultivars, that's why it's reaction to heavy metal stress is much mure characteristic). In the case of the lower epidermis there were the following: by the Sudan grass cultivars the average length of a stoma measured on a control sample was 31.05 µm, in the case of the sample treated with sewage sediment from Lovász-zug it was 30.85 µm. In the case of silage sorghum cultivars the length of a stoma decreased from 33.88 µm to 31.23 µm on soil treated with heavy metal.



a. b. c. d.

Fig. 3. The length of the stomas in the case of control and treated silage sorghum cultivar with sewage sediment
a. Upper epidermis: Sorghum bicolor (L.) Moench. cv. GK Balázs – Control; b. Upper epidermis: Sorghum bicolor (L.) Moench. cv. GK Balázs - 10% sewage sludge; c. Lower epidermis: Sorghum bicolor (L.) Moench. cv. GK Balázs – Control; d. Lower epidermis: Sorghum bicolor (L.) Moench. cv. GK Balázs - 10% sewage sludge

As an effect of the treatments, the width of the stomas decreased by both plants tested, in the case of both of their epidermises (Table 1 - 2.). Of course, in the case of this micromorphometrical parameter too, the most characteristic reduction was noticable on plants grown on soil mixed with sewage sediment.

4 CONCLUSION

By examining the 2 species and 2-2 cultivars belonging to the *Sorghum* genus (*Sorghum bicolor (L.) Moench x Sorghum sudanense (piper) Stapf. cv*. GK Csaba, *Sorghum sudanense (piper) Stapf. cv*. Akklimat, *Sorghum bicolor (L.) Moench.* cv. GK Balázs, *Sorghum bicolor (L.) Moench.* cv. Róna 1) changes in the micromorphometrical parameters can be noted inducted by toxic element contamination. It can be said that the changes in the micromorphometrical parameters are in connection with the toxic element content of the plant growing medium, especially with its cadmium and lead content, and copper, nickel and zinc content and the toxic element concentration in the leaves.

To sum up our microanatomical examinations, we can state, that out of the examined sorghum species and cultivars the Sudan grass GK Csaba cultivar has the best adaptation abilities induced by toxic elements (on a microanatomical level this species has the best ability of defending itself against the toxic elements in its system).

With the examinations we had the opportunity to limit those microanatomical parameters which we can use to monitor the adaptation process of the plants to the toxic element stress. According to our research the following parameters are the best to examine the effects of the toxic element contamination: epicuticular wax thickness; thickness of adaxial epidermis; thickness of abaxial epidermis; bulliform cells width; bulliform cells height; number of bulliform cells; mesophyll thickness; vascular bundle height; vascular bundle width; thickness of subepidermal sclerenchyma caps; stomatic density; width of stomatal complex; lenght of stomatal complex.

5 ACKNOWLEDGMENTS

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Authors addresses

[1]Csilla Tóth, college associate professor, University of Nyíregyháza, Institute of Engineering and Agricultural Sciences, H-4400 Nyíregyháza, Sóstói Str. 31/b., (06 42) 599 400/2415, toth.csilla@nye.hu

[2]Katalin Irinyiné Oláh, college senior lecturer, University of Nyíregyháza, Institute of Engineering and Agricultural Sciences, H-4400 Nyíregyháza, Sóstói Str. 31/b., (06 42) 599 400/2607, olah.katalin@nye.hu

[3]László Simon, professor, University of Nyíregyháza, Institute of Engineering and Agricultural Sciences, H-4400 Nyíregyháza, Sóstói Str. 31/b., (06 42) 599 400/2391, simon.laszlo@nye.hu

Contact person

[*]Csilla Tóth, college associate professor, University of Nyíregyháza, Institute of Engineering and Agricultural Sciences, H-4400 Nyíregyháza, Sóstói Str. 31/b., (06 42) 599 400/2415, toth.csilla@nye.hu

Digital manufacturing enabling the integration of electronic components into 3D printed parts

Ioan Turcin[1,*], Manfred Pauritsch[2],
Cosmin Cosma[3[0000-0002-3022-4457]], Nicolae Balc[4]

Abstract: The special content presented in this study brings a valuable contribution and useful references for future applications in digital manufacturing. Digital manufacturing (DM) processes such as additive manufacturing (AM) technology, allow a high degree of integrability and functionality of printed parts. In this work, we present a proof of the DM concept focused on the integration approach where a product is developed and embedded with sensors. We also take this example one step further and introduce a method that allows 3D printing of heating elements into the rehearsals. The thermal characteristics of the developed heaters are investigated, and the results detailed. The novelty relates to a heater prototype injected and solidified into a curved 3D printed channel, which can produce a temperature between 23-46°C on the printed surface of the sample both in a dry and wet environment. This research demonstrates that it is possible to construct parts with embedded electrical structures using the described method.

Keywords: Digital manufacturing, stereolithography, sweat glands module, 3D printed sensors, conductive ink.

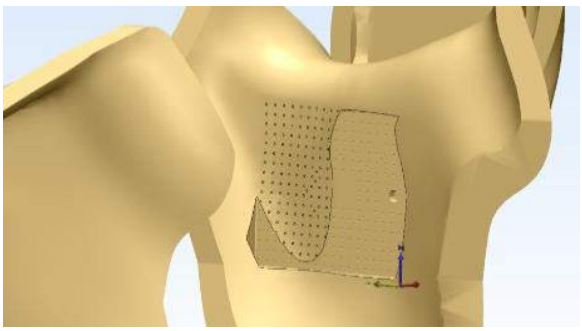
1 INTRODUCTION

The focus of this paper is to show in which way a concept design using the complex methods, tools, and processes of digital manufacturing can be integrated to achieve the needed functionality.

This work uses complex methods, tools, and processes to demonstrate the possibilities of digital manufacturing (DM). The proposed approach combines the design and manufacturing information with the concept of functionalizing additively manufactured parts in various aspects. As a practical case study, we present an anatomical sweat glands module, which was developed with DM instruments, starting from design and conception to the direct fabrication by additive manufacturing (AM). This prototype will be further developed to optimize textile materials and to elaborate specific analysis of this industry.

The sweating glands are all over the human body surface within the first 3 mm of the skin. Their density is between 80 to 100 glands/cm2 and they have 40 μm diameter. These reduced characteristics of sweat glands are not possible to be fabricated with standard AM machines. Due to AM limitations, we concentrated on considering the surface and the sweat rate. Thus, an anatomical module was designed that offer the possibility to bring the same amount of liquid to the required surface. The armpit area was selected to develop a complex sweat glands module [1]. Regarding the AM possibilities, various scientific papers shown that 3D printing technologies can produce complex prototypes for different applications under the "layer by layer" principle [2-11]. Comparing with conventional manufacturing methods [12-14], 3D printing provides reduced time to market, lower product development costs, and improved design process [15]. Emerging technologies such as 3D printing and robotics [16] accelerates a sustainable developing of Industry 4.0 with DM. Analyzing the literature recommendations, the actual sweat glands module can be manufactured by stereolithography (SLA) technology. This AM process can be used continuously, suit the needs of different users, has good accuracy, can obtain one of the best surfaces and can use a wide range of materials. A sweat glands module was designed according to AM requirements. Following the technological observations regarding the SLM manufacturing, the virtual model was redesigned considering all the required aspects and at the same time to be integrated into the axilla area.

a)



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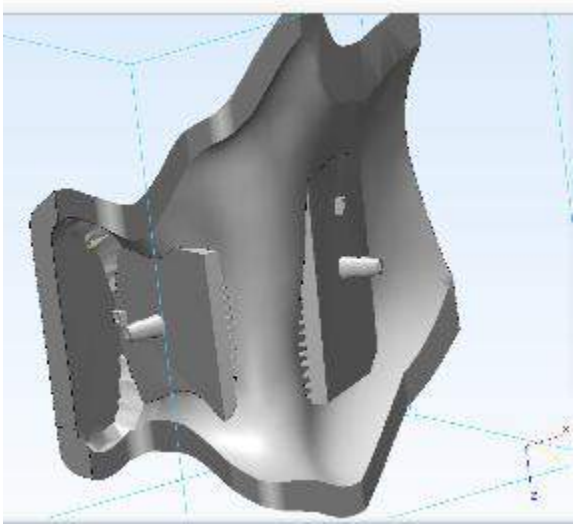


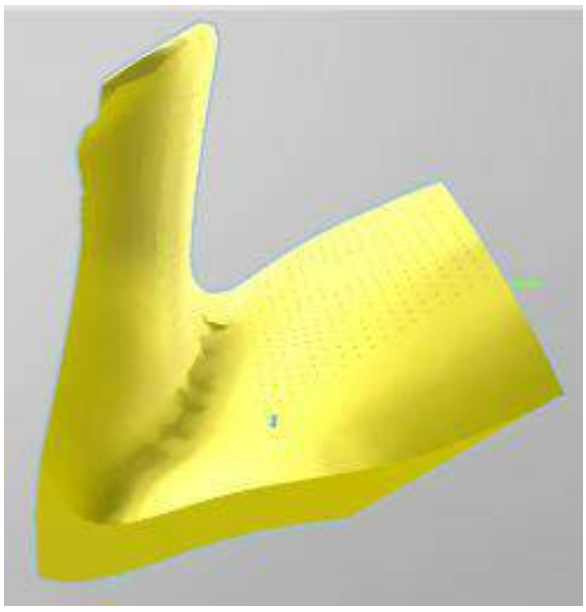


Fig. 1. a) Subtraction type boolean operations, b) Cutting the outlets channels after the unification between anatomical model and redesigned sweat glands module, c) The final virtual model of armpit with sweat glands modules after correction of errors and thickness analysis

Following the technological observations regarding the SLM manufacturing, the virtual model was redesigned considering all the required aspects and at the same time to be integrated into the axilla area. To design the sweat glands module, boolean and CAD operations were developed using Creo Parametric and Meshmixer software. Example of workflow can be seen in Fig.1.
Boolean operations offer a versatile tool for editing or modifying the STL format, adding artificial constructions [17, 18]. With the design freedom afforded by the SLA process, atypically channels networks were developed for liquid flow. The designed and printed part is illustrated in Fig. 2. This module contains more than 600 outlet glands on the anatomical shape of the armpit. All the parts from this study were fabricated using a Form2 SLA system and a standard photopolymer (Clear Resin-Formlabs).
To add functional requirements to the actual sweat glands module, the study was focused on embedding electronic components into the 3D printed parts.
This work combines additive polymer printing with liquid metal infiltration for use in potential practical applications. The novelty of this study relates to a heater prototype developed by injecting a silver conductive ink into a curved channel, which can produce a temperature between 23-60°C on the printed surface of the sample.

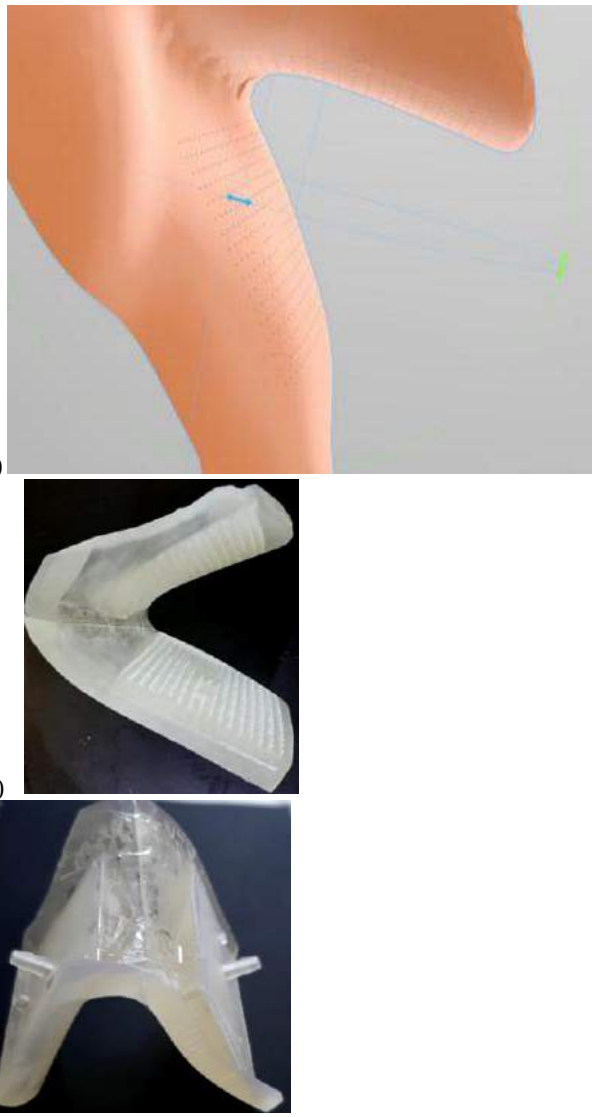
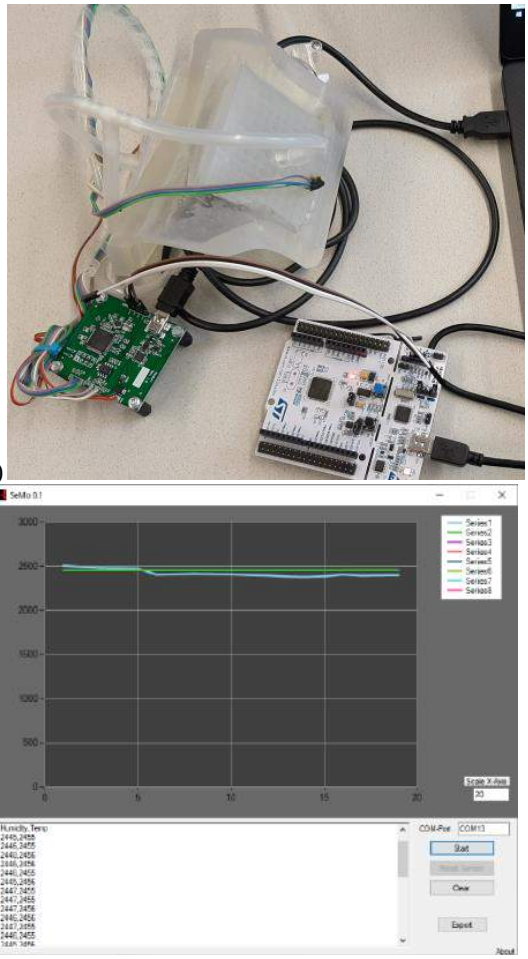


