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SZENT ISTVÁN UNIVERSITY
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Dear Reader!

I welcome you on the occasion of holding the most recent issue of the Hungarian Agricultural Research in your hand. As our faithful readers may have noticed, our journal has been renewed in both its contents and its appearance. We gave a new image for the paper, it has become more high-standard, clearly structured and colourful since the last issue. We received a lot of positive feedback that reinforces the editorial board in its ambition to present the most recent scientific results of Hungarian agriculture, institutions conducting scientific research, the characteristics of the Hungarian countryside with a scientific standard of demand, yet absorbable for the interested readers, too. We aim to not only enumerate the results of Hungary but also to step outside the borders, and to create a publishing opportunity for the Hungarians in the Carpathian Basin. In this issue, colleagues of the University of Timişoara (Temesvár) publish an interesting study on their research at the Retezat National Park.

Therefore we would like that our paper could be typified by the same diversity as the Hungarian agriculture and countryside. The healthy rate of farm size, the structure of production, producing raw material for foodstuff and processing is a subject of continuous debate. I think that there is no way of monopolising any mean of usage among the diverse natural conditions of the Carpathian Basin, there are no exclusivities in either the farm size nor the intensity of production. In the Hungarian countryside, there is a place for both animal husbandry and plant cultivation based on big-sized technologies just as equally as for the products of small and medium family farms that encompass the whole product chain. But the sectors that can contribute to the recovery of the current production structure should be highlighted in agricultural research. Our effort to show the research results of animal husbandry, horticulture, food production and landscape studies in a more stressed way in our paper is already present in this issue.

I hope that our current issue can contribute to raise and strengthen the interest in the results of Hungarian agriculture.

By wishing a useful professional journey and reading,

Csaba Gyuricza
chief editor

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Cover photo: Buffaloes at Karcag (Apolka Ujj)

BIOGAS CONTROLLING SYSTEM TESTING WITH POULTRY FEATHER RECYLING

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ABSTRACT

Feather is produced in large amounts as a waste in poultry slaughterhouses. Only 60-70% of the poultry slaughterhouse products are edible for human being. The high protein content of poultry feather - dried feather contains 91% proteins (Salminen and Rintala 2002) - makes it an excellent raw material for biogas production. The keratin-content of feather difficult to digested, so physical, chemical and/or biological pre-treatment are needed in practice, which have to be set according to the utilization method. Chicken feather waste was enzymatic degraded, and then digested in anaerobic bioreactors in different ratio (0, 5, 7.5 and 10%). Cattle slurry, corn silage and mesophilic digestate was the control without pre-treated feather. The bioreactor system (4 digesters with 6 litre volumes) was controlled by an ACE SCADA software which granted pre-programmed measurement (pH, temperature, mixing, CH_4, CO_2, etc.). The produced biogas flows were filtered. Following the quantity measuring of the biogas, the gas was switched (doubled valve-system). The quality of the gas mixture was monitored continuously with custom created and periodically with MX42A gas-analyser (H_2S, NH_3).

Our main objectives were testing the new biogas controlling system, to determine the methane potential of feather waste and the most effective treatment ratios. Variance analysis with Tukey's test was applied to examine differences between the control and different treatments. Feather waste recycling with anaerobic digestion provides an environmentally friendly way of utilization.

keywords: biogas production, poultry feather, waste recycle

INTRODUCTION

In Hungary, only 10 high-capacity agricultural by-products and waste processing biogas plants were built in the least 10 years. Manure, slurry, plant by-products, energy plants are usually utilized as raw materials, but often is used food industrial by-products and wastes (Al Seadi et al. 2008). Feather is produced in large amounts as waste in poultry slaughterhouses. Only 60-70% of the poultry slaughterhouse products is edible for human (Hegedűs et al. 1998). Dried feather contains 91% protein (Salminen and Rintala 2002), the high protein content of poultry feather makes it an excellent raw material for biogas production. The problem is, that the keratin-content of feather difficult to degraded, so physical, chemical and/or biological pre-treatment are needed in practice, which have to be set according to the utilization method.

The quality and quantity of biogas is being monitored continuously throughout the process. The manufactured, pre-designed and commercially available software are not enough adaptable and their parameterization are not solved. Our main objectives were testing the new biogas controlling system, to determine the methane potential of pre-treated feather waste and the most effective treatment ratios. Quality and quantity of biogas production depend up on the feed stock characteristics (Tada et al. 2005) as well as on the digester operating conditions (Stafford et al., 1980). In the biogas plant the control and the monitoring are indispensable in case of certain parameters - such as pH, temperature and organic loading rate, mixing and biogas yields. Primary importance operates these parameters in an optimal interval to effectiveness operation of the biogas plant (Yadvika et al. 2004). The recent researches focused on the fermentation process controlling based on Fuzzy logic.

MATERIAL AND METHODS

The anaerobic degradation was examined in the Biodegradation Laboratory of the Institute, who the fermentation areas were 4 stainless steel digester (the volume was 6 l per each) in Incubators. In the incubator were used controlled thermometer probes (Pt100) and ventilators to ensure the optimal conditions (mesophilic: 38°C) *(Figure 1)* (Mézes et al. 2008). In 2010 the Institute's laboratory decided to use a new Compair ACE (Adaptive Control Environment) controlling

system for supervising experiments and collect process data for further analysis in a higher level than before and this permit of a knowledge-based process control implementation *(Figure 2).*

Figure 1: Incubators and custom created biogas analyser

As a part of this was the evaluation of CView SCADA (Supervisory Control and Data Acquisition) software and determination of the development trends (Tamás et al. 2012).

Pre-treatment of the chicken feather was occurred with *Bacillus licheniformis KK1* strain. The strain was isolated and identified by Kovács et al. 2002, Perei at al. 2004. Keratin degradation rate (%) was calculated from protein content of raw chicken feather and protein concentration of liquid culture filtrate (Mézes et al. 2014). The inoculum (Liquid digestate) was obtained from a large Hungarian Agricultural Biogas Plant. Batch-tests were carried out at mesophilic conditions (38°C) for 30 days. Mesophilic liquid digestate (2.2 kg), corn silage (0.2 kg), cattle slurry (2.6 kg) and pre-treated feather (0, 5, 10 and 20%) was added to the batch digesters *(Figure 3).* All experimental setups were performed in triplicates.

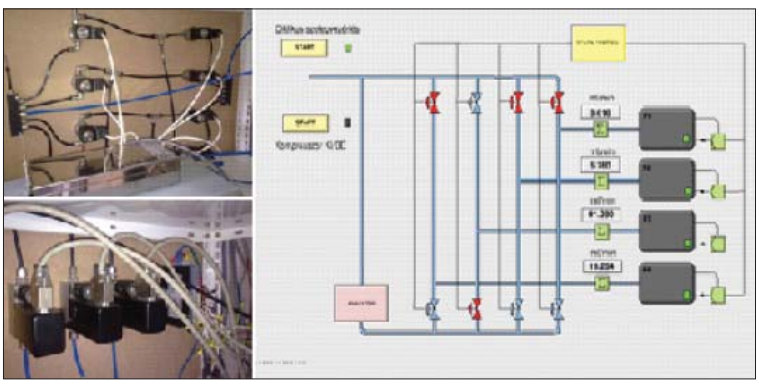

Figure 2: Digital implementation and mass flow controlling system of the anaerobic fermentation process

Figure 3: Batch anaerobic digestion with pre-treated chicken feather

Quantity parameters of raw materials were measured before setting up experiments, and after that was calculated a weighted average of dry matter- (DM %) and organic matter content (oDM %) by each the experiments *(Table 1).*

TABLE 1: Average DM and oDM (%) by different experiments

Digester number	1	2	3	4
Pre-hydrolysed feather%	0	5	7.5	10
DM%	3.9±0.5	3.7±0.6	3.7±0.4	3.6±0.4
oDM% in DM%	3.1±0.4	2.8±0.3	2.7±0.5	2.5±0.2

The highest DM and oDM (%) was calculated by the control experiment without hydrolysed feather. The DM and oDM (%) were determined according to the standard methods. Carbon and nitrogen content of raw materials were analysed by Elementar VARIO EL universal analyser. Hanna Instrument HI2550 multifunctional device was used to pH, ORP (mV), temperature (°C), EC (mS/cm), TDS (g/l), NaCl (%) measuring (measuring limit: 0-14±0.01 pH; ±999.9±0.2 mV; ±2000 ±1 mV; -20-+120°C±0.4; 0-500±1 mS/cm; 0-400±1 g/l; 0-400±1 %). Phosphate buffer (7.0) was obtained for pH setting from VWR International (USA).