Fig. 2. Sweat glands module of armpit: a) virtual model, b) SLA manufactured

2 SLA PARTS WITH INTEGRATED ELECTRONICS

AM technologies offer the possibility to integrate electric components and sensors in complex parts. Various applications of 3D printed sensors were reported for measuring the following: strain, pressure, ultrasounds, gas detection, food quality, biosensor, or even brain activity [19]. Discussing all the possibilities of integrating sensors and other components in additively manufactured parts goes beyond the scope of this paper, and into the area of 3D-printed electronics, examples of which can be found in works such as [21]. This paper describes two practical examples of how electronic components could be integrated into a sweat glands module. The first method is a straightforward one, where traditionally manufactured electronic components and sensors are integrated into pre-designed holes in the printed part. After the part was SLA manufactured, additional sensors were integrated into the pre-designed holes. The concept is presented in Fig. 2,

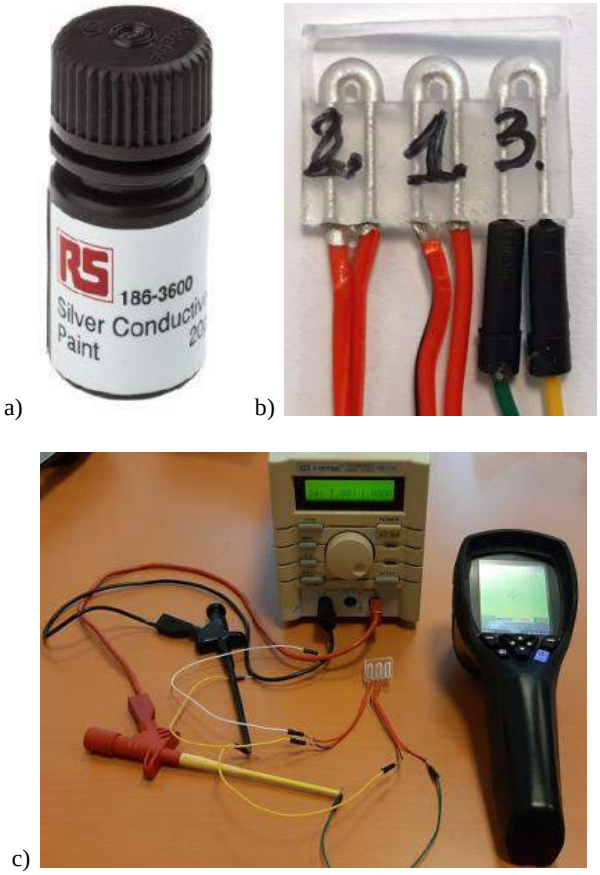
where humidity and a temperature sensor are connected. The humidity sensor is Honeywell HIH-4000-003 and has the following features: near linear voltage output versus relative humidity, laser-trimmed interchangeability, low power design, enhanced accuracy, fast response, and low drift performance and chemical resistant. The temperature sensor is a PTF type produced by TE Connectivity. It combines a resistance temperature detector using a platinum resistor in the thin film as a sensing element. This sensor contains a structured platinum film on a ceramic substrate, passivated by glass coating [20]. The main features of it are the following: resistance tolerance ±0.12%, application temperature ±200°C, and silver wire. As shown in Fig. 3, a specially printed circuit board (PCB) was designed, equipped with an ARM controller (STM32C476), which controls the electronics. This board enables the connection of various sensors and actuators and controls the integration of the components. After setting up the controller via an ST-Link (Nucleo-F103RB), the first data from the sensors (temperature and humidity) were read (Fig. 3b). Furthermore, this sweat glands module, and electronics will be implemented in a mechatronic system, which will allow us to simulate the sweating process in various conditions.



a) b)

Fig. 3. Sweat glands module with integrated sensors: a) setting up the controller b) sensors data

The second example is based on a previous report focused on 3D printed microelectronics for integrated circuitry and passive wireless sensors [21]. In this method, some channels are left intentionally hollow in the part, and after manufacturing, they are filled with conductive ink. In this manner, interesting components such as micro-electro-mechanical systems (MEMS) could be developed [22]. Using this technique, we produce integrated paths in the 3D printed sample, which can be used for actuating, in this case, thermal regulation, or even sensing purposes. Several samples were SLA manufactured with "U" channels (Fig. 4b). Each sample has three channels with a 1.00 mm diameter and 26 mm length. The SLA parts were post-cured with 1.25 mW/cm2 of 405 nm LED for 60 minutes at 60°C. For these conditions, the heat deflection of SLA parts is approx. 58.4°C for 1.80 MPa load value (according to ASTM D 648-07). Using a normal syringe, all the channels were injected with a conductive liquid (Fig. 4a). The material used is based on silver conductive element and has a volume resistivity of 0.001 Ω cm (product code RS PRO 186-3600). According to the material data sheet, this conductive ink contains 50-75% silver, 10-25% 2-methoxy-1-methyl ethyl acetate, and 10-24% n-butyl acetate. In general, this conductive ink is used to repair circuits on printed circuit boards or to make electrical connections to non-solderable surfaces.



a) b)

c)

Fig. 4. a) Silver conductive ink used, b) 3D printed heater: SLA sample where the "U" channels injected

with silver conductive ink, c) Instruments used for temperature sensitivity experiment

Fig. 4b shows a sample developed using this procedure, which contains three resistive elements.
To investigate the heating behavior of these elements integrated into the SLA part, they were characterized for temperature sensitivity. In this step, we analyzed their suitability as heating elements. To undertake this work, a programmable DC power supply from Instek PSS-3203, and an infrared thermal camera from Flir i7 was used (Fig. 4c). The power was varied from 0 to 300 mW and the surface temperature of SLA parts was recorded. Typical temperature maps in air at different power values are shown in Fig. 5.

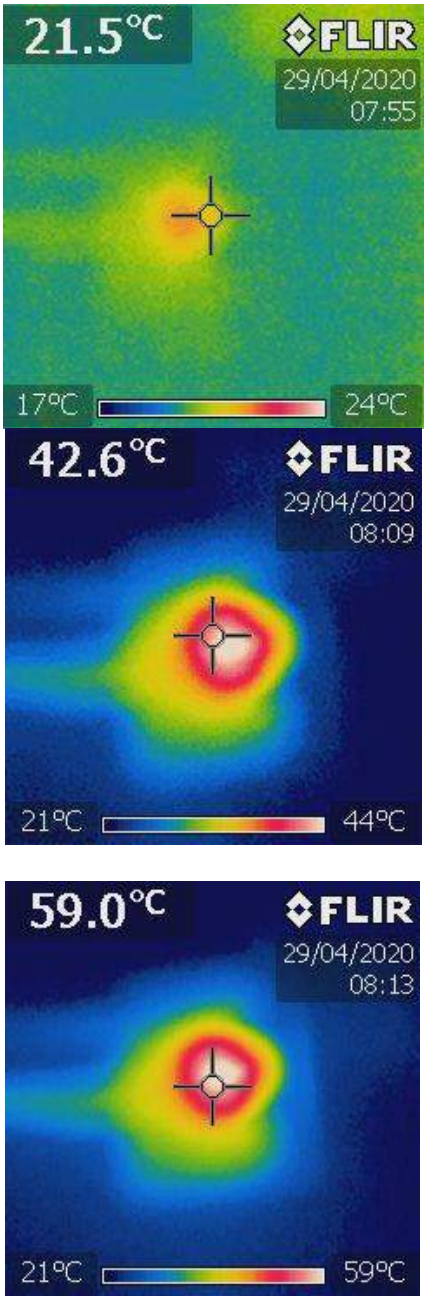


Fig. 5. Temperature maps with elements in air at different values of power

Moreover, Fig. 6 shows the temperatures measured in air and with the elements immersed in a liquid with respect to increasing power.
The results presented are the mean values recorded on the surface. All the measurements were made until the part was no longer conductive.

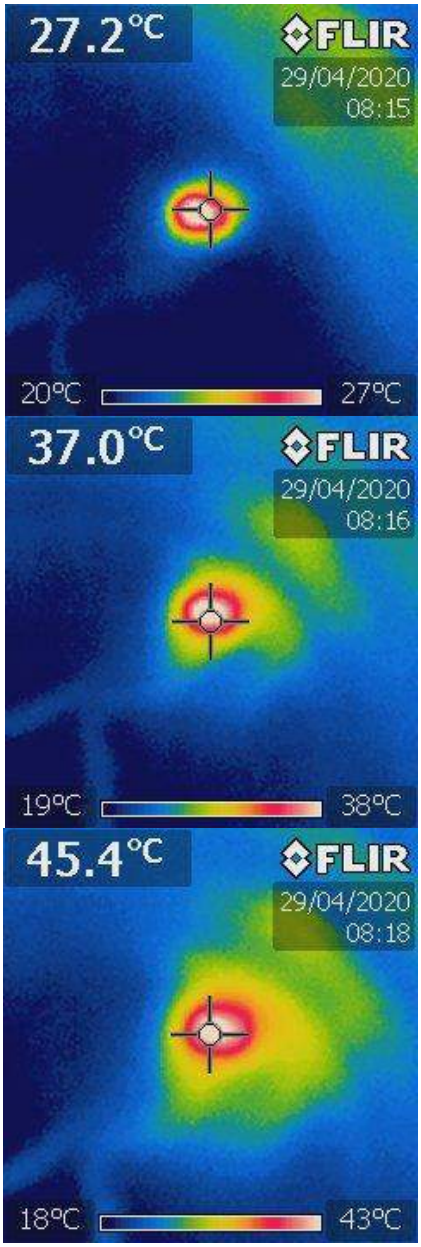


Fig. 6. Temperature maps with elements in a liquid at different values of power

The interruption appears at maximum resistance, where a voltage supply of 1.15 V was applied (power of ~ 298 mW). The resistance of samples varied between 3.278 and 3.727 Ω. These results show that temperature from 31°C to 42°C can be achieved using a power input from 40 to 107 mW in a dry environment (Fig. 7a).

a)

b)

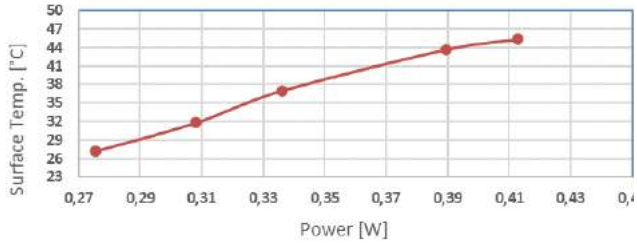


Fig. 7. Chart with surface temperature versus power: a) Dry environment, b) Wet environment

To investigate this system in a sweating environment, other samples were tested in water at room temperature (18°C). The results are exposed in Fig. 7b. In this case, the power was increased up to 420 mW. In a wet environment, temperature from 32°C to 44°C can be achieved using an input between 310 and 390 mW.

For better mechanical and electrical properties, the conductive ink could be cured at 121-148°C for 5 to 10 minutes. To achieve this, another resin must be used for the printing process (e.g., High Temp Resin from FormLabs).

The measurements conducted above allow the determination of the thermal resistance (Rth) using the following equation:

$$Rth = \frac{\Delta T}{P} = \frac{(Td - Ta)}{P} \quad [°C/W] \qquad (1)$$

where Td is the device temperature (°C), Ta is the ambient temperature (°C) and P is the electrical power through the device (W).

The results of thermal resistance are shown in Fig. 8. Depending on the power supply, the thermal resistance varies from 34 to 142 °C/W.

Fig. 8. Thermal resistance (Rth) versus power consumption

The presented results showed that this concept of resistive elements can be used as a heater. Future studies will integrate this heater concept into the anatomical shape of the sweat glands module, allowing us to simulate the sweating process at various temperatures in a dry or wet environment. To create an instrument, which combines both fluidic channels and sensing elements, the actual study shows a possible method to integrate electronic components into a 3D printed part.

The results reported brings a valuable contribution and useful reference for future applications of DM. The work was focused on functional design and the high levels of integration enabled by DM. In this study, the SLA process has been utilized to develop a sweat glands module with integrated electronic components such as temperature and humidity sensors, and a heating component made of silver conductive ink. Combining the 3D printing process and liquid metal paste filling method, a heater prototype was developed. The heating results show that it is possible to obtain a temperature from 36°C to 46°C both in a dry or wet environment using this heater. This preliminary study demonstrates that it is possible to develop an embedded heater into the SLA parts. From the manufacturing point of view, these findings suggest that a future heater can be constructed into the anatomical shape of the sweat glands module.

3 CONCLUSIONS

With the increase in the quantity and quality of computer systems in production facilities, the transition to a DM approach has become popular. DM concept refers to smart, networked methods, techniques, and tools that enable more flexible and customized manufacturing, increasing productivity and strengthening competitiveness [23]. In this study, a practical implementation of DM was developed which explores the benefits of 3D printing. Due to enabling to produce prototypes, tools, and final parts directly from virtual models, DM fosters dramatic reductions in delivery times and production costs while improving overall product quality. From our perspective, the technique described can be used to produce various electrical components with an atypical structure such as resistors, capacitors, inductors, circuits, and wireless sensors.

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Authors addresses

[1] *Turcin, Ioan, Dipl.-Ing. (FH), CAMPUS 02 University of Applied Sciences, Degree Programmes in Automation Technology, Koerblergasse 126, 8051 Graz, Austria, ioan.turcin@campus02.at*

[2] *Manfred, Pauritsch, FH-Prof. Dipl.- Ing. Dr. techn., CAMPUS 02 University of Applied Sciences, Degree Programmes in Automation Technology, Koerblergasse 126, 8010 Graz, Austria, manfred.pauritsch@campus02.at*

[3] *Cosma, Cosmin, Dr. eng., Technical University of Cluj-Napoca, Muncii 103-105, 400641, Cluj-Napoca, Romania, cosmin.cosma@tcm.utcluj.ro*

[4] *Nicolae, Balc, Prof. Dr. eng., Technical University of Cluj-Napoca, Muncii 103-105, 400641, Cluj-Napoca, Romania, nicolae.balc@tcm.utcluj.ro*

Contact person

[*] *Turcin, Ioan, Dipl.-Ing. (FH), CAMPUS 02 University of Applied Sciences, Degree Programmes in Automation Technology, Koerblergasse 126, 8051 Graz, Austria, ioan.turcin@campus02.at*

A View on Residential Areas in Romania from the Perspective of Urban Indicators

Teodora UNGUREANU*

Abstract*: The development of cities in Romania is a complex phenomenon, with significant differences between neighbouring areas. The current research analyses four Romanian residential areas from the perspective of urban indicators and* examines some of the aspects in which current legislation controls the development of new residential areas in Romania. The aim is to identify how the new developments are regulated, answering the research question: how do urban rules and technical indicators such as floor space index (FSI) and building coverage ratio (BCR) impact the density of residential areas?

Keywords: *urban indicators, built density, urban analysis, residential areas, Romanian neighbourhoods*

1 INTRODUCTION

The development of cities in Romania is a complex phenomenon, with significant differences between neighbouring areas. On the one hand, we find cities that are experiencing shrinking, and on the other hand, we can observe magnet cities that attract the workforce and generate an accelerated and dense development of residential areas (Cristea et al. 2017; Păun Constantinescu and Voiculescu 2019). Furthermore, the development of new residential areas in Romania is a process often left to private investors who apply urban regulations in such a way as to maximise their profit, ignoring other factors such as ensuring an increased quality of urban life. This economic model of urban development can have long-term negative effects on the inhabitants of the areas, which can have a knock-on effect on the overall development of the cities they belong to.

The present study examines some of the aspects in which current legislation controls the development of new residential areas in Romania. The aim is to identify how they are regulated, answering the research question*: how do urban rules and, in particular, technical indicators such as floor space index (FSI) and building coverage ratio (BCR) impact the density of residential areas?*

In order to answer the current paper analyses the following key points:

- the definitions of key concepts at a general level, based on international research and local practice.
- the current Romanian urban legislation for residential areas, focusing on the key technical indicators FSI and BCR
- a method of investigating a series of case studies presenting the identified control indicators for built density in Romanian residential areas

2 CONTEXT

2.1 General Definitions

Starting from the hypothesis stated in the introduction, this sub-chapter defines and presents critical concepts used in the study. The aim is to create a common ground between author and reader by avoiding different interpretations of terms that could result from the differences in international urban practice in interpreting the three concepts: *residential area, built density* and *urban indicators.*

2.1.1 Residential area

The term residential is used in current legislation, in '*Government Decree No 525/1996 approving the General Urban Planning Regulation'*, but it is not defined in any normative act. In the Romanian Civil Code, we find the term '*residential development*', which regulates co-ownership and owners' associations (Civil Code, art. 648 and art. 659). Thus, one of the essential functions of the city has no straightforward definition in Romanian legislation.

Taking from the definition presented by Evert et al. in the '*Encyclopaedic Dictionary of Landscape and Urban Planning*' I will consider the definition of the residential area presented by the French practice (Evert et al., 2010). Thus, a residential area is an urban area reserved mainly for housing, containing a certain number of dwellings, the related infrastructure, and the facilities necessary for the daily life of the resident population: such as services, commerce, building equipment. In order to define the type of residential area, from a strictly quantitative point of view, I will consider a classification according to the number of housing units based on the model presented in the framework:

- neighbourhoods with 2500-4000 units;
- neighbourhood units with 800-1200 units;
- residential groups of several hundred units. (Evert et al. 2010)

It is noted the definition of the residential area in the '*Minister of Health Order No. 119/2014 for the approval of the Rules of hygiene and public health on the living environment of the population*':

'*b) housing area - an area constituted as a functional grouping of territorially delimited lots and plots of land on which buildings with dwellings predominate having as a measurement parameter the average density of housing;*' (Authors translation)

This vague definition does not specify the type of functions that may accompany housing. It also introduces the concept of "*average housing density*", but

there is no further regulation of this density in any normative act.

2.1.2 Urban Indicators

In Romanian legislation, urban indicators are defined by *'Law 350 of 2001 on spatial planning and urban development'* as: 'specific urban planning tools' used in the control of planning and sustainable development of the urban areas. Two urban indicators used in Romanian urban practice are

- *building coverage ratio (BCR)* - the ratio between the footprint of the building or projection of the perimeter of the upper floors on the ground and the surface area of the plot.
- *floor space index (FSI)* - the index between a building's total floor area and the area of the plot.

Further details concerning exceptions and calculation methods will be discussed in the third chapter concerning the case studies.

2.1.3 Built Density

The Methodological Framework Guide "Density of buildings in residential areas - POT and CUT", drawn in 1995 by the Romanian Ministry of Public Works and Spatial Planning, highlights the direct link between urban indicators and built density. Moreover, the guide highlights six general types of factors that influence, density and thus the FAR and BCR:

i. reference land area: when measuring an urban indicator, it is important to delimit the reference land. The recommendation is to base the delimitation on homogeneity of morphology and primary functions.
ii. height regime: the analysis of the average number of levels alone cannot express the typology or morphology of an area, as this value can be the same for an area with a uniform height regime as for an area whose height regime varies greatly. Therefore, an analysis that combines FAR, BCR, and other indicators associated with density is recommended.
iii. level of functionality and comfort: determined by the principles of sustainable development. The use of urban indicators on the urban fabric analysis can point to urban dysfunctions in the case of extreme values for the urban indicators.
iv. urban morphology: analysis of morphology allows the demarcation of the reference land area (i). The urban morphology analysis led in part to the development of the value scale table (Table 1).
v. size and profile of the city: as a rule, the values of FAR and BCR are reduced in small cities, and usually, economic growth of an area or city leads to an increase in the indicators
vi. environmental factors or factors mediated by local urban planning regulations: the first category relates to natural conditions and the second category relates to the local context, including areas of historical value. (The Ministry of Public Works and Spatial Planning, 1995)

Based on the six factors, the guide also proposes, as an operational working tool, the implementation of a scale of indicator values (Table 1). These six factors were employed in the analysis of the four case studies in the present study, in chapter four.

Table 1. *"Value Scale of FAR and GSI indicators". Source: "Density of buildings in residential areas FAR and CGSIUT - 1995" - Ministry of Public Works and Spatial Planning - Urban and Spatial Planning Series / Framework methodologies for the preparation of urban planning documents - Volume 12. P.17*

Building typology	Indicators	Heigh of the building (number of levels)					
		1	**2**	**3**	**4-5**	**6-8**	**over 8**
Individual housing	**BCR**	20 - 40	20 - 35	20 - 30	-	-	-
	FSI	0,2 - 0,4	0,4 - 0,7	0,6 - 0,9	-	-	-
Semi-detached housing	**BCR**	25 - 35	25 - 35	25 - 35	-	-	-
	FSI	0,25 - 0,35	0,5 - 0,7	0,75 - 1,05	-	-	-
Collective housing and complementary functions	**BCR**	-	-	20 – 35 %	22 – 30 %	20 – 30 %	18 – 25 %
	FSI	-	-	0,75 – 1,05	0,9 - 1,5	1,2 - 2,4	1,6 – 2,5
Residential Neighbourhood and compatible functions	**BCR**	-	-	22 – 32 %	20 – 30 %	18 – 25 %	16 – 20 %
	FSI	-	-	0,6 - 1,0	0,8 - 1,5	1,1 - 2,0	1,3 - 2,0
Central areas	**BCR**	-	-	33 – 40 %	20 – 25 %	28 – 32 %	25 – 30 %
	FSI	-	-	1,0 - 1,2	1,2 - 1,7	1,8 - 2,6	3,0 - 3,5

2.2 The Romanian Legislation and Practice in Urban Planning

The previous sub-chapter introduced the fundamental concepts of the research from the

perspective of the implications and interpretations of the terms. Considering the terms regulation, urban planning regulation and urban regulation as having the same meaning, we started from the definition of regulation as *`the totality of instructions, norms, and rules (prescriptions, regulations, decrees, legal ordinances, directives) that establish a legislative basis `* (Iancu 2012). This sub-chapter will briefly present the structure of urban planning regulations in Romania and how they relate to residential areas.

The aim is to identify and delimit those elements that directly impact the density of residential areas. Urban regulations are normative acts defined according to current legislation, as shown in figure 1.

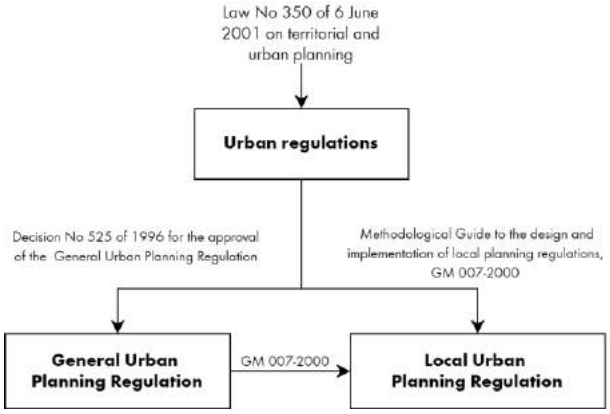

Figure 1. The structure of urban legislation in Romania. Source: The author.

2.2.1 General Urban Planning Regulation

The General Urban Planning Regulation (GUPR) is a normative act approved by *`Government Decree no.525 of 27 June 1996 for the approval of the General Urban Planning Regulation`*. The GUPR has two definitions in normative acts: in GD 525/1996 it is defined as a *`unitary system of technical and legal rules that underpins the preparation of land-use plans, urban development plans and local planning regulations`*, while *`Law 350/2001 on territorial and urban planning`* introduces an economic element: *"General urban planning regulations are the system of technical, legal and economic rules underlying the preparation of urban planning plans and local urban planning regulations."*

The General Urban Planning Regulation sets out the "rules for the occupation of land and the location of buildings", which form the basis for, among other things, local urban planning regulations. It comprises 40 articles containing "technical, legal and economic rules", structured into four chapters and annexes 1-6.

The implementation of the GUPR in local planning regulations is presented in the "Guide to the preparation and approval of local planning regulations" (G.M-007-2000). Published in 2000, G.M-007-2000 details and illustrates the General Town Planning Regulations for the design of Local Town Planning Regulations.

Bearing in mind that each article of the GUPR must be respected and represent a unitary system of rules, the following part describes those regulated elements that impact urban density or the quality of urban life in residential areas. The following section presents from the *Methodological Guide to the design and implementation of local planning regulations*, GM 007-2000, those elements that describe the built environment: amenities, compatibility of functions, BCR, alignment, location, plots system, green spaces, parking.