TABLE 2: Quality parameters of biogas raw materials				
Raw materials	**Corn silage**	**Cattle slurry**	**Liquid digestate**	**Pre-treated feather**
DM%	26.00±2.73	3.60±0.52	2.80±0.91	19.94±1.36
oDM %	93.00±3.35	82.70±3.89	72.40±4.02	96.40±2.31
C:N ratio	27.60	13.00	18.00	1.47
C-content	45.80±0.87	40.40±2.40	47.30±2.07	15.09
N-content	1.70±0.29	3.10±1.21	2.60±0.25	10.26

TABLE 3: The pH values of liquid and solid digestate					
pH	**Liquid digestate**	**Liquid digestate**	**Liquid digestate**	**Solid digestate**	**Solid digestate (pH_{KCl})**
Sampling time	**1. day**	**10. day**	**30. day**	**30. day**	**30. day**
1. Digester	8.20	8.00	9.85	8.80	8.60
2. Digester	6.80	6.70	8.15	8.71	8.46
3. Digester	6.20	6.40	7.79	8.82	8.34
4. Digester	6.20	6.30	8.55	8.67	8.10

Variance analysis with Tukey's test and independent sample t-test was applied to examine differences between the control and different treatments by 5% significant level.

RESULTS

Analysis of biogas raw material and process of anaerobic digestion

The biogas raw materials were analysed before anaerobic degradation process *(Table 2).* Under these parameters were calculated the optimal DM, oDM (%) content and C/N ratio of the digesters. C- and N-content of biodegraded feather was also calculated (Mézes et al. 2014).

During the anaerobic digestion process was controlled the pH, conductivity (mS/cm), Total dissolved solid (g/l) and NaCl% content of the liquid digestate samples and after the digestion process liquid and solid digestate have been separated. The results of the analysis are shown the *Table 3, 4 and 5.*

After applying more than 7.5% of pre-treated feather ratio the pH was decreased intensively in the 1th day. Between the pH values was not detectable a significant difference by the liquid and solid digestate after 30 day *(Table 3).*

TABLE 4: Conductivity (mS/cm) values of liquid and solid digestate			
Conductivity (mS/cm)	**Liquid digestate**	**Liquid digestate**	**Solid digestate**
Sampling time	**1. day**	**30. day**	**30. day**
1. Digester	18.77	13.51	5.32
2. Digester	20.26	27.88	5.82
3. Digester	15.86	23.64	6.78
4. Digester	16.89	15.55	5.47

After the anaerobic digestion process could be detected three times higher conductivity values in liquid digestate than solid digestate *(Table 4).* In case of the liquid digestate the total dissolves solid values were also higher than in case of solid digestate.

Biogas production of biodegraded chicken feather

Upon the results of the experiments it can be stated the mixture rate of the raw material that contains both cattle slurry and poultry feather determined the biogas production significantly *(Chart 1).* Under mesophilic conditions the mixture rates of 5% result in a favourable production, the amount of the produced biogas (Nm^3 day-1) exceeded the values of the production at mixture rates of 7.5 and 10% by far (50%). The 5% mixture result the highest methane yield, the maximal value was 0.38±0.18 Nm^3 kg-1 DM, second was the control experiment (0.35±0.21 Nm^3 kg-1 DM) after 30 days, therefore did not show any significant differences between control and 5% experiments. Anaerobic digestion process of 7.5 and 10% mixture was stopped after 22 days despite the initial

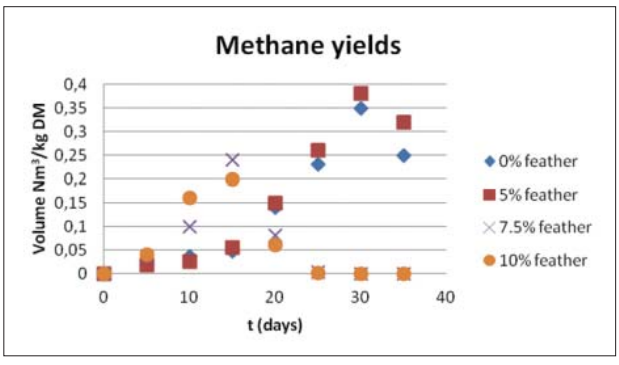

Chart 1: Methane production during co-digestion of different pre-treated feather ratio

high biogas yields. Under methane yields two groups could be selected. Control, 5% experiments and 7.5, 10% experiment showed significant differences.

Biogas quality analysis

The biogas quality in case of the poultry feather mixture rate of 5 showed better results and differed significantly from the rates of 7.5 and 10%. In case of treatments with a feather mixture rate of 5 methane concentrations around 60% stayed stabile *(Chart 2).*

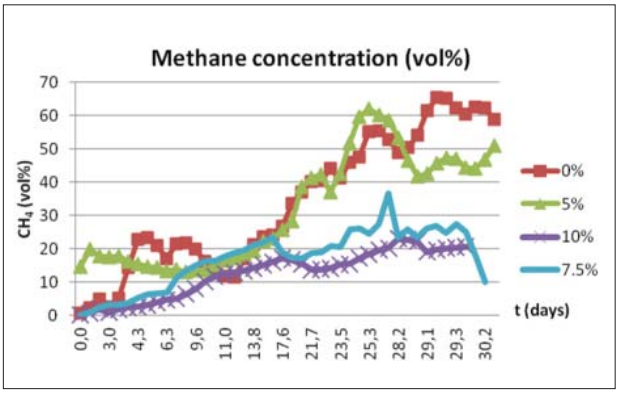

Chart 2: Methane concentration (vol%) production during co-digestion of different pre-treated feather ratio

The amount of H_2S – that has a corrosive effect and causes bad smell – was significantly increased in case of a feather mixture rate of more than 7.5% at the beginning of the fermentation and it affected the methane production negatively. In case of the mixture rates of 7.5 and 10 the hydrogen sulphide concentrations of the produced biogas – in contrast to the higher mixture rates – were more favourable and showed a significant difference in the first phase of the production.

Biogas controlling system

Adaptive fuzzy control of the biogas process was introduced. CH_4 and CO_2 proved to be most effective input indicator components and C/N ratio and NH_4 content can be controlled by fuzzy algorithm. The mean output variables, so the intervention parameters were temperature, mixing intensity and acid dosage.

IF/THEN fuzzy convention, which regulates external conditions of biogas production, was evaluated in case of temperature. Effect of different temperature on CH_4 and CO_2 production shows the *Figure 4.*

IF CH4	CO2	THEN DoS	Temperatures
high	very_low	0.90	very_high
very_high	very_low	1.00	very_high
medium	very_low	0.60	high
very_low	very_low	0.20	medium
low	very_low	0.20	high
very_high	low	1.00	very_high
high	low	0.90	high
medium	low	0.60	high
low	low	0.20	medium
very_high	medium	1.00	high
very_low	medium	0.80	low
medium	medium	0.50	medium
high	medium	0.50	high
low	medium	0.30	low
very_high	high	1.00	high
very_low	high	0.90	very_low
low	high	0.90	low
medium	high	0.60	low
high	high	0.50	medium

Figure 4: Effect of temperature on CH_4 and CO_2 production

DISCUSSION

Salminen and Rintala (2002) reported his study, that feather waste has 0.2 methane potential (m^3 kg-1 VSadded) and 0.05 methane potential (m^3 kg-1 wet weight). Comparison our results with his study, the pre-treated feather waste has higher biogas yields. Forgács et al. (2011) reported 0.35 Nm^3 kg-1 VS methane production of feather after biological pre-treatment with *B. licheniformis ATCC 53757* strain, which biogas yields were similar then our results.

The production of the hydrogen sulphide reached its maximal value (170 ppm) already on the 8th day in case of the 10% treatment. Regarding the ammonia content of the biogas it can be stated that the produced amount was significantly high in the first stage, because the most of the easily degradable nitrogen. After that this value decreased as the not so easily degradable forms were degraded. This process was more balanced. In the first stage of the ammonia production a significant difference could be revealed between the following groups: 0, 5 and 7.5% and 10% treatments. In the much more balanced ammonia-producing final stage three groups could be differed: 0% treatment build the first, and 5% was the second.

CONCLUSIONS

Positive effects on biogas production:

In our case 2.5% pre-treated feather ratio result in a favourable biogas production, the highest methane yield was 0.38±0.21 Nm^3/kg DM, second was the control experiment (0.35±0.18 Nm^3/kg DM) after 30 days. Control, 5% experiments and 7.5, 10% experiments showed significant differences, while the 7.5 and 10% was in the third group. These treatments showed a significant difference.