In order to explain the articles, the guide defines some of the terms present in GD 525/1996 as well as associated terms. The definition of the built-up area, the developed area, the building regime with alignment, the height of the buildings and the percentage of occupation of the land are noted. However, there is no definition of FAR or of residential areas. It should be noted that some terms have changed over time: for example, the definition of the BCR will be modified from the version present in GD 525/1996 and in GM-007-2000 by *Ordinance no. 27/2008 amending and supplementing Law no. 350/2001*, which introduces the definition of BCR and FAR in Annex no. 2 of the law.

The General Urban Planning Regulation is defined in art.1 as a document of broad generality. Its application considers the interests of citizens with those of the community by protecting private property and the public interest. Chapter 2 contains "*Basic rules*". It defines and exemplifies concepts such as building amenities (art.13), the compatibility of functions (art.14), BCR (art. 15), the alignment of the buildings (art. 23).

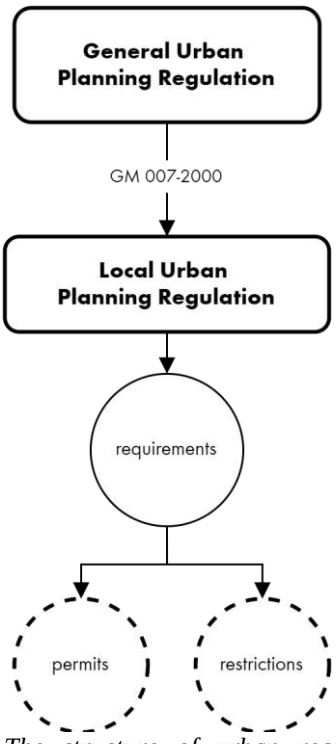

Figure 2. The structure of urban regulations in Romania. Source: The author.

2.2.2 The Local Urban Planning Regulations (LPR)

The Local Urban Planning Regulations (LUPR) are detailed in the "*Guide for the preparation and approval of Local Planning Regulations" (G.M-007-2000)*. The Regulations contain prescriptions and recommendations explaining and detailing the plans they accompany, extending the rules formulated by GUPR, figure 2. Law 350/2001 extends the definition contained in Government Decree 525/1996. However, the law does not specify whether local regulations can bring new rules within the city or how the provisions of the GUPR are minimal.

2.3 Conclusions and comments on the context

In this chapter, we have aimed at a brief presentation of the structure of the Romanian town planning regulations from the perspective of residential areas by studying mainly the "*Government Decision no. 525 / 1996 for the approval of the General Urban Planning Regulations*", the "*Law no.350 of 6 June 2001 on Town and Country Planning*" and the "*Guide for the elaboration and approval of local town planning regulations" - Indicative G.M.-007-2000*. In addition to these, those pieces of legislation related to urban planning that deal with design and construction in residential areas have been studied.

As can be seen, the legislative acts do not constitute a unified body of law that could facilitate rapid access to the desired information. The importance of defining a single body of specialised laws in the field of urban planning that brings together all the urban-related legislation in urban is also stressed in the publication "*An interdisciplinary approach to increasing the quality of housing through the rehabilitation of large housing estates in Romania* (Eftenie and UAUIM CNCSIS 2007).

Another important observation for the research is the lack of definition of the concept of the residential area. Although laws refer to these areas, no regulations define exactly what a residential area entails. For example, rules on the maximum number of inhabitants, the ratio of built-up area to green space, the required infrastructure or building equipment are not clearly established. Some of these elements are mentioned in GM-007-2000, but without further clarification, and the examples are neither sufficient nor up to date and often do not correlate with the text to which they belong.

Based on the legislation studied, we identified the definition of urban indicators as "specific urban planning tools to control the design and sustainable development of urban areas" (Law 350/2001). GM-007-2000 emphasises on several occasions the importance of BCR, FSI and building height for the design and obtaining of building permits. These indicators have the potential to influence urban form directly. The following chapter will analyse four examples of residential areas from the perspective of urban indicators.

3 THE BUILT DENSITY OF ROMANIAN RESIDENTIAL AREAS. FOUR CASE STUDIES

This chapter presents a mapping of BCR and FSI in four neighbourhoods in Bucharest and Cluj Napoca. The first example is the Floreasca neighbourhood, built between 1950 and 1970, and the second Militari Residence, built after 2000. From the city of Cluj Napoca, we studied a part of the Gheorgheni neighbourhood, built in the 1960s, and the Bonjour Residence residential complex, built around 2015. These four examples were based on the aim of comparing Romanian neighbourhoods developed during the socialist period and neighbourhoods built after the 2000s that considered the current legislation presented in Chapter 2.

3.1 Built Density and Urban Indicators

Describing an urban development by only two urban indicators used in Romanian urban practice, BCR and FSI, can present shortcomings in genuinely understanding the urban form and urban performance, as seen in figure 3 (Berghauser Pont et al. 2021) through extensive studies.

Considering that the four case studies were chosen based on collective housing typology, the current research will only focus on three urban indicators: BCR, FSI and building height. Building Coverage Ratio - BCR

The *building coverage ratio* is defined in Annex

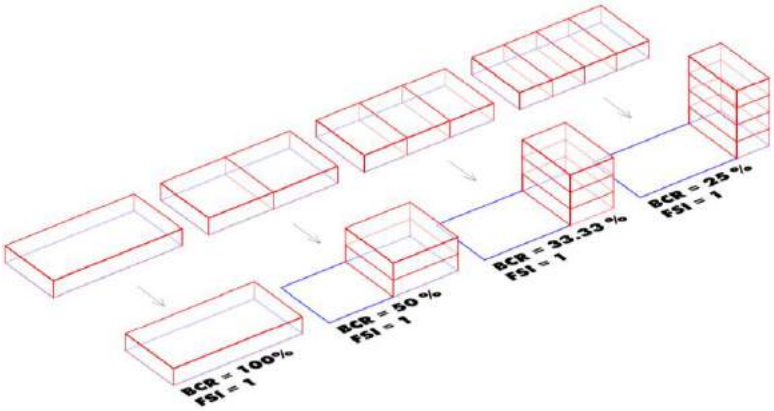

Figure 3. The following scenarios have the same floor space index but differ in building coverage ratio.

2 of Law 350/200, While Annex 2 of GD 525/1996 defines the maximum values according to the types of residential areas (art. 2.1.5.):

- *'exclusively residential area with dwellings on single, one or two stories, BCR = 35%.*
- *Residential area with dwellings with more than 3 stories, BCR = 20%*
- *predominantly residential area (dwellings with related facilities) with collective housing, BCR = 40%.'*

The Methodological Guide GM 007-2000 supports art.15 of GD 525/1996, which requires that the maximum BCR set by the Local Urban Planning Regulations by-law must not be exceeded for the construction to be authorised. The guide defines the terms and explains the calculation of the urban indicator, as seen in equation 1 and figure 4.

$$\boldsymbol{BCR = \frac{S_c}{S_t}\ \%}$$

Equation 1. The calculation of the BCR. Where Sc is the footprint of the building or projection of other architectural elements, and St is the total surface of the plot.

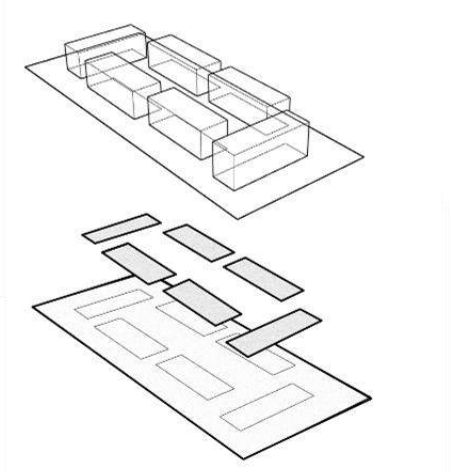

Figure 4. Diagram explaining the surfaces considered in the calculation of BCR.

By the Governmental Decree no. 27/2008 amending and supplementing Law no. 350/2001, it is introduced into the definition of BCR a clarification of Sc as '*the area of the horizontal section at ground floor level ±0.00 measured on the outer contour of the walls, excluding the recesses with an area less than 0.4 m^2, niches with an area greater than 0.4, external steps m^2 and uncovered terraces*'.

Also, G.M.-007-2000 mentions that the General Urban Planning Regulation establishes a maximum value for BCR, and the General Urban Masterplan must take into account these maximum percentages and the typologies of the urban fabric in each context.
G.M.-007-2000 refers to the importance of correlating the BCR with the FSI, the alignment regime and the height, which together form a set of mandatory values required for the approval of new constructions. It should be noted that the guide refers to the FSI, although it is not defined in GD 535/1996, but in a Ministry of Development, Public Works and Administration Order 91/1991.

3.1.1 Floor space index - FSI

The *floor space index* (FSI) is defined in Annex 2 of Law 350/2001 as the index between a building's total floor area and the plot area. The exceptions in considering the total floor area are applied in the case of `*area of basements with a free height of up to 1.80 m, the area of basements strictly for parking vehicles, technical spaces or spaces intended for civil protection, the area of balconies, loggias, open and uncovered terraces, non-circulating terraces and awnings, as well as unenveloped bridges, pedestrian access paths/pavements in the premises, external stairs, protective pavements.*`, as seen in equation 2 and figure 5.

$$\boldsymbol{FSI = \frac{S_d}{S_t}}$$

Equation 2. The calculation of the FSI. Where Sd is the total floor area of a bulding, and St is the total surface of the plot.

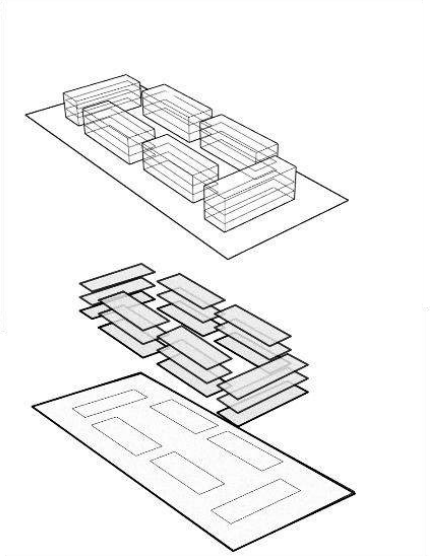

Figure 5. Diagram explaining the surfaces considered in the calculation of FSI.

The values of the urban indicators imposed by the GUPR and LUPR can be modified based on a Zonal Urban Plan, according to Law 350/2001. Thus, it is possible to implement exceptions to apply the maximum indicators set by the GUPR and LUPR based on planning documents approved by the local public administration. The lack of clear specification of the mandatory and minimum character of the rules established by GUPR has allowed the implementation of these exceptions, which can prove detrimental for the urban area.

3.2 Method employed

3.3

3.3.1 Delimitation, measurement, and analysis

For the measurement of urban indicators within the residential areas, the delimitation of the study area was considered the central axis of the streets, delimiting the islands as the delimitation of the study area. Berghauser Pont et al. (2021) noted that the measurement of the urban indicators can differ depending on how the open areas around the assemblies are calculated.

As noted in the previous chapter, Romanian legislation does not cover the delimitation of the areas to be considered in the calculation of the BCR and FSI except the ownership perspective: the plots.

For the study, OpenStreetMap data correlated with Google Maps and Bing Maps were used to draw the studied areas plans and update any missing data. These data were then vectorised in a CAD application to obtain the exact dimensions needed to measure the urban indicators. These dimensions were entered into a spreadsheet using Excel to calculate the BCR and FSI of the studied areas according to the formulas outlined in sub-chapters 3.1.1 and 3.1.2. The use of tables allows the case study data to be easily compared.

As a possible method for future work, I would like to develop a method using a GIS (geographic information system) platform that allows direct generation of tables, graphs and indicators from the plans of the areas studied. This method would allow research of several areas and disseminate information through online platforms or smartphone applications. However, currently, the studied areas are not included in official GIS files.

3.4 Case studies: BCR and FSI in Romanian residential areas

3.4.1 Floreasca Neighbourhood, Bucharest

Considered one of the most attractive areas to live in Bucharest, the Floreasca neighbourhood illustrates a particular approach to the quality of urban life in Romania. Although the housing units are minimal sized, residents describe it as 'pleasant, comfortable, even luxurious' (Zahariade 2009). I chose this example because of the involvement of the neighbourhood's inhabitants in preserving the specific character of the area. The wave of retrocessions (considered by many residents to be abusive) has led to a densification of the built-up area, with a negative impact on residents' quality of life (Marian 2018).

According to the 2002 Zonal Urban Plan, the area under study is part of L3 - a subzone of medium-sized collective dwellings (3-4 levels) located in predominantly residential complexes, with a BCR=40% and an FSI=1.0. As will be seen, the BCR is respected, while half of the constructions exceed the FSI set by the ZUP. As seen in Table 2, the values measured for the BCR are under the maximal size, but the FSI exceeds the maximal size imposed by the ZUP.

Table 2. *The calculation of urban indicators for the Floreasca case study*

Plot (figure 6)	*Total Surface (m^2)*	*Number of buildings*	*Built surface at ground (m^2)*	*Total built surface (m^2)*	***BCR***	***FSI***	***Height*** *(number of levels)*
01	12366	8	3625	11,33	**29.31**	**0.92**	**2/3**
02	10837	12	3577	10.73	**33.01**	**0.99**	**2/3**
03	11348	9	3163	9,489	**27.87**	**0.84**	**2/3**
04	16128	11	5111	17,88	**31.69**	**1.11**	**3/4**
05	14211	16	4883	17,09	**34.36**	**1.20**	**3/4**
06	14790	9	4713	17,67	**31.87**	**1.19**	**3/4**
Average	13280	11	4178	17,550	**31.35**	**1.04**	**3**

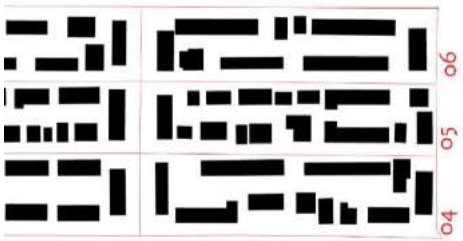

Figure 6. The study area of Floreasca.

3.4.2 Militari Residence, Bucharest

The construction of the complex started around 2010, but as can be seen in figure 8, it is still under construction. Although the name refers to the military district, the complex is actually located in the village of Roșu, which belongs to the town of Chiajna.

According to the Chiajna General Urban Masterplan (approved in 2015, according to the city hall website), for this area, the BCR is a maximum of 25%, the FSI of 1.75 and the maximum building height of 6 floors. As shown in Table 3, these values are far

exceeded by real estate developers, and the construction of new buildings continues.

Table 3. *The calculation of urban indicators for the Militari Residence case study*

Plot (figure 7)	*Total Surface (m^2)*	*Number of buildings*	*Built surface at ground (m^2)*	*Total built surface (m^2)*	***BCR***	***FSI***	***Height*** *(number of levels)*
01	30257	9	10925	96140	**36.11**	**3.18**	**8+m**
02	23904	5	7760	68288	**32.46**	**2.86**	**8+m**
03	17667	9	6881	61929	**38.95**	**3.51**	**8+m**
Average	23942	7.67	8522	17,550.33	**35.84**	**3.18**	**8+m**

Table 4. *The calculation of urban indicators for the Gheorgheni Neighbourhood case study*

Plot (figure 9)	*Total Surface (m^2)*	*Number of buildings*	*Built surface at ground (m^2)*	*Total built surface (m^2)*	***BCR***	***FSI***	***Height*** *(number of levels)*
01	46930	10	8265	55250	**17.61**	**1.18**	6.2
02	48235	11	6875	34375	**14.25**	**0.71**	4
03	27825	7	4716	40775	**16.95**	**1.47**	8.2
Media	40996.67	9.33	6618.67	43466.67	**16.27**	**1.12**	6.13

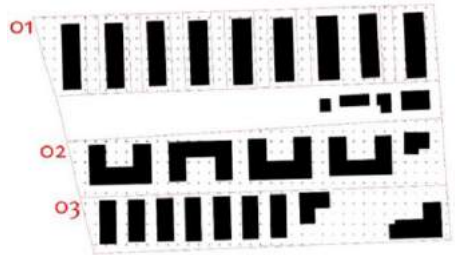

Figure 7. The study area of Militari Residence.

Table 5. *The calculation of urban indicators for the Bonjour Residence case study*

Plot (figure 11)	*Total Surface (m^2)*	*Number of buildings*	*Built surface at ground (m^2)*	*Total built surface (m^2)*	***BCR***	***FSI***	***Height*** *(number of levels)*
-	15330	8	5221	37180	**34.06**	**2.43**	7

Figure 8. Satellite image of Military Residence. Source: Google Maps 2019

3.4.3 Gheorgheni Neighbourhood, Cluj Napoca

Built in the 1960s in Cluj Napoca, the Gheorgheni district preserves the original urban plan, focusing on green spaces, recreational areas, and parks (figure 9 and figure 10). The General Urban Masterplan and the related local regulations result in a maximum BCR of 60%, a maximum FSI of 1.2, 1.5 for corner plots and a maximum building height of 26m.

Table 4 shows that the BCR used in this zone is much lower than the maximum allowed by the regulation, thus enabling multiple public open spaces, compared to the previous cases from Bucharest.

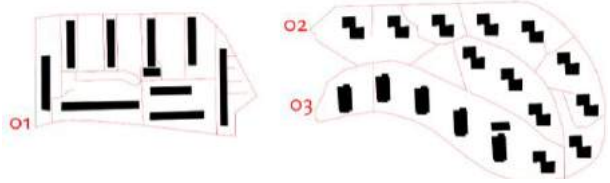

Figure 9. The plan of the case study of Gheorgheni Neighbourhood

Figure 10 . Satellite image of Gheorgheni Neighbourhood. Source: Google Maps 2019

3.4.4 Bonjour Residence, Cluj Napoca

Built around 2013, the Bonjour Residence complex is part of a residential area under development. From the General Urban Masterplan regulations, it results a maximum BCR of 35%, a maximum FSI of 1.2 and a maximum building height of 28 m. As shown in table 5, the BCR used is the maximum, but the FSI is double the maximum allowed.

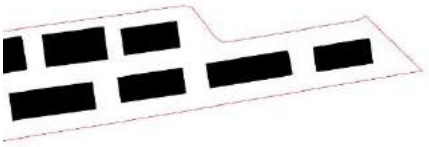

Figure 11. The plan of the case study of Bonjour Residence

4 Discussions and future research directions

The *building coverage ratio* and *floor space index* are defined by Law 350/2001 as "*specific urban planning tools for design control*". Although the FSI is not defined in GD 525/1996, it is mentioned by the methodological guide GM 007-2000 together with the BCR, alignment and building height as a set of mandatory values for urban planning. This highlights the importance of associating the indicators into a composite indicator such as *density* and not using them singularly.

Although the General Urban Planning Regulations contains minimal standards (Iancu, 2012), the setting of the values of urban indicators is based on these limits imposed by the GUPR and the decision of the urban planners that design the Local Urban Planning Regulations. In these Local Urban Planning Regulations of Romanian cities, it is generally observed the lack of obligations and fixed limits that Urban Zoning Plans cannot in the future modify. There are, however, a few General Urban Masterplans in which the Local Urban Planning Regulations have prohibited the change of some areas, and thus the urban indicators. Another observation is the lack of emphasis on maintaining the regulated urban indicators as a common good and positive impact on the community and the current emphasis on the profit of the real estate market (Moroni 2016).

The 2017 Seoul Biennale of Architecture and Urbanism had a theme that might seem inappropriate in the current urban context in Romania, but given the accelerated development of some of the cities, it should be put into question: 'The Imminent Commons' (Zaera-Polo and Anderson 2017). Although the themes that have been addressed in the Seoul Biennale focus on the problems faced by a major metropolis in the global economy, the hypothesis of the projects presented can easily be applied to the Romanian local context: how the development and evolution of architectural and urban planning practices reflect on the quality of urban life.

The present research does not touch on such complex issues presented in the biennial, such as the access to urban open data as a common good to be used towards understanding and studying urban processes or the re-use of thermal energy generated by urban activities such as air conditioning systems, food industry, etc. However, the aim is similar: bringing awareness that the development process of Romanian cities should not be seen only as a right and private good of some investors without any moral obligation towards the city, implicitly and the community, in which they build. The fact that urban planning regulations are or are not respected will impact the city's inhabitants, whether they perceive it or not. As a result, the development of Romanian cities should be understood as an *'imminent' common good*. In this context, compliance with urban planning indicators should be first a matter of ensuring the common good for the inhabitants of the area and then achieving maximum private profit for the investors.

Acknowledgements

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University of Architecture and Urban Planning, Bucharest.

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Authors addresses: *Teodora, UNGUREANU, PhD student, "Ion Mincu" University of Architecture and Urban Planning, architect at NIRD URBAN-INCERC, email: teodora.ungureanau123@gmail.com*

Investigation of the effect of green manuring on mineral nutrient uptake in organic farming

Zsuzsanna Uri[1] - Szabolcs Vigh[1] - Béla Szabó[1] - Edit Kosztyuné Krajnyák[1]*

Abstract: *An open-field large plot green manuring experiment was set up during in 2017 at Ferenctanya-Nyírtelek Educational Farm of the University of Nyíregyháza (Hungary) on an area under organic farming. In our research, we applied secondary seeding green manures and mixtures of green manures. Mineral nutrient uptake and kernel yield of hybrid sunflower was studied. The essential nutrients uptake of sunflower was influenced differently by green manures. The concentration of nitrogen of sunflower after TillageMix Attila N seven-species green manure mixture incorporation showed significant differences among treatments, with higher values associated with legume presence compared to other green manure treatments and the control. The untreated control plot yielded the highest yield of sunflower. Similar yields were achieved only in the area treated with TillageMix Attila N cover crop mixture. The application of multi-component green manure mixtures was more efficient than that of mono-component, but the green manure treatments are not brought the expected results. The immediate yield-increasing effect of single sowing of green manure crops cannot be justified.*

Keywords: green manure, cover crops, organic farming, organic sunflower cultivation, nutrient uptake

1 INTRODUCTION

In fact, green manure is one of the natural fertilizers which manure is most associated with organic farming. Soil fertility is a primary factor influencing the yield and quality of organic crops and a key to the sustainability of organic farms. Green manures, a type of cover crop are sown primarily for the purpose of improving soil fertility. However, green manures are multifunctional, and can provide many benefits. Green manure is a kind of locally produced organic fertilizer. Green manure crops are usually fast-growing plants. Their foliage smothers weed and their roots prevent soil erosion. Green manures can provide an opportunity to break pest and disease cycles in rotations crops. Cover crops can add to the biodiversity of agroecosystems by promoting habitat for natural enemies. They improve soil structure and return valuable nutrients to the soil. The average amount of nitrogen accumulated by leguminous plants can completely replace the mineral nitrogen fertilizer in addition (Aranyi - Sztahura, 2018; Gyuricza, 2008; Rayns - Rosenfeld, 2010).

A good green manure plant is a herbaceous plant, has a short growing season, requires little water for germination and initial development, gives a fast growth, has lots of biomass, richly and deeply rooted, covers the soil, good nutrient releases and mobilization, seed costs is low. Different crops have different benefits, and can be grown in combination. Growing multiple green manure plants together can support a range of benefits over single-component manures (Aranyi - Sztahura, 2018). When choosing the composition of mixtures of green manuring, it is important to consider crop rotation, soil type, climatic conditions and the purpose to be achieved with green manure (Aranyi - Mándiné, 2017; Aranyi, 2018).

Nutrient management of organic farming system relies on crop rotation, crop residues, animal manures, legumes, green manures and on-farm wastes. Yields in organic farming are lower than chemical farming during initial years of practice and it takes a few years to stabilize the yields. Organic farming systems are depleted of nitrogen, but testing a soil sample can help determine the need for supplemental nitrogen amendments. One of the strategies of organic grower use is to grow early maturing crops like cereals the year before sunflowers, and grow a cover crop of a fast-growing annual legume directly after grain harvest (Reddy, 2020).

The aim of our research is to investigate the effect of various cover crops on crop yield, and macro- and micro-nutrient uptake of sunflower in organic farming system.

2 MATERIAL AND METHODS

An open-field large plot green manuring experiment was set up during in the fall of 2017 at Ferenctanya-Nyírtelek Educational Farm of the University of Nyíregyháza (Hungary) on "Kovárvány" brown forest soil (sandy forest soil with interstratified layers of colloid and sesquioxide accumulation). The most important physical and chemical characteristics of the soil of the experiment are reported in Table 1.

In our research we used cover plants marketed by Démétér Biosystems Bt. The criteria for selecting cover plants were C/N ratio, fix of nitrogen, cold resistance, drought tolerance and weed suppression. The one-component product, Global Sunn, is composed of sunn hemp (*Crotalaria juncea* L.), which as a leguminous plant, it fixes a significant amount of nitrogen (140-160 N kg/ha/60-70 days). It is drought tolerant, it develops rapidly in warm, dry soils. It produces 5-6 t/ha of green mass during the growing season. It protects the soil from erosion. It suppresses weeds. It suppresses nematodes. Tillage Radish is composed of daikon radish (*Raphanus sativus* L. var. *longipinnatus* Bailey), which produces significant amounts of roots and above-ground green shoots. The root, which reaches up to 1.5 meters, effectively uptakes and stores nutrients (nitrogen,

potassium and sulphur). It effectively breaks compacted soil layers, performing soil loosening instead of machines. It suppresses autumn weeds. It decomposes rapidly in the spring, delivering stored nutrients to the following main crop. TillageMix Tas (2017) is a five-component summer green manure mixture, of which 30% is buckwheat (*Fagopyrum esculentum* L.), 30% is Sudan grass (*Sorghum sudanense* (L.) Piper), 25% is sunn hemp (*Crotalaria juncea* L.), 7.5% is daikon radish (*Raphanus sativus* L. var. *longipinnatus* Bailey) and 7.5% cow pea (*Vigna unguiculata* (L.) Walp.). TillageMix Attila N (2017) is a seven-species, cold resistant, long-growing season green manure mixture, of which 26% is rye (*Secale cereale* L.), 20% faba bean (*Vicia faba* L.), 20% field pea (*Pisum sativum* subsp. *arvense* L.), 16% hairy vetch (*Vicia villosa* Roth.), 12% crimson clover (*Trifolium incarnatum* L.), 4% oil radish (*Raphanus sativus* var. *oleiferus* L.) and 2% white clover (*Trifolium repens* L.) (Démétér Biosystems Bt., 2019).