Negative effects on biogas production:

The produced biogas (Nm^3 day-1) exceeded the values of the production at mixture rates of 10% by far (50%). Anaerobic digestion process of 7.5 and 10% mixture was stopped after 22 days despite the initial high biogas yields. Due to the amount of produced hydrogen sulphide (ppm) the critical mixing ratio of feather proved to be 7.5% in laboratory environment. The production of the hydrogen sulphide reached its maximal value (170 ppm) already on the 9th day in case of the 10% treatment. Three treatments group could be selected in case of the highest ammonia concentrations (control and 5% and 7.5, 10%) which were detected after 18 days. Above 7.5% inhibitory effect was observed in case of produced ammonia.

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ROLE OF RELIABLE NIR LAB SERVICE IN THE MODERN DAIRY FARM WORK IN HUNGARY

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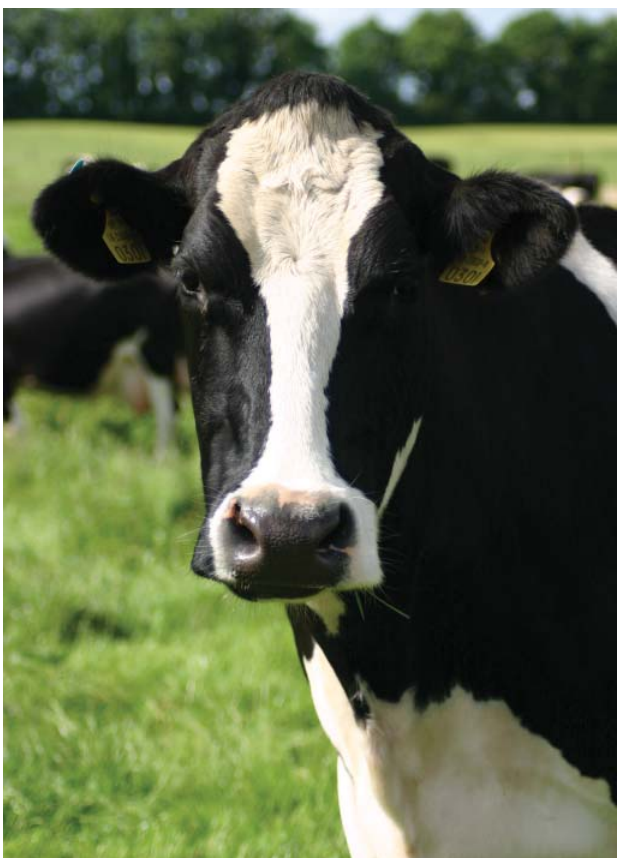
The modern dairy farms need fast, accurate and reliable forage data in order to maintain the herd good health status, reproductive performance and high milk production level even in variable environmental conditions. The forage nutrient content and fermentation quality are rather variable according to the harvest season, the phenological state, the silotype, the storage place et cet. So, regular quality control of the different forages (maize silage, lucerne silage, grass silage, whole crop cereal silages, mixed cereal-pea silages, grass and lucerne hays) is the fundament of sustainable milk production with the ability of quick and adequate reply for the forage quality changes. The quick forage results are essential to modify the TMR composition as quick as possible, when there is a serious metabolic disorder in the herd. There are a lot further developments in dairy nutrition worth to follow on our dairy farms. Recently, the TMR control is another aspect of the quality control and balanced nutrient supply of the dairy herd. The routine wet labs can not provide such important data as NDF rumen degradability, rumen degradable NDF, by-pass starch or digestible protein on time! These data can help us to prevent of our cows against (for example) high blood urea level, subclinical rumen acidosis, ketosis. Every farmers



know the importance of quick steps and detrimental effect of long term metabolic disorders on dairy herds.

Near InfraRed spectroscopy is a method that uses the near infrared region of the electromagnetic spectrum (from 780 nm to 2500 nm). The discovery of near-infrared energy is described by Herschel in 1800, but the first industrial application began in the 1950s, and application of NIRS on chemical analysis of feed samples began in the 1980s. Currently it is one of the most commonly used rapid methods to identify the chemical structure

of a feed sample and to check the purity of products. Nutrient content of samples is usually determined by conventional wet-chemical analysis, which determines separately each parameter (using different laboratory methods). This type of analysis is time-consuming, moreover, the accuracy highly depends on the technical condition of the laboratory and the person performing the test. The BLGG 'dry' forage NIR analyses is much faster than the conventional wet methods due to an extraordinary database established in the Netherlands. The BLGG AgroXpertus laboratory was established in 1928 by Dutch farmers. Currently it is one of Europe's leading independent laboratories with more than 80 years of experience in sampling, analytical and ruminant advisory activities. Besides the operation of the huge capacity wet-chemical laboratory, development of the NIR-technology began 20 years ago. Satellite laboratories of the BLGG can be found in Belgium, Germany, Denmark, Russia, Sweden, Spain, Kenya, Morocco, and in Hungary. The main profile of this European lab-network is the forage NIR analysis of different grass silages, maize silages, lucerne silages, whole crop cereal silages and hays. The 'European-wide'database and the special calibration method are based on millions of data. Tremendous value of this special database is that it contains wet-chemical analyses, *in vitro* degradability and digestibility data of nearly eight decades, currently from many regions for nine countries, covering lowland and upland areas, as well as wet and dry continental areas. And the size of the database: more than 200.000 samples/ year derived from nine countries. So, the latest analytical methods, fast and reliable results with a wide-range of parameters (20-30 independent parameters for one forage sample) are available now for the Hungarian farmers, feed manufacturers and distributors in an independent satellite NIR-lab at the LP Ltd. (Gödöllő, Hungary). The 'dry' NIR satellite lab established by the Livestock Performance Ltd at Gödöllő in 2012.

The new method is not only cheaper, but results are rather accurate and reliable. In this system the sample preparation is carried out by drying and grinding. As the drying and grinding are based on a uniform, standardized methodology, reliability of the analytical results is much higher than the analysis of fresh materials by the NIR device. Drying and grinding slightly slow down the process (report within 48 hours in Hungary), but they greatly improve the reliability of analytical results. Further steps are extremely fast. Scanning of a spectrum of a sample requires less than 30 seconds, so the operator of the NIR-device can process up to 100 samples in an hour. The resulting NIR-spectra are sent to The Netherlands central database by automatically, so samples do not need to be physically sent to Wageningen. Calibration is also done in a special way; it is based not on calibration curves, but a more precise mathematical method (a 3D-type method, it forms data from 500 analytical results closest to the sample). The analysis results are returned to the laboratory from Wageningen within 2 hours.

BLGG AgroXpertus has developed mathematical models to translate NIRS information into reliable data. In contrast to many commercially available global NIRS analytical models, BLGG AgroXpertus uses a model that works on the basis of local calibration. Global calibration, on one hand, involves a fixed calculation model. For this, all available information is used for each calculation to determine the parameter values of the unknown samples. Local calibration, on the other hand, has a computational model which focuses on the spectrum of the sample. Through an automatic search, this spectrum is combined with a number of spectra from the corresponding calibration set, that resemble the measured spectrum. For a good local calibration, hundreds

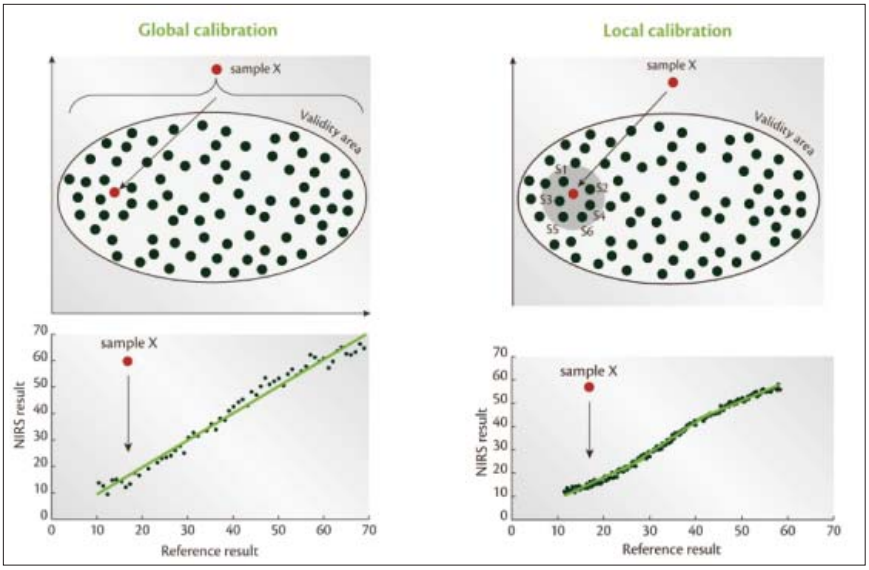


Figure 1: Comparison between global (left) and local calibration (right). The graphs show that the line representing local calibration better matches the measured points.

of similar NIR spectra are needed. These reference spectra are then entered into the computational model, together with the corresponding primary analytical data to calculate the different parameters for the unknown sample. This approach has the advantage of the calculation being accurate even when the relationship between the NIR spectra and an analysis feature is not linear.