Table 1. The most important soil characteristics of the experiment

Soil characteristics	Measured quantity in soil samples taken from a depth of 0-20 cm
pH(KCl)	6.15
KA	34
Humus (%)	1.67
Total water-soluble salt (%)	< 0.02
$CaCO_3$ (%)	< 0.1
KCl-NO_3-N (mg/kg)	2.59
AL-P_2O_5 (mg/kg)	60.4
AL-K_2O (mg/kg)	159
KCl-Mg (mg/kg)	177
KCl-SO_4 (mg/kg)	95.4
EDTA-Cu (mg/kg)	6.02
EDTA-Mn (mg/kg)	307
EDTA-Zn (mg/kg	2.16
AL-Na (mg/kg)	36.5

KA = Sticky point (upper limit of plasticity) according to Arany

In our experiment sunflower (*Helianthus annus* L.) hybrid - LG 54.92 HO CL - was grown, which is mid-season maturing. It contains high levels of oleic acid (85-90%). The hybrid has a good overall disease resistance, which is broomrape and mildew resistant (LG Seeds Magyarország, 2019).

In open-field large plot green manuring experiment, was set up five plots of 1.4 ha each, with 4 replications. In four of the five plots were green manuring, and leaving an untreated (without cover plant) control (with stubble stripping). The preceding crop was triticale. The green manure was sown in August and September 2017. In April 2018, the green manure plants were disked into the soil and the seedbed was prepared. Sunflower hybrid was sown on May 7, 2018, and was harvested in September 2018.

Plant samples were taken to study the nutrient uptake of the hybrid sunflower. The first sampling took in the 6-8 leaf stage of the sunflower plant (on June 15, 2018), the complete plant was sampled. The second sample was made when the sunflower was flowering (on July 11, 2018), and the first full-grown leaf under the flower was cut off. The nutrient contents of the sunflower hybrid were determined in the accredited laboratory of SGS Hungária Kft. in Nyíregyháza. To study the yield, at harvest (in September 2018), an average sample was taken from the sunflower kernels per plot.

3 RESULTS AND DISCUSSION

1.1 Effect of green manures on the concentration of essential nutrient elements of hybrid sunflower

1.1.1 Effect of green manures on the concentration of essential macro- and micronutrient elements of hybrid sunflower in the 6-8 leaf stage of the sunflower plant

Figure 1 shows the concentration of essential macroelements (N, P, K) in the above-ground shoots of sunflower hybrid grown in a green manuring experiment, in the 6-8 leaf stage of the sunflower (on June 15, 2018). It was found that the mineralization of organic matter and subsequent N release after incorporation of TillageMix Attila N seven-species green manure mixture in soil showed the highest nitrogen uptake and Global Sunn the lowest. However, the potassium uptake was the highest in the case of control. The phosphorus uptake of sunflower in the 6-8 leaf stage of plants did not differ among treatments (Figure 1).

Figure 2 illustrates the concentration of essential microelements (B, Cu, Fe, Mn, Zn) in the above-ground shoots of sunflower hybrid grown in a green manuring experiment, in the 6-8 leaf stage of the sunflower (on June 15, 2018). A significant difference in the content of essential micronutrients in sunflower was observed between the treatments in the samples taken in the 6-8 leaf stage in the case of Fe under the effect of the TillageMix Attila N cover plant mixture (Figure 2).

1.1.2 Effect of green manures on the concentration of essential macro- and micronutrient elements of hybrid sunflower during flowering of the sunflower plant

Figure 3 shows the concentration of essential nitrogen, phosphorus and potassium in the leaves of sunflower hybrid grown in a green manuring experiment, when the sunflower was flowering (on July 11, 2018). No significant difference was found in the macroelements content of sunflower leaves between the treatments. Comparing the treatments, the highest N content was measured on the plot treated with TillageMix Attila N green manure, where the N concentration of sunflower leaves was 2.80% by weight

(Figure 3). This was probably due to several leguminous plants in the multi-component green manure mixture.

The concentrations of essential microelements (B, Cu, Fe, Mn, Zn) in the leaves of the sunflower hybrid at the time of flowering of the sunflower plant (on July 11, 2018) are shown in Figure 4. The most significant difference in the content of essential micronutrients in sunflower was observed among treatments in the samples taken during flowering in the case of Mn under the effect of Global Sunn green manure (Figure 4).

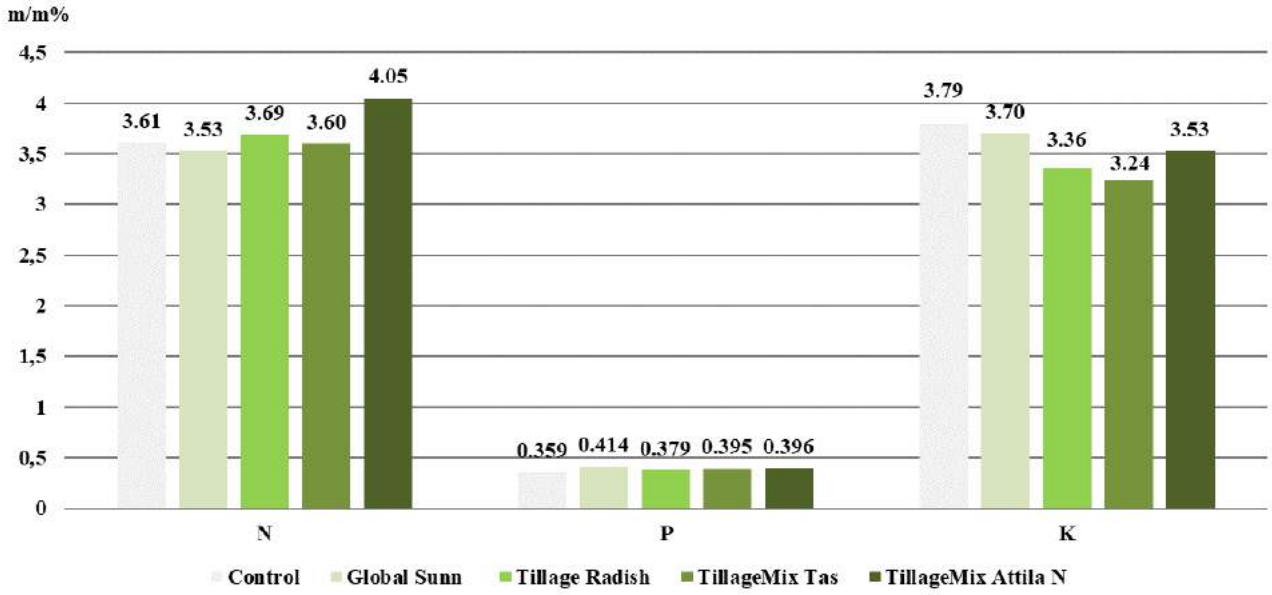

Figure 1. Effect of green manures on the concentration of essential macroelements of the complete sunflower plant in the 6-8 leaf stage (Nyírtelek-Ferenctanya, Hungary, 2018.06.15.)

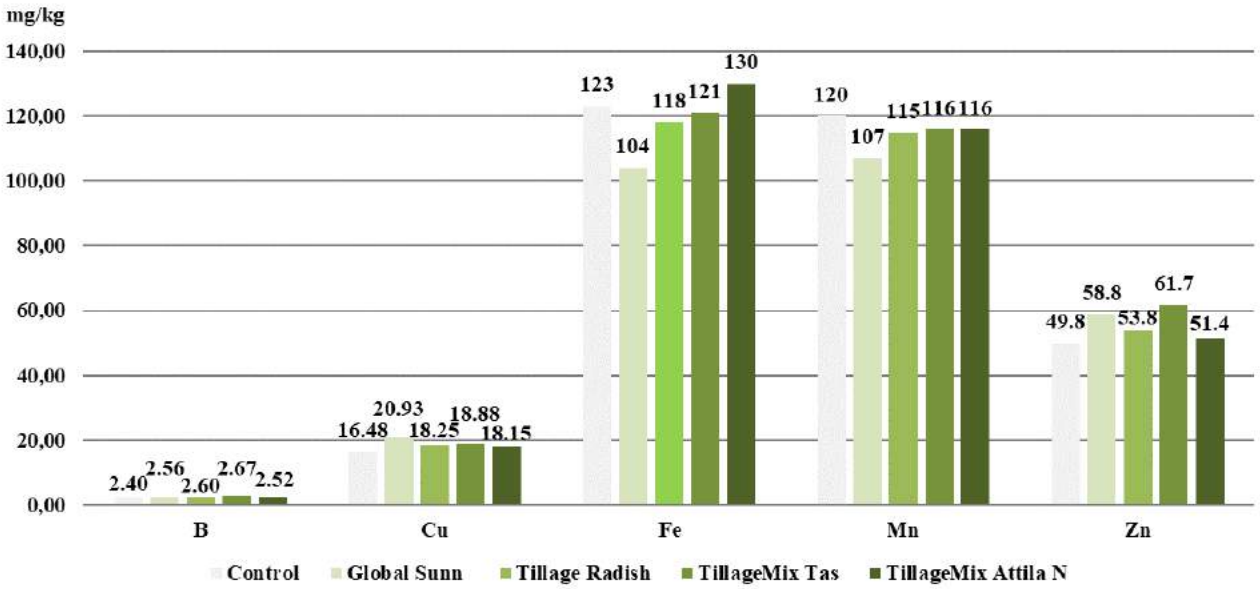

Figure 2. Effect of green manures on the concentration of essential microelements of the complete sunflower plant in the 6-8 leaf stage (Nyírtelek-Ferenctanya, Hungary, 2018.06.15.)

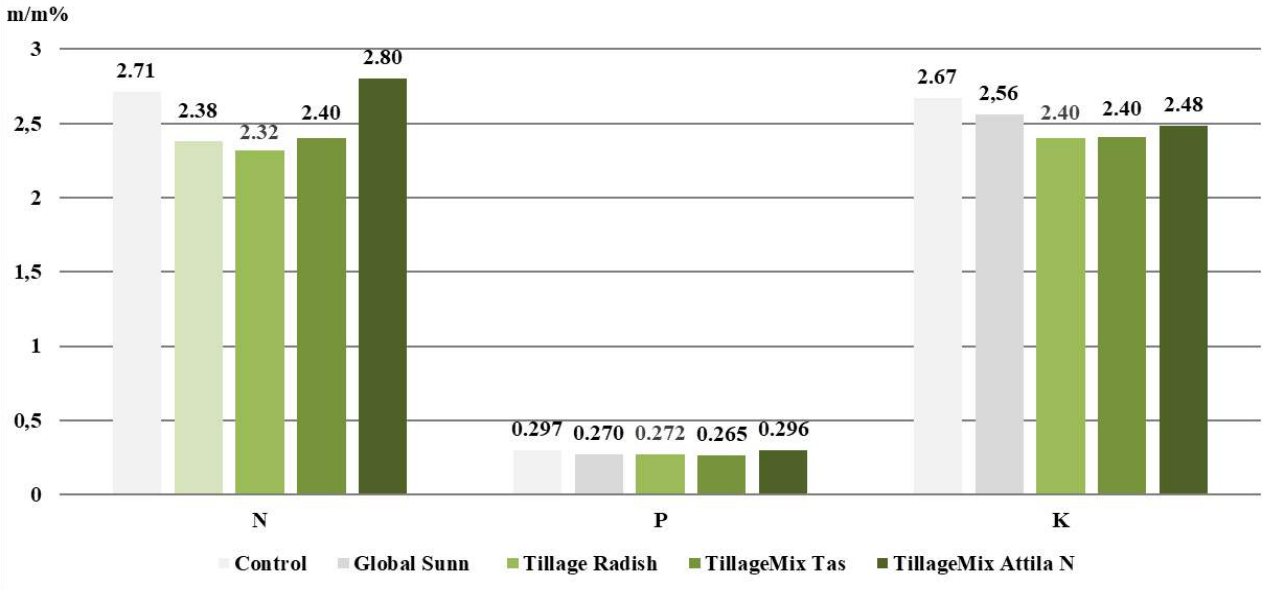

Figure 3. Effect of green manures on the concentration of essential macroelements in the leaves of sunflower (Nyírtelek-Ferenctanya, Hungary, 2018.07.11.)

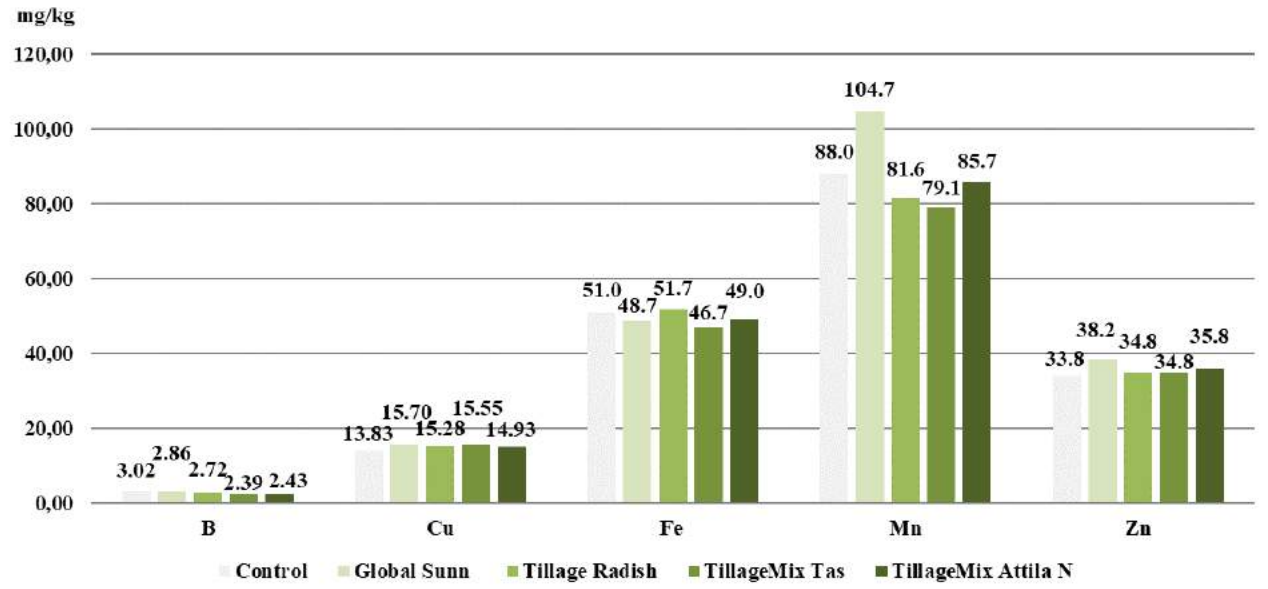

Figure 4. Effect of green manures on the concentration of essential microelements in the leaves of sunflower (Nyírtelek-Ferenctanya, Hungary, 2018.07.11.)

1.2 Effect of green manures on yield of hybrid sunflower kernels

Figure 5 illustrates the yield of sunflower hybrid kernels grown in a green manuring experiment. It was found that the untreated control plot reached the highest yield average of 2.61 t/ha. A similar yield to the control was obtained with the TillageMix Attila N green manure mixture (2.48 t/ha). One-component green manures reduced the yield of sunflower hybrids the most to the control. After Global Sunn, 2.10 tons of sunflower was grown per hectare. The effect of Tillage Radish was produced kernels 1.94 tons per hectare (Figure 5).

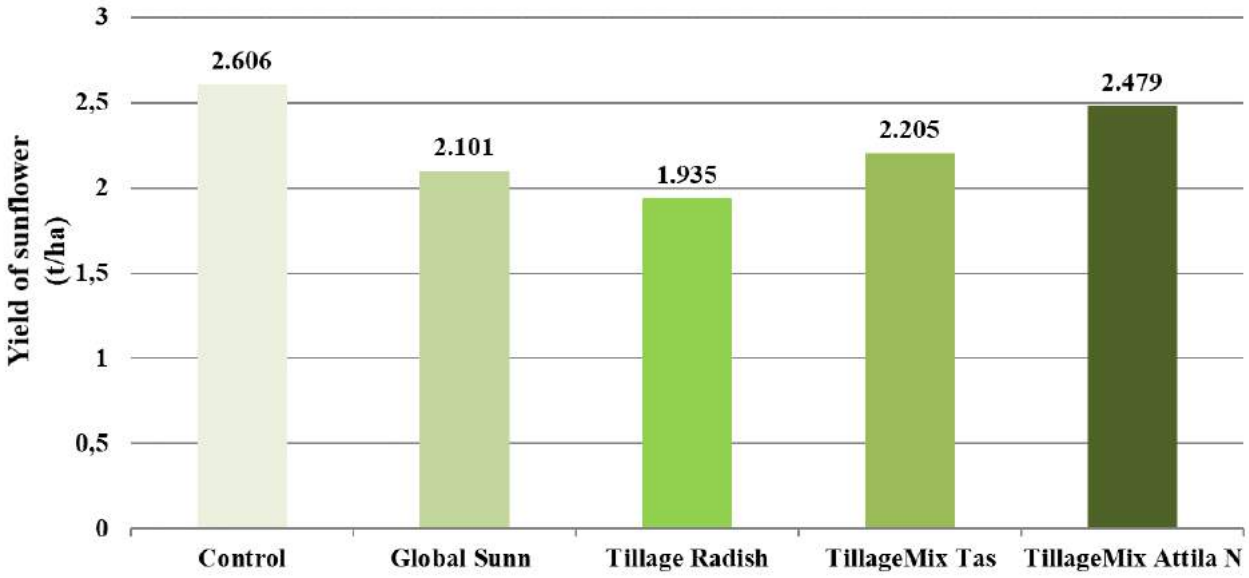

Figure 5. Effect of green manures on yield of hybrid sunflower (LG 54.92 HO CL) kernels in a green manuring experiment (Nyírtelek-Ferenctanya, Hungary, 2018.09.)

4 CONCLUSIONS

The success of green manure application is influenced by several factors, including the annual ecological factors. Under unfavorable weather conditions, green manures have no yield-increasing effects, despite higher amounts of green biomass applied to the soil. In our case, the biologically-bound nutrients were presumably slowly mobilized because of the poor rainfall conditions; therefore the mineral nutrients could not be fully available for the sunflowers.

Of the green manure crops and green manure mixtures tested, TillageMix Attila N seven-species green manure mixture exerted the maximum beneficial effect on sunflower yield and N uptake due to several nitrogen fixers in green manure mixture.

The use of multi-component green manure mixtures was more effective than single component. Sowing of cover crop mixtures has many advantages over pure sowing, as the benefits of various plant species are utilized at the same time.

It should be pointed out that accurate evaluation of the advantages and disadvantages of green manure crops and their management should be carried out not only taking into account following cash crop productivity but also the effects on soil fertility dynamics (Mazzoncini et al., 2004).

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Authors addresses

[1]Zsuzsanna Uri, University of Nyíregyháza Engineering and Agricultural Sciences Institute, Kótaji Str. 9-11, P.O.Box.166 4400 Nyíregyháza, Hungary, Phone: 00-36 -42-599-400, e-mail: uri.zsuzsanna@nye.hu

Contact person

[*]Zsuzsanna Uri, University of Nyíregyháza Engineering and Agricultural Sciences Institute, Kótaji Str. 9-11, P.O.Box.166 4400 Nyíregyháza, Hungary, Phone: 00-36 -42-599-400, e-mail: uri.zsuzsanna@nye.hu

Spectrophotometric analysis of plum jams

Szabolcs Vigh[1,*] - Nikoletta Kovács-Paulusz – Tamás László Sinka

Abstract: *One of the most important tasks today is to provide the growing population with the right amount and quality of food. With the help of the food we eat, we supply our body with the necessary quantity and quality of nutrients, which significantly affects our well-being as well as our longevity. Dietary fiber helps in the smooth functioning of the digestive system. Healthy food is rich in protein, carbohydrates, fats, minerals and vitamins. Regular consumption of foods with inadequate nutrients can have serious health effects. Analytical measurements were performed mainly on plum jam products from conventional and organic farming. In our experiments, the flavonoid, polyphenol and anthocyanin concentrations of the jams were determined.*

Keywords: plum, organic, flavonoid, polyphenol, spectrophotometer

1 INTRODUCTION

1.1 Importance of plum

It is an extremely nutritious fruit due to its exceptionally high sugar content. The organic acids in them help digestion. Among the content values, the vitamin content of plums is low. It contains the highest amounts of vitamins B1 and B2, as well as significant amounts of minerals and organic acids. Plums are characterized by particularly high dry matter and carbohydrate contents, high fiber content, pectic and tartaric acid content, energy content and medium acidity. Despite these positive properties, it is low in vitamin C and other vitamins are easily degraded by high temperatures. The ripening time of the plum can also significantly influence the development of the content characteristics, because the later the ripening of the variety, the higher the dry matter and sugar content and the lower the acid content. Plum has a blood cleansing and salivating effect, helps with proper muscle growth and regeneration of red blood stains, and increases blood plasma due to the high amount of potassium in plums. Due to its beneficial effects, it is especially recommended for patients with liver and kidney problems, as well as for patients with rheumatism, gout and atherosclerosis (Megyeri, 2014; Tóth and Surányi, 1980).

Plums are also rich in vitamin E, which offers protection against oxidation damage and functions at the same time with other essential nutrients, like fatty acids and vitamin A. Prunes contain a higher percentage of fiber than fresh plums. The fiber helps to protect against a series of disorders of the alimentary canal (smooth and effective laxative), including the intestine cancer. Plums also contain minerals: potassium, phosphorus, magnesium, calcium and iron, which are very important for health (Pree Birwal, 2017).

After drying, the plum leaves have an antipyretic and diuretic effect. Excessive consumption may cause convulsions and diarrhea. Plum kernels give plum brandy a characteristic almond-like taste, which can be attributed to the hydrogen cyanide content released during the decomposition of amygdalin (Tóth and Surányi, 1980). Only high-quality and ripe fruit, in which the aromas and flavors have been fully developed, can be used to make the jams. Plum jam may be made without the addition of sugar with a dry matter content of 52 to 55% or with the addition of a maximum of 15% sugar with a dry matter content of 54 to 57%. Blue plums are used to make the jam, other varieties may be used up to a maximum of 10% (eg. white or red plums) (Bognár, 1975).

1.2 Polyphenols

Polyphenols are chemically very diverse molecules. These are secondary metabolites that are synthesized by plants and of which more than 8,000 species have been identified (de Rijke et al., 2006). Polyphenols are compounds that link aromatic rings (p-coumaric acid) or multiple hydroxyl groups. Polyphenols can be divided into two groups: one group is flavonoids, the other group is non-flavonoids, which can be benzoic acid, hydroxycinnamates, stilbenes, lignans, gallic acid tannins and gallotannins. Polyphenols play an important role in plant life as they also promote the pigmentation of flowers, fruits and seeds. Almost all biotic and abiotic stresses can increase their concentration on vegetative shoots, roots and fruits. In vitro test systems have shown that polyphenols have antioxidant capacity, and the number and location of hydroxyl groups that act primarily as H donors may enhance the antioxidant activity of polyphenols However, polyphenols also contribute to the regulation of redox processes in humans and animals (Cao et al., 1997; Shekher Pannala et al., 2001).

1.3 Flavonoids

Flavonoids, which belong to the subclass of polyphenols, are components that have no nutritional value for the human body. Polyphenols are also found in fruits, vegetables, wines, tea and cocoa beans. Their physiological effects and chemical structure have been studied in several decades, which confirmed the antioxidant, anti-inflammatory, anticarcinogenic, antiallergic, antibacterial, hepatoprotective, antithrombotic, antiviral and estrogenic activity of flavonoids (Wang et al., 2003).

The approximately 5,000 different flavonoids currently known are characterized by a carbon backbone in a C6-C3-C6 ring, where the two benzene rings (A and B) are attached via a heterocyclic pyran or pyrone ring (C) containing an oxygen atom (Bravo, 1998). Flavonoids can be classified into seven subclasses based on the bonding of rings B and C and the oxidation status and functional group of ring C (Table 1.) (Beecher, 2003; Szekeresné, 2014).

One of the most commonly tested compounds is quercetin, which has been shown to be antimutagenic and anticarcinogenic in a number of studies. Quercetin reduced the viability of "triple-negative" breast cancer cells in a time- and dose-dependent manner by stopping the cell cycle by modifying FOXO3A (a gene). This type of cancer is one of 17 subtypes of breast malignancies in which the malignant cells do not contain two types of hormone (estrogen and progesterone) and growth factor (HER2) receptors. Discovery is of paramount importance because of the aggressiveness of this type of cancer, as it is more likely to metastasize to other organs than other types of breast cancer (Nguyen et al., 2017).