This lab-network system also performs calibration services, so if one of the analytical data is out of normal range, then after posting the given sample to Wageningen, it is analyzed by wet-chemical analysis within one week. The same procedure applies to special feed samples because of season, age-group and regional impacts. BLGG AgroXpertus organizes ring-test (inter-laboratory calibration), and it validates its satellite labs, as well.

The system offers for the customers NIR packages (Standard and Profi package) containing parameters are relevant for the actual sample. The measured data by NIR in the Profi package depends on the forage sample, but generally are the followings: dry matter, crude protein, crude fat, crude fibre, crude ash, NDF, ADF, ADL, sugar, starch, by-pass starch, digestible organic matter OMd, NFC (non-fiber carbohydrate), NDF-rumen degradability, degradable NDF, NDF N-free, pH, acetic acid, lactic acid, total-NH_3, soluble crude protein, chlorine, nitrate and local energy and metabolisable protein data. There is available mineral package (ICP analyses: Ca, P, Na, K, Mg, Mn, Zn, Fe, S). The cation-anion balance is another important factor in the close-up and high milking dairy cow groups provided by this service.

In Hungary a special method was adapted to measure the corn silage processing score (CSPS) by Ferreira and Mertens (1988). The Ro-Tap Sieve Shaker (Madison, Wisconsin, US) can provide accurate data for starch content of the cracked (and potentially digestible) seeds. The modified digestible starch and modified net energy content were developed based on the non-digestible whole seeds in the silage. In optimal situation more than 70% of the starch is in the processed corn seed (<4,75 mm fragment size). The lab instrument is adequate to measure the physically efficient NDF (peNDF). When the peNDF concentration is above 23%DM in the TMR (and the range of chop size above 2 cm is between 2-8%), the rumination will be intensive and the rumen fluid will be buffered by the alkaline saliva keeping the pH above 6.

So, combination of NIR technology with other important practical and state of the art methods, the new generation of the 'dry' NIR forage lab can efficiently help the modern dairy farm routine work in Hungary.

EFFECT OF SEED RATIO ON NUTRITIVE VALUE OF OAT-PEA AND OAT-VETCH MIXTURES

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ABSTRACT

The authors investigated the effect of different seeding rate on nutrient content, nutrient digestibility and nutritive value of six oat-pea (*Avena sativa* and *Vicia sativa*), and six oat-vetch (*Avena sativa* and *Pisum sativum*) summer annual mixtures harvested in flowering stage of oat plant (for whole crop silage). The study is a comparative description of the six oat-pea and the six oat-vetch seed combinations, respectively. Field trial was carried out at Kaposvár University, in 2013. Sampling was carried out 19th June (oat and the legume in flowering) by hand (randomized sampling with standard frame: 1 m^2, n=4) on randomized experimental plots (plot size: 1,5m x 10m = 15m^2/treatment, yield data n=16, laboratory analyses n=4, respectively). Green- and dry matter yield, crude nutrient content, fiber fractions, organic matter digestibility and NDF degradability were determined. Samples were dried and grinded according to the Guidelines of Samplinq® system (BLGG AgroXpertus, Wageningen), equivalently with the Hungarian National Standard. Crude nutrient content, fiber fractions, organic matter digestibility and NDF rumen degradability were determined by Near-InfraRed Spectroscopy. The spectroscopic method (database developed by the BLGG AgroXpertus, Wageningen, the Netherlands) uses the near-infrared region of the electromagnetic spectrum (range: 1000 - 2500 nm). Spectra were determined according to the guidelines of NEN-EN-ISO 12099 (Q-Interline Quant FT-NIR analyser, ISO 12099:2010). BLGG AgroXpertus uses local calibration model. List of the reference methods and determination coefficients are available at the corresponding author. It was found that the six different seeding rate have not got siginificant effect on nutritive value of the oat-pea mixtures. However, according to a non-significant positive tendency, combination of 1.500.000 oat seed/ha and 650.000 pea seed/ha is recommended to investigate in the future. It was found that the seeding rate had significant beneficial

effect on oat-vetch mixtures, therefore combinations of 3.000.000 vetch seed/ha and 2.000.000 oat seed/ha, moreover 3.000.000 vetch seed/ha and 2.500.000 oat seed/ha had significantly ($p \leq 0.05$) higher crude protein and digestible crude protein concentration compared to the other treatments. The higher vetch seed number had positive effect on nutritive value. The summer oat-pea and oat-vetch mixtures (according the limited crude protein and net energy concentration) are recommended into heifer growing and dry cow diet. Additionally, application of the summer mixtures in the rotation systems is difficult (late harvest in May-June), so the oat-based mixtures are recommended to use as secondary choice beside the main winter crops and winter mixtures having priority in the plant growing strategy.

keywords: oat, pea, vetch, mixed forage, nutrition

INTODUCTION

Low yield, poor starch- and net energy content of the maize silage caused by the heat stress and drought damage during 2012-2013 in the dry continental region of Europe, shows the risk of maize-based plant growing strategy on dairy farms (NEl 2013: 6,21 MJ/kg DM, starch 246 g/kg DM, n=352, database of Livestock Performance Testing Ltd in Hungary). Improved intake due to better palatability of the legume makes small grain-pea mixtures a dairy quality forage, as secondary component of the dairy diet beside the maize silage.

Small grain cereal crops have a wide range of adaptation (soil, temperature, rainfall). Forage yields in the range of 6 to 18 ton/ha have been reported (Hadjichristodoulou 1976), but crude protein content declines rapidly as the crops mature. Crude protein content can be as low as 37 g/kg DM in mature whole-crop cereals (Moreira 1989). According to the National Hungarian Database, the small grain whole crop has rather low crude protein concentration (70-100 g/kg DM) between milky and dough stage (Várhegyi and Várhegyiné 2000). On the other hand, these crops generally contain sufficient concentrations of fermentable carbohydrates to support rapid and intensive fermentation (McDonald 1981). If oats are harvested at the late boot stage (less than 1% heads emerged) the digestible fiber can be expected to be 60-70% NDF (Undersander 2003).

The legumes can produce high yields, but they are more drought sensitive than the small grains (Hadjichristodoulou 1976). Crude protein concentration of legumes (150-239 g/kg DM) are typically much higher than for small grains (Caballero et al. 1995; Lunnan 1989). The shortcomings of pea and vetch as silage crops are high moisture concentration, a high degree of lodging, high buffering capacity and low fermentable carbohydrate concentration (Kung et al. 1990).

Combination of small grain cereal crops with pea or vetch compensates for some of the shortcomings of each crops, but the success of such mixtures depends on obtaining the proper balance of cereal and legumes in the harvested forage. Botanical

composition is important because the mixture must contain enough legume to improve silage crude protein content and enough cereal to reduce the silage moisture concentration (Panciera et al. 2003). Botanical composition can be influenced by agronomic factors such as seeding rate, fertility and harvest time.

Small grain pea mixtures should be harvested based on the maturity stage of the small grain. These mixtures should be harvested at the late boot stage (few heads showing) for lactating dairy cows and the soft dough stage for heifers, dry cows, beef cattle (Undersander 2003). Improved intake due to better palatability makes small grain-pea mixtures a dairy quality forage.

The authors investigated the effect of different seeding rate on nutrient content, nutrient digestibility and nutritive value of six oat-pea (*Avena sativa* and *Vicia sativa*), and six oat-vetch (*Avena sativa* and *Pisum sativum*) summer annual mixtures harvested in flowering stage of oat plant (for whole crop silage).

MATERIAL AND METHODS

Six different oat-pea and oat-vetch mixtures were sowed on 28th March 2013. Nitrogen fertilization was carried out before sowing in March 2013 (200 kg/ha NPK and 54 kg N/ha). Experimental plot size was 1,5m x 10m = 15m^2 per repetition (treatments= 6, n= 4). The following Hungarian varieties were sowed: oat - Martonvásári Pehely, vetch - Maxivesa, pea - Rubin. Treatments were the following (Table 1).

Sampling was carried out 19th June (oat and the legume in flowering) by hand (randomized sampling with standard frame: 1 m^2, n=4) on randomized experimental plots (determination of the yield n=16, samples for laboratory analyses n=4, respectively). Nutrient content, organic matter digestibility (OMd) and NDF rumen degradability of the six different mixtures were determined by Near-InfraRed Spectroscopy.