Table 1. Flavonoid subclasses, food flavonoids and food sources (Beecher, 2003; Szekeresné, 2014)

Flavonoid subclass	Prominent flavonoids	Foods rich in flavonoids
Flavanols	Catechin Gallocatechin Epicatechin Epigallocatechin Epicatechin-3-gallate Epigallocatechin 3-gallate	Teas, red grapes, red wine
Flavanons	Eriodictyol Hesperetin Naringenin	Citrus fruits
Flavons	Apigenin Luteolin Crysin	Green leaf spices e.g. parsley and fruit peel
Isoflavons	Daidzein Genistein Glycitein Biochanin A Formononentin	Soy, legumes
Flavonols	Isorhamnetin Kaempferol Miricetin Quercetin Galangin	Commonly found in food
Flavanonol	Taxifolin	Citrus fruits
Anthocyanins	Cyanidin Delphinidin Malvidin Petargonidin Petunidin Peonidin	Red- and blue berries, cranberries, currants

In addition to the significant anticarcinogenic effects of flavonoids, procarcinogenic properties are also observed, which is supported by rat experiments. Studies have shown that 0.1% of dietary quercetin caused intestinal and bladder carcinoma in rats, as well as an increased incidence of liver tumors. Other experiments have shown that consumption of high-dose (5% flavonoid in the diet) quercetin in male rats for 2 years increased the rate of development of renal tumors, whereas short-term, lower-dose consumption did not cause adverse effects (Pamukcu et al., 1980; Dunnick and Hailey, 1992; Lugasi, 2001).

1.4 Anthocyanins

Anthocyanins are common glycosides in the plant world that are highly soluble in water and have inducing properties. The pigments that cause this type of color change in plants were named anthocyans and later changed to anthocyanins. These compounds are plant dyes that are also found in flower petals, fruits, peelings, and leaves. Three groups are distinguished: pelargonidine-chloride → orange; cyanidin-chloride → red color; dolphinidine-chloride → blue color. The only difference between the three groups is the number of hydroxyl groups attached to the phenyl group. When carboxylic acids other than anthocyanidin chloride and monosaccharide are formed during the hydrolysis of hydrochloric acid, they are called complex anthocyanins. Anthocyanins, which are common among plants, are crystalline compounds that are highly soluble in water but insoluble in hydroxyl-free organic solvents (such as benzole). Anthocyanin chlorides are poorly soluble in aqueous or alcoholic solutions. The colors caused by anthocyanins also depend on pH. For example, an aqueous or dilute acidic solution of cyanidine-chloride is red when the pH is 3 or less. A violet color develops when the pH is 8. At pH 11, the solution is blue. The change in flower petals depends on the pH of the cell fluid. The red color depends on the presence of the cyan cation, while the blue color depends on the cyanine phenolate. The coloration of the petals depends on the co-pigments or aglycone substituents present. Temperature, light, and pH also affect color development. It is found in nature bound to a sugar molecule, which increases solubility and inhibits degradation (Tarr, 2002).

There are more than 300 types of anthocyanins in nature and they have many beneficial physiological effects, such as: protective effect, blood sugar lowering effect, inactivate enzymes that damage connective tissues, they repair the defective proteins found in the wall of the vessel, anti-inflammatory effect, enhance the II. types of collagen production, inhibit metalloproteases responsible for skin aging, which are responsible for breaking down collagen and elastic fibers, protect against UV radiation, they can also be effective against cancer. The type of anthocyanin formed is also affected by plant variety, temperature, humidity and soil quality.

Each plant produces several types of anthocyanins, and there are few plants that can synthesize only one type of anthocyanin (Boniface, 1996).

2 MATERIALS AND METHODS

The plum jams required for the experiments were obtained from three different locations. All three jams were made in 2018. The plum varieties used for the jams were „Besztercei" and „Stanley".

The first jam is homemade plum jam. The second jam can be bought in the shop of Nyíregyháza EKO Konzervipari Kft. The third jam is a product made from organically grown plums, which was purchased from the Farm of the University of Nyíregyháza. The „Besztercei" plum variety was used for the home plum jam, the „Besztercei" and „Stanley" varieties for the organic plum jam, while the plum variety used for the shop jam is unknown. The „Stanley" variety is grown to a greater extent on the farm, so this variety has been used in greater quantities during processing.

Fig. 1. Factory and homemade jam used in the test (own picture)

2.1 Preparation of plum jams

During sample preparation, 2.00 g of plum jars were weighed into an 100 ml conical flask on an analytical balance. The jams placed in the flask were charged with 40 ml of 70% methanol, and the flask was then foiled and placed in an ultrasonic bath at 40 ° C for 30 minutes. The solutions were then filtered through a 0.45 µm filter. Three independent sample preparations and measurements were performed from each of the three jams.

Fig. 2. UV-VIS spectrophotometer (own picture)

2.2 Spectrophotometric methods on the plum jams

Analytical measurements were performed at the Agricultural and Molecular Research Institute of the University of Nyíregyháza. Double beam UV-VIS spectrophotometer was used to measure the light intensity.

2.2.1 Determination of total phenolic content

Total phenolic content was determined using the method developed by Singleton and Rossi (1965). Total phenolic content was estimated by the Folin-Ciocalteu colorimetric method, using gallic acid as a standard phenolic compound. 200 µl of extracts were added to 3000 µl of distilled water, 500 µl of Folin-Ciocalteu reagent and 2000 µl of sodium carbonate solution (15 g/100ml), and the mixture was allowed to stand for 20 min at RT. 4300 µl of distilled water was added and the absorbance was measured at 765 nm after 1 hour incubation period with the spectrophotometer (Perkin Elmer Lambda 35). The total phenolic contents were calculated from a calibration curve with 50, 100, 300, 500, 750 µg/ml points and the results were expressed as mg gallic acid equivalent per g dry weight. Each extract was measured in triplicate.

2.3.2 Determination of total flavonoids

The total flavonoid content of the extract was determined by the aluminium chloride colorimetric method following the procedure described by Dae-Ok Kim *et al*. (2003). We have made a reagent solution containing 5 ml (10g/ml) of aluminium chloride, 5 ml of KOAc (potassium acetate, 1M), 75 ml of methanol and 140 ml of distilled water (AS). 0.5 ml of the extract was mixed with 4.5 ml of AS, filtered (0.45 µm) and the absorbance was determined at 415 nm in the spectrophotometer (Perkin Elmer Lambda 35). The concentrations were calculated based on the equation obtained from the standard rutin curve (10, 40, 70, 100 µg/ml). Results were expressed as mg rutin equivalents. Each extract was measured in triplicate.

2.3.3. Determination of total anthocyanins

The total anthocyanin (TA) content was determined using an earlier described method (Lee et al., 2005). It detects the total monomeric anthocyanin concentration by the pH differential method. The method is a rapid and simple spectrophotometric application based on the anthocyanin structural transformation that occurs upon a change in pH (colored at pH1 and colorless at pH4). The standard solution was prepared by weighing 82.2 mg of cyanidin-3-glucoside chloride, dissolving in distilled water and diluting to a final volume of 1 L in a volumetric flask. 0.3 ml of extract was added to 2 ml of buffer (pH=1 or pH=4) and 1.7 ml of distilled water. Samples were filtered (0.45 µm), and absorbance recorded using a Perkin Elmer Lambda 35 spectrophotometer at wavelengths of 520 and 700 nm, for solutions at pH 1.0 and pH 4.5, respectively. Results

were expressed as cyanidin-3-glucoside (% w/w) equivalents. Total anthocyanin contents were calculated as follows:

$$TA_{(mg/L)} = \left(\frac{A * MW * DF * 10^3}{\varepsilon} \right) \div l$$

where: A = $(A_{520nm} - A_{700nm})_{pH1} - (A_{520nm} - A_{700nm})_{pH4}$; MW (molecular weight) = 449.2 g/mol for cyanidin-3-glucoside; DF = dilution factor; l = path length in cm; ε = 26 900 molar extinction coefficient, in L* mol^{-1} * cm^{-1}, for cyd-3-glu; and 10^3 = factor for conversion from g to mg. Each extract was measured in triplicate.

3 RESULTS AND DISCUSSIONS

Based on the results of the flavonoid test, homemade plum jam showed the best results. The average of the results obtained is 1.06 mg / g, which is more than twice the total flavonoid content of the factory and organic jams. In second place is the organic jam with an average flavonoid value of 0.47 mg/g, followed by a store-bought jam with an average value of 0.34 mg/g (Table 2.).

In the examination of the total polyphenol content, it can be stated that the homemade jam is the most prominent, with an average value of 2.62 mg/g. Like the total flavonoid content, the value of the organic jam is higher than that of the in-store jam. The average value obtained was 1.91 mg/g for organic jam and 1.01 mg/g for shop jam (Table 3.).

In the case of anthocyanin contents, it is clear, that the concentration of anthocyanin content in the homemade jam is barely detectable, and the anthocyanin content of the jam purchased in the store is practically 0. One of the reasons for this may be that the anthocyanin content is completely decomposed by heat treatment. In the case of organic plum jam, a higher anthocyanin value (0.06 mg/g and 0.11 mg/g) was obtained after the measurements. During the measurements, the result of homemade jam and factory jam was the expected value, as the total anthocyanin content of homemade jam is between -0.07 and -0.57 mg/g, while the result of factory jam is 0.01 mg/g and 0.00 mg/g (Table 4.).

Table 2. Total flavonoid content of plum jam

Plum jam	Absorbance value	Calculated concentration (µg/ml RUE)	Content (mg/g RUE)	Average (mg/g RUE)	Scatter
Homemade	0.190	54.6	1.09	1.06	0.03
	0.179	51.5	1.03		
	0.183	52.6	1.05		
Factory	0.059	17.6	0.35	0.34	0.01
	0.056	16.8	0.34		
	0.057	17.0	0.34		
Organic	0.079	23.3	0.47	0.47	0.01
	0.081	23.8	0.48		
	0.081	23.8	0.48		

Table 3. Total polyphenol content of plum jam

Plum jam	Absorbance value	Calculated concentration (µg/ml GAE)	Content (mg/g GAE)	Average (mg/g GAE)	Scatter
Homemade	0.199	134.7	2.69	2.62	0.10
	0.187	125.5	2.51		
	0.196	132.4	2.65		
Factory	0.091	51.6	1.03	1.01	0.02
	0.088	49.3	0.99		
	0.089	50.1	1.00		
Organic	0.144	92.4	1.85	1.91	0.06
	0.152	98.5	1.97		
	0.149	96.2	1.92		

Table 4. Total anthocyanin content of plum jams

Plum jam	Absorbance value (pH=1)		Absorbance value (pH=4)		A	Calculated concentration (µg/ml GAE)	Content (mg/g GAE)
	520nm	700nm	520nm	700nm			
Homemade	0.138	0.013	0.157	0.017	-0.02	134.7	2.69
	0.137	0.010	0.265	0.011	-0.13	125.5	2.51
	0.138	0.011	0.184	0.012	-0.05	132.4	2.65
Factory	0.049	0.003	0.049	0.005	0.00	51.6	1.03
	0.051	0.005	0.053	0.006	0.00	49.3	0.99
	0.049	0.005	0.050	0.006	0.00	50.1	1.00
Organic	0.094	0.013	0.064	0.006	0.02	92.4	1.85
	0.119	0.026	0.086	0.018	0.03	98.5	1.97
	0.102	0.018	0.081	0.011	0.01	96.2	1.92

4 DISCUSSIONS

The importance of organic products is becoming more and more widespread in everyday life, as its most prominent feature is that organic products are free from the various pesticide residues used in cultivation. Antioxidants (poliphenols, flavonoids, etc.) have a number of beneficial effects, mainly in the health of people. We can get the right amount into our body primarily with food of plant origin.

I observed the tests mainly on the products produced in different farming ways. The importance of organic products is becoming more and more widespread in everyday life, as its most prominent feature is that organic products are free from the various pesticide residues used in cultivation.

In the case of plum jam, based on the results of laboratory tests, we obtained the most favorable values for homemade jam, which is due to the high fruit content and presumably less plant protection work during cultivation, as pesticides were used only when very necessary. Due to the characteristic of home-made jam cooking, the heat treatment took a long time, as a result of which a significant part of the favorable content values could decompose. Overall, the flavonoid and polyphenol contents were the most favorable for this jam, while the anthocyanin concentration was the lowest, as this group of compounds was completely degraded due to the long cooking time. The results of the bioleacher were favorable during the measurements. The total anthocyanin content was measurable, the cooking was probably not done long enough, as a result of which we could measure positive values. Overall, the laboratory results of the factory jam were the most unfavorable. This is due to the fact that during the processing processes, the valuable content parameters are significantly reduced, regardless of the cultivation used.

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Authors addresses

[1]Szabolcs Vigh, assistant professor, University of Nyíregyháza, 4400 Nyíregyháza Sóstói str. 31/B., +36-42-599-400, vigh.szabolcs@nye.hu

Contact person

[1]Szabolcs Vigh, assistant professor, University of Nyíregyháza, Hungary, 4400 Nyíregyháza Sóstói Str. 31/B., +36-42-599-400(2368), vigh.szabolcs@nye.hu