Samples were dried and grinded according to the Guidelines of Samplinq® system (BLGG AgroXpertus, Wageningen), equivalently with the Hungarian National Standard. Crude nutrient content, fiber fractions, organic matter digestibility and NDF rumen degradability were determined by Near-InfraRed Spectroscopy. Spectra were determined according to the guidelines of NEN-EN-ISO 12099 (Q-Interline Quant FT-NIR analyser, ISO 12099:2010 guidelines). A NIRS-analysis is an indirect method and has been calibrated on primary classical wet-chemical analysis, as reference methods. BLGG AgroXpertus uses local calibration model, as special mathematical model to calculate the desired parameters based on the NIR spectra. List of the reference methods and determination coefficients are available at the corresponding author.

Applied statistical models were the following: Levene test for homogeneity test, one way ANOVA and two-way ANOVA ($p \leq 0,05$) for comparison of the different mixtures applying the SAS 9.3.1 version.

RESULTS

Crude nutient and net energy content of the oat-pea and oat-vetch mixtures are shown in Table 2.

TABLE 1: Combination of different seed number of oat-pea and oat-vetch mixtures (28th March - 19th June 2013, Kaposvár University, Hungary)

	Seed number/ha			Seed number/ha	
	Oat	Pea		Oat	Vetch
Oat-pea mixture 1	1.500.000	650.000	Oat-vetch mixture 1	1.500.000	2.000.000
Oat-pea mixture 2	2.000.000	650.000	Oat-vetch mixture 2	2.000.000	2.500.000
Oat-pea mixture 3	2.500.000	650.000	Oat-vetch mixture 3	2.500.000	2.500.000
Oat-pea mixture 4	3.000.000	500.000	Oat-vetch mixture 4	3.000.000	2.000.000
Oat-pea mixture 5	3.500.000	850.000	Oat-vetch mixture 5	2.000.000	3.000.000
Oat-pea mixture 6	1.000.000	500.000	Oat-vetch mixture 6	2.500.000	3.000.000

TABLE 2: Crude nutrient content of the oat-pea and oat-vetch mixtures (28th March - 19th June 2013, Kaposvár University, Hungary)

			Dry matter	Crude protein	Crude fat	Crude fiber	Crude ash	N-free extract	NEl_{vc} [1]
			g/kg	g/kg DM	g/kg DM	g/kg DM	g/kg DM	g/kg DM	MJ/kg DM
Oat	**Pea**					**Oat-pea mixture**			
1.500.000	650.000	mean	176a	166a	29a	255a	107a	444a	5,8ab
		st. dev.	10,1	13,9	1,3	12,7	9,0	10,3	0,2
2.000.000	650.000	mean	180a	149a	28,5a	274a	100ac	449a	5,6a
		st. dev.	5,4	7,1	0,6	13,8	2,4	18,5	0,1
2.500.000	650.000	mean	174a	164a	28a	253a	97ab	458a	5,8ab
		st. dev.	2,6	9,5	0,8	17,9	5,4	26,2	0,2
3.000.000	500.000	mean	201a	143a	26,5a	271a	90b	470a	5,6ac
		st. dev.	7,6	0,8	0,6	5,8	2,6	6,3	0,1
3.500.000	850.000	mean	191a	164a	28a	258a	94ab	456a	5,8b
		st. dev.	3,8	10,6	0,8	8,0	1,3	7,8	0,1
1.000.000	500.000	mean	192a	153a	28,3a	264a	92bc	462a	5,7bc
		st. dev.	4,4	5,3	1,7	7,9	2,4	8,9	0,1
Std. error			1,62397	1,79902	0,22838	1,84217	1,18432	3,07606	0,02662
Oat	**Vetch**					**Oat-vetch mixture**			
1.500.000	2.000.000	mean	182a	157a	30ab	266ab	105a	443a	5,5a
		st. dev.	9,3	5,2	1,2	9,0	10,1	18,1	0,2
2.000.000	2.500.000	mean	185a	159ab	28,5a	258ab	110a	446a	5,6a
		st. dev.	20,0	10,8	1,0	21,8	13,3	35,3	0,3
2.500.000	2.500.000	mean	177a	157a	30,5b	254a	105a	454a	5,7ab
		mean	4,7	11,2	2,1	13,0	8,4	33,3	0,2
3.000.000	2.000.000	st. dev.	176a	170bc	30,0ab	274b	103a	424a	5,7ab
		mean	12,1	8,0	0,8	2,4	4,1	8,5	0,1
2.000.000	3.000.000	st. dev.	176a	178c	29,8ab	261ab	103a	428a	5,9b
		mean	6,9	2,2	1,3	9,5	3,3	13,5	0,1
2.500.000	3.000.000	st. dev.	174a	176c	30,5b	256ab	103a	434a	5,9b
		mean	5,6	5,0	1,3	7,8	1,9	8,5	0,1
Std. error			2,12871	2,33552	0,27788	2,59406	1,50993	4,58215	0,04319

different letters show significant difference $p \leq 0,05$
[1]lactation net energy based on measured digestibility according to BLGG AgroXpertus (Wageningen) method

Non-fiber carbohydrate content, digestibility and rumen degradability of the oat-pea and oat-vetch mixtures are shown in Table 3.

Fibre content and fibre fraction composition of the oat-pea and oat-vetch mixtures can be seen in Table 4.

DISCUSSION

It was found that the type of the mix (pea – vetch p=0,00) and the seeding ration (p=0,004) had significant effect on crude protien content.

The seed ratio of aot and pea has not got significant effect nor the crude nutrient content, nor the nutritive value. In the case of oat and vetch combnations the seed ratio has significant effect (p=0,001) on crude protein content (dependency: 63,8%). The seed ration has advantageous influence on hemicellulose concentration, also (p=0,035; dependency: 46.1%).

TABLE 3: Nutrient content, nutrient digestibility and nutirtive value of the oat-pea and oat-vetch mixtures (28th March - 19th June 2013, Kaposvár University, Hungary)

			Sugar	Starch	OMd[1]	DOM[2]	FOM[3]
			g/kg DM	g/kg DM	%	g/kg DM	g/kg DM
Oat	**Pea**				**Oat-pea mixture**		
1.500.000	650.000	mean	64,5a	35a	70,4a	629ab	511a
		st. dev.	3,9	13,1	1,1	11,0	10,5
2.000.000	650.000	mean	56,8b	37,5a	67,8b	610a	497ab
		st. dev.	10,8	17,5	0,8	8,7	4,3
2.500.000	650.000	mean	61,0ac	51a	69,6ac	628ab	500ab
		st. dev.	8,2	21,4	1,9	20,2	20,5
3.000.000	500.000	mean	69,0bc	53,8a	68,0bc	619ab	495ab
		st. dev.	4,5	6,2	0,8	7,5	6,5
3.500.000	850.000	mean	73,3ab	44a	68,9ab	624b	492b
		st. dev.	3,0	2,8	1,1	9,7	5,3
1.000.000	500.000	mean	67,8bc	45,8a	68,5bc	622b	503ab
		st. dev.	2,9	16,1	1,0	10,7	19,1
Std. error			0,28361	2,96048	0,82521	2,35849	2,6648
Oat	**Vetch**				**Oat-vetch mixture**		
1.500.000	2.000.000	mean	57,8a	29a	67,5a	605a	495a
		st. dev.	13,1	11	1,4	18,9	20,4
2.000.000	2.500.000	mean	45,5a	46,5a	68,5a	611ab	494a
		st. dev.	11,1	34,7	2,5	30,3	23,2
2.500.000	2.500.000	mean	56,0ab	39,0a	69,0ab	617ab	500a
		st. dev.	8,8	21	1,8	21,6	16,4
3.000.000	2.000.000	mean	50,8ab	28,0a	68,8ab	617ab	504a
		st. dev.	3,8	3,5	0,8	7,3	7,3
2.000.000	3.000.000	mean	44,3b	36,3a	70,9b	635b	515a
		st. dev.	8,5	16	0,5	6,9	7,2
2.500.000	3.000.000	mean	46,3b	42,8a	70,8b	635b	508a
		st. dev.	5,9	10,7	0,9	8,8	16,6
Std. error			0,36539	3,70092	1,04060	4,01152	3,33134

different letters show significant difference $p \leq 0,05$
[1]OMd organic matter digestibility, [2] DOM digestible organic matter, [3] FOM fermentable organic matter

According to the results, the hemicellulose content was in strong positive correlation with NDF rumen degradability (0,71, n=48).

CONCLUSIONS

It was found that the six different seeding rate have not got significant effect on nutrient content and nutritive value of the oat-pea mixtures. However, according to a non-significant positive tendency, combination of 1.500.000 oat seed/ha and 650.000 pea seed/ha is recommended to investigate in the future.

The higher vetch seed number had positive effect on nutritive value. It was found that the seeding rate had significant beneficial effect on oat-vetch mixtures, therefore combinations of 3.000.000 vetch seed/ha - 2.000.000 oat seed/ha, and 3.000.000 vetch seed/ha - 2.500.000 oat seed/ha had significantly ($p \leq 0.05$) higher crude protein concentration compared to the other treatments.

The summer oat-pea and oat-vetch mixtures (according the limited crude protein and net energy concentration) are recommended into heifer growing and dry cow diet. Additionally, application of the summer mixtures in the rotation systems is difficult (late harvest in May-June), so the oat-based mixtures are recommended to use as secondary choice beside the main winter crops and winter mixtures having priority in the plant growing strategy.

ACKNOWLEDGEMENTS

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TABLE 4: Fibre content of the oat-pea and oat-vetch mixtures (28th March - 19th June 2013, Kaposvár University, Hungary)

			NDF	ADF	ADL	Hemicellulose	Cellulose	NDFd[1]	dNDF[2]
			g/kg DM	g/kg DM	g/kg DM	g/kg DM	g/kg DM	%DM	g/kg DM
Oat	**Pea**					**Oat-pea mixture**			
1.500.000	650.000	mean	512a	302a	31a	210ab	271a	65a	333ab
		st. dev.	41,6	10,5	3,7	33,5	11,4	2,9	39,8
2.000.000	650.000	mean	532a	313a	29a	219ab	284a	64ab	338a
		st. dev.	19,2	11,4	1,5	8,3	10,9	1,1	15,0
2.500.000	650.000	mean	492a	299a	32a	194ab	267a	63bc	308bc
		st. dev.	20,3	18,6	2,4	13,0	16,9	0,8	13,3
3.000.000	500.000	mean	523a	310a	30a	212a	280a	63abc	327ab
		st. dev.	5,3	3,0	1,6	6,3	1,5	1,5	10,7
3.500.000	850.000	mean	488a	311a	33a	178b	278a	61c	297c
		st. dev.	12,2	3,2	1,3	10,7	4,1	0,6	9,3
1.000.000	500.000	mean	517a	304a	27a	214ab	276a	63abc	324ac
		st. dev.	16,5	8,7	3,9	18,7	6,4	1,7	18,4
Std. error			3,44896	1,89945	0,46793	2,78285	1,75012	0,39162	4,76662
Oat	**Vetch**					**Oat-vetch mixture**			
1.500.000	2.000.000	mean	528a	310a	28ab	218ab	282a	64ab	340ab
		st. dev.	12,4	8,4	3,2	13,0	5,4	1,1	12,1
2.000.000	2.500.000	mean	515ab	302a	29a	213ac	273a	63a	326ab
		st. dev.	44,4	25,8	1,5	20,3	25,5	1,7	33,3
2.500.000	2.500.000	mean	511ab	293a	25b	217abc	268a	65ab	330ab
		st. dev.	9,0	18,6	2,6	10,0	16,6	1,4	12,0
3.000.000	2.000.000	mean	532a	301a	26b	231b	275a	65ab	344a
		st. dev.	5,0	7,9	1,3	3,6	7,2	0,3	4,4
2.000.000	3.000.000	mean	522ab	296a	27b	226ab	269a	66b	342ab
		st. dev.	18,4	12,4	2,6	10,2	11,9	0,5	11,6
2.500.000	3.000.000	mean	495b	294a	26b	201c	268a	64ab	319b
		st. dev.	9,0	5,2	1,7	7,9	6,8	1,3	9,8
Std. error			4,56065	2,94187	0,50809	2,94863	2,74912	0,25497	3,55983

different letters show significant difference $p \leq 0,05$
[1] NDFd rumen degradability of the NDF, [2] dNDF degradable NDF

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OVERVIEW OF THE COLLECTIONS OF THE FIRST AGROBOTANICAL GARDEN OF HUNGARY

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INTRODUCTION

The botanical garden of the Faculty of Agricultural and Environmental Sciences of Szent István University was founded in 1959 after the moving of the University of Agricultural Sciences from Budapest to Gödöllő. The construction was based on the plans of Tibor Hortobágyi – the famous Professor of Botany and – and his colleagues dr. István Précsényi and dr. Albert Koltay. In the next 3 years the first agrobotanical garden of Hungary was completed (Hortobágyi 1963). It is situated on the slopes of the Gödöllő Hills (GPS coordinates: 47.593027, 19.366136) at an altitude of 220 m above sea level (Taba & Tuba 1999).

The fifty-five years old Garden located in the heart of the campus area of Szent István University, occupies a 4,3 hectares site. It provides the teaching and research collection of living plants for the university, which numbers over 1250 taxa. The botanical garden is a nature conservation area since 2008, and has over 110 protected plant species of the Hungarian Flora. Beside the numerous species of Hungary visitors can get acquainted with several indigenous species of faraway continents (America, Asia, Africa, Australia). Almost a dozen of thematic collections and a rare, natural forest community make it also an ideal place for recreation.

In the history of the garden beside the beginnings only one significant improvement was carried out in 2009 and 2010 in the frame of an EU & Hungarian Government sponsored project (KMOP-3.2.1/B-2008-0003). During the reconstruction processes several collections were renewed and new habitats were created (Czóbel 2010). Among others wetland habitats were reconstructed and their number has increased. A new subtropical and mediterranean collection and two types of sandy grasslands (open and closed) were also established. In June 2010 the staff of the garden significantly increased, which was

Figure 1: Nymphaea alba photo: Gábor Takács

Figure 2: *Inula helenium* photo: Károly Bellus

essential in order to maintain and improve the garden. After creating the useful infrastructure the garden has opened for visitors in 2011.

COLLECTIONS OF THE GARDEN

I. Aquatic Habitats

The "Central Pond" the largest of the aquatic habitats was constructed in the 1960's is located in the centre of the Systematic Beds. In the deepest water it houses water lilies, including the protected water-lilies (*Nymphaea alba* and *Nymphoides peltata*) or the endangered bog bean (*Menyanthes trifoliata*). The peninsulas houses dense vegetation emerging from the surface – rushes, sedges or *Acorus calamus*, *Butomus umbellatus, Glyceria maxima, Iris pseudacorus.* Newts, waterboatmen and dragonflies also live in and around our "Aquatic Gardens".

To the right side of the pond one tree of the swamp cypress (*Taxodium distichum)* can be found growing. Its original habitats are oxygen-poor swamps of South-Eastern United States and Mexico. In order to oxygenate the roots, the trees send up pneumatophores, or 'breathing roots', above the surface of the water.

The Small Pond beside the entrance was completed in 2010 with a U-shaped stream to exhibit primarily species of a tall-herb community, which is one of the typical vegetation type of the streams in hills and mountains of Hungary. This habitat is characterized by such plants like Butterbur *(Petasites hybridus)*, the yellow flowered Teleki-flower (*Telekia-speciosa),* or the 2 meter tall Elecampane (*Inula helenium).* While alongside the pond marsh-loving sedges (e.g. *Carex appropinquata*), grasses, flowering plants like marsh-marigold (*Caltha palustris*) or loosestrife (*Lythrum salicaria*) and the airy sprays of *Sanguisorba officinalis* appear.

The Upper Pond was evolved in 2010 in order to enrich the landscape in the upper part of the garden.

Along the bank marginal aquatics and swamp species are displayed such as *Symphytum officinale, Ranunculus repens*. Several *Typha* species can be observed in the water-body, among them floating the specimens of *Utricularia vulgaris*, which is a native insectivorous plant of Northern hemisphere. On the leaf of the plant several specific traps are waiting for the preys, to catch them in 0,1 second. Its yellow flowers open from June to September.

II. Bamboo collection

The research collection was originally created in 2010, planned and managed by the Institute of Horticulture, SZIU, supervised by András Neményi. Between 2010 to 2014 the collection has been greatly enriched with many new taxa supplementing the original small grove of *Phyllostachys flexuosa* planted in the 1960'ties. Nowadays this collection is the most diverse *Phyllostachys* bamboo collection in Hungary, besides its aesthetic qualities serving the purposes of education and scientific research. In the near future a Japanese Tea House will supplement this collection creating a unique and pleasant atmosphere.

Figure 3: *Phyllostachys flexuosa* photo: Szilárd Czóbel

Figure 4: Collection of Cultivated Plants photo: Ivett Sós

III. Collection of Cultivated Plants

Because our garden is the educational site of the university the collection of cultivated plants is one of

Figure 5: *Momordica charantia* photo: Judit Horel

Figure 6: *Drosera capensis* photo: Gábor Takács

the most emphasized part of the garden. In the beds the most important economic plants of agriculture and horticulture are exhibited from beans to cereals. Different herbs and spices are displayed like Fennel *(Foeniculum vulgare),* Lovage *(Levisticum officinale),* Hyssop *(Hyssopus vulgaris).* But visitors can consider exotic, edible specialities originated from other continents. Here you can find the caigua (*Cyclanthera pedata*) or the bitter melon (*Momordica charantia*) members of *Cucurbitaceae*, the cannibals tomato (*Solanum uporo*) member of *Solanaceae*, the teel (*Sesamum indicum*), the okra (*Hibiscus esculentus*), the artichoke (*Cynara scolymus*) from *Asteraceae* or the peanut (*Arachis hypogaea*) from *Fabaceae*.

Figure 7: *Passiflora alata* photo: Gábor Takács

Figure 8: *Cymbidium orchid* photo: Gábor Takács

IV. Greenhouse collection

In our tiny glasshouse three new thematic collections have been created between 2012 to 2014.

a.)Carnivorous plants section

The most typical feature of these plants is that they use different strategies to attract and catch their preys. These strategies and digestive enzymes help them to obtain extra nutrient from the insects and other small preys. This adaptation allows them to colonize nutrient poor habitats. Here you can see specimens of *Dionaea muscipula, Drosera* spp., *Pinguicula* spp., *Sarracenia* spp., *Nepenthes* spp. and *Utricularia* spp.

b.)Epiphytes and tropical plants

Most of the orchid, bromeliad and tillandsia taxa are epiphyte. These plants use another plant, typically a tree, for their physical support, but they do not draw nourishment from it. Some tropical economic or fruit-bearing plants are demonstrated here also. You can see fruiting coffee (*Coffea arabica*) shrubs, ananas (*Ananas sativus*), passion flower (*Passiflora alata*), vanilla (*Vanilla planifolia*) and cocoa (*Theobroma cacao*) plants.

c.)Succulent plants exhibition show such plants which originated from dry habitats (like deserts, semi-arid areas) developing different strategies to survive the dry periods. The most important stem-succulents the cacti bloom in spring greeting the visitors with wonderful flower pomp. Furthermore several leaf-succulent plants can be explored like the ice-plants (*Aizoaceae, Mesembryanthemum* sp.) or the living-stones members of *Lithops* genus.

V. Living fossils collection

The garden displays a dozen of picturesque ancient plants, composing the so called "living fossil" collection. This collection was enlarged with several new taxa in 2011.

A "living fossil" is a survival species that is also known from fossils looking just the way it looks today. Among them *Ginkgo biloba* is a very old line of plants, their earliest representatives being found in rocks of Permian age some 280 million years old. At times in the geological past they have been widespread and abundant, and the dinosaurs surely fed upon them. The ginkgo tree is well-known today as an ornamental tree, but for centuries it appeared to have been extinct in the wild. Only cultivated trees survived, in Buddhist monasteries in China, until they were planted across Asia starting about a thousand years ago. *Dawn Redwood* (*Metasequoia glyptostroboides)* is a conifer that sheds its leaves every year, unlike its cousins the *coastal redwood* and *giant sequoia*, which also occur in the garden. Fossils of closely related species date from late in the Cretaceous and occur all over the northern hemisphere. The genus *Metasequoia* was first described as a fossil from the Mesozoic Era in 1941, but shortly a small stand was discovered in China.

VI. Magnolia garden

The continuously increasing *Magnolia* collection is one of the most significant ornamental elements of the garden. It consists of a wide variety of taxa differing in flower sizes, coloration and pattern.

VII. Mediterranean and subtropical collection

This house holds a representative selection of plants from around the Mediterranean Basin. They form part of a larger

Figure 9: *Magnolia* × *soulangeana* photo: Ivett Sós

Figure 10: *Helleborus lividus* photo: Gábor Takács

collection of plants from the five areas of the world that have Mediterranean climates, with cool wet winters and hot dry summers. The greenhouse and its surrounding areas demonstrate plants from the Mediterranean areas of South Africa, Australia, California and Chile.

Plants from the Mediterranean Basin have become more popular in Hungary among gardeners and include popular shrubs such as *Cistus* and *Lavandula*, while the fascinating umbrella pine (*Pinus pinea)* and the pea relative, *Spartium junceum* provide feature plants. Shrubs and trees, both important life forms in the Mediterranean, are well represented. This area includes also economically important plants from the Mediterranean basin, such as figs, pomegranates, mastic tree, olive tree and the bay laurel. The collection was created in 2010 within the frame of the reconstruction project, planned and managed by Szilárd Czóbel.

VIII. Reconstructed sandy grassland communities

Native and endangered open and closed sandy grassland communities have been created on a ca. 2 500 m^2 area

Figure 11: Sandy grassland with *Stipa borysthenica* photo: Gábor Takács

Figure 12: *Rosa sancti-andreae* photo: Gábor Takács

Figure 13: *Crocus reticulatus* photo: Gábor Takács

in 2009 (Czóbel et al. 2012), representing the once characteristic grassland vegetation of the Gödöllő-Hills. Both communities are abundant in dry tolerant, steppe elements, but the open sandy grasslands is rich in endemic (Pannonian) elements too, such as *Festuca vaginata* and the spectacular feather grass, *Stipa borysthenica. Koeleria glauca, Centaurea arenaria, Polygonum arenarium* are typical taxa in the open sandy grassland, while the closed sandy grassland is characterized by *Festuca rupicola*, *Chrysopogon gryllus*, *Salvia* spp., and *Thymus* spp. The grassland communities were planned and supervised by Ildikó Pándi and Szilárd Czóbel.

IX. Relict forest stand

More than a quarter of the garden is covered by a unique, natural forest stand, which belongs to a rare community "*Aceri campestri-Quercetum roboris*". The stands of which were native only on some points of the country but nowadays appear only in Gödöllő Hills, one of which is in the botanical garden. These relict forest patches have national importance. The community and its stands in Gödöllő Hills were published and described by Professor Gábor Fekete (Fekete 1965). The most characteristic species in the upper canopy layer are *Quercus petraea* and *Q. robur* and their hybrids, *Carpinus betulus* appears here only singly and is displaced by the more abundant *Acer campestre*.

Reconstruction of this forest stand has been carried out in 2010-2011, by removing the alien and invasive plants (*Robinia pseudo-acacia* and *Ailanthus altissima*), furthermore several characteristic species of the community were planted. Walking along the trail you can explore the natural values of the forest. The open-air classroom is used for environmental education from kindergartners to adults.

X. Rock Garden

The tiny Rock Gardens display Hungarian native plants e.g. liverleaf (*Hepatica nobilis*) plus those from mountainous parts of Europe and around the world, like the southern European Christmas rose (*Helleborus niger*) and alpine

barrenwort (*Epimedium alpinum*), and the Himalayan May apple (*Podophyllum hexandrum*) with large scarlet, ovoid fruit.

XI. Systematic beds

These beds have for decades been used for teaching taxonomy, the science of plant classification This collection is abundant in native species of the Carpathian Basin as well as a decorative creation of living plants. Order beds are arranged like a Greek theatre with an artificial pond in the centre. The plants are brought together into families within which the species show resemblances to each other based on morphological characteristic and genetic structure. In these order beds plant families were arranged on the base of the phylogenetic plant system of Professor Soó a famous Hungarian botanist, taxonomist.

The Systematic Beds hold an important scientific research collection of about 400 plant species belonging to several families dispersed across in more than 60 beds. Among the collected plants there are several protected species, like *Rosa sancti-adreae* or Jerusalem sage (*Phlomis tuberosa)* from the *Mint* family. Beside the indigenous species some aliens disappear as well, like Barrenwort (*Epimedium alpinum)*, or *Helianthemum appenninum*.

XII. Tropical and subtropical fruit trees collection

The tropical and subtropical fruit trees collection consists of some well-known species, like avocado (*Persea americana*), guava (*Psidium guayava*) and several less-known taxa, such as peculiar *Citrus* species and macadam-nut (*Macadamia tetraphylla*) native to Australia and noted as the most tasty nut in the world. The fruit of some species resembles to other taxa with high economical importance in the temperate zone, like pitanga or suriname cherry (*Eugenia uniflora*). It has similar sized and coloured fruit like the cherry. Another example is tomato tree (*Cyphomandra betacea*), native in the hill region of South America. Most of the species are regularly flowering and bearing-fruit. This collection was donated to the garden by András Paksi of the Institute of Horticulture in 2011.

Figure 14: ***Paeonia tenuifolia*** **photo: Gábor Takács**

Figure 15: ***Citrus medica var. sarcodactylis*** **photo: Gábor Takács**

The celebrity tree of the garden

The most famous wild pear (*Pyrus pyraster*) tree of Hungary and Europe located in our garden won the Tree of the Year Competition of Hungary in 2013 and received the second place in the European Competition in 2014. It is 18 m in height, the diameter of the canopy is 16 m, and the circumference of the trunk is more than 3.2 m, thereby one of the largest and oldest wild pear specimen in the Pannonian Basin. According to the local legend count Antal Grassalkovich planted one thousand wild pear trees in the 18th century, as he had found shelter in such a tree while escaping from a wounded wild boar during a hunting. They say that Lajos Kossuth wrote the Declaration of Independence in 1849 under this tree but it is also called the tree

Figure 16: ***Macadamia tetraphylla*** **photo: Gábor Takács**

Figure 17: ***Eugenia uniflora*** **photo: Judit Horel**

Figure 18: The giant ***Pyrus pyraster*** **photo: Gábor Takács**

of lovers, as count Andrássy met and fell in love with Queen Sissy here.

Experimental station

Over 0.5 ha area is used for scientific experiments related to grassland management, plant ecology and ecophysiology. The "Global Climate Change and Plant Research Station" located in the Garden was established by Professor Zoltán Tuba in 1993.

Index Seminum

The catalogue of seed collection (*Index Seminum*) has been published almost every year since the establishment of the Botanical Garden.

Research and teaching

Several BSc, MSc and PhD research works have been connected to the collections and habitats of the garden. Ongoing researches cover monitoring activities, climatic adaptations of native and exotic taxa and vegetation dynamics.

Tasks of the garden

We strive hard to complete the increased tasks of a modern botanical garden which includes, maintaining and developing the collections involving ex situ gene conservation, collaborating with other gardens and arboreta, taking part in environmental education in every level of education, organizing programs, making publications, collaborating with researchers etc. in harmonization with the advised tasks of the Botanical Gardens Conservation International.

The Garden offers all-year interest and seasonal inspiration. Whatever time of year you visit, you will always discover something to intrigue and captivate. Beside the herbaceous plants several exotic tree species lure the visitors all over the garden e.g. *Acer palmatum, Kalopanax spictus, Gymnocladus dioicus*. While in the winter the different evergreens provide colourful features, during the autumn *Cotinus coggygria* adds ember colours.

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EUROPEAN SYSTEM OF EVALUATION OF VETERINARY TRAINING, ACCREDITATION OF THE FACULTY OF VETERINARY SCIENCE BUDAPEST OF THE SZENT ISTVÁN UNIVERSITY

PÉTER **SÓTONYI** - LÁSZLÓ **FODOR**

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Assurance of high quality of higher education is a top national priority in all countries. Level of teaching quality of the universities can hardly be assessed by employers, students or the public. In order to overcome this problem and to monitor the quality of university education, accreditation processes have been introduced in most of the developed countries. The Hungarian Accreditation Committee is assigned to examine the education structure of the universities in Hungary, including veterinary training in every 5th year. Accreditation of university education is generally a national issue; however, increasing student mobility underpins the need for international accreditation.

European Association of Establishments for Veterinary Education

Association Européenne des Etablissements d'Enseignement Vétérinaire

Certificate of Accreditation

FACULTY OF VETERINARY SCIENCE, SZENT ISTVÁN UNIVERSITY

In accordance with our Standards and based on the educational requirements of the EC Directive 2005/36, Article 38, the Faculty of Veterinary Science, Szent István University is an accredited EAEVE/FVE establishment.

Prof. Dr. Ana M Bravo del Moral
President

Prof. Dr. Stuart W J Reid
Chairman of ECOVE

DATE OF ACCREDITATION: FEBRUARY 2014

European Association of Establishments for Veterinary Education

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DATE OF APPROVAL: FEBRUARY 2014

Veterinary training has a special position within the European Union (EU), since together with human medicine, dentistry, pharmacy, training of general nurses, midwifes and architects it belongs to the controlled professions, where European Directives define the structure and the content of the training together with the Day-1 competences, which enable the new graduates to work in any country of the EU at any field of the veterinary profession.

In order to compare the veterinary training in the different countries a pilot study was initiated by the EU between 1986 and 1989, and after the successful completion of this project the task of evaluation was delegated to the European Association of Establishments for Veterinary Education (EAEVE) by the European Commission. Albeit the official assignment was not extended in 2000, the European veterinary schools realising the beneficial effects of the evaluation, not only maintained but by including the Federation of Veterinarians of Europe (FVE) further developed the system. This evaluation system is the only profession specific international evaluation system in Europe and its main advantage is that similar establishments are compared by experienced experts from the best veterinary schools, who can judge the schools without any bias. The report summarising the results of the visitation focuses not only on the fact, whether the training, the academic staff, the teaching methods, the equipment used in teaching and clinical activities and the infrastructure meet the up-to-date requirements of the veterinary training but it contains suggestions of the expert team.

The accreditation system of EAEVE is based on the principles of the European Association for Quality Assurance in Higher Education (ENQA) with a strong focus on the evaluation of the profession specific characteristics. The two-stage-system is a speciality of the EAEVE evaluation. In Stage 1 the profession specific characteristics of the training are evaluated, it is examined if the training meets the requirements laid down in the Directives 2005/36/EC and 2013/55/EC and the new graduates have the Day-1 competences needed to veterinary activity. In the course of Stage 2 the quality assurance system of the establishment in its teaching, research and service activity is assessed. A successful Stage 1 evaluation is a precondition of Stage 2 evaluation. The second stage evaluation examines if the quality assurance and quality management system of the school guarantee that the content and the conditions of the training are continuously examined, evaluated and developed by the school resulting a continuous improvement of the quality of training. The present Stage 1 evaluation looks back more than 25 years. Most faculties in the EU passed it twice or three times and became "approved". Our school was evaluated in 1995 and 2004; first it became approved immediately, and in 2004 after rectifying two

deficiencies. The second stage of the evaluation was introduced just a few years ago; in case of a successful Stage 2 visitation the establishment receives accreditation. Before the evaluation of our school in February, 2014 only 6 establishments (Copenhagen, Ghent, Helsinki, London, Vetsuisse, Vienna) earned accreditation. Several faculties evaluated in the recent years, even well acknowledged ones, did not undergo this higher level of the examination. Now, out of the 97 member establishments of the EAEVE 8 belong to the accredited schools, including the Faculty of Veterinary Science Budapest, 49 are among the approved, 5 among the conditionally approved ones, while 20 are not approved and 15 schools were not evaluated yet. The details are available on the homepage of the EAEVE (www.eaeve.org).

The first step of the evaluation process is preparation of a self evaluation report (SER) by the school following the guidelines of the EAEVE. In the SER a profession specific evaluation of the establishment is introduced (history, structure, finances, infrastructure, teaching staff, support staff, number of students and graduates etc.), the curriculum is presented, data are given on animals used in teaching, treated, operated, hospitalised at the clinics and involved in the mobile clinic activity. Data of the recent years have to be presented in order to give an insight of the tendencies. The factual evaluation is helped by different ratios, e. g. student/teacher, student/staff, caseload and post mortem cases per student etc. The SER of the quality assurance contains 12 chapters, focusing on mission statement, quality assurance practice regarding students, teaching staff, curriculum, post graduate and continuing education, teaching environment, clinics, laboratories, research and public relations. The establishment has to present the documents of an at least two-year-long presence of the quality assurance system. The most valuable part of the evaluation is perhaps writing of the SER, at this phase the management and the public of the school can see the strengths and weaknesses of the establishment underpinned with data. The SER is at the same time an excellent collection of the most important data of the school and the training, which can serve as a useful source and can help decisions of the management.

In the case of a complete visitation including both Stage 1 and Stage 2, two visiting teams are sent. The profession specific evaluation is carried out by a team of five experts, while the quality assurance is examined by two persons. The teams are complete with a student and a coordinator. One each member of the Stage 1 team is expert of basic subjects, animal production, food hygiene, while the clinical activities are examined by an expert from academia and a practitioner. The Stage 2 team consists of two quality assurance members. The most experienced person of the team is nominated to chair. The team members come from approved or accredited schools of different countries and different regions; they can have no connections with the visited school, so conflict of interests is excluded. The experts receive no compensation; they do the work out of enthusiasm.

THE SITE VISIT LASTS FIVE DAYS:

Day 1: The two teams have a closed session to discuss the SERs, make a plan for the visit, the members give preliminary reports on the chapters assigned to them and the questions to be clarified at the visit are defined. This occasion is also used for training the team members.

Day 2: At a plenary session where the staff members and the students of the school are present, the chair introduces the team members and outlines the aims and the procedure of the visitation. At the same time the Dean gives a short introduction on the school, mentioning its history, position and importance in the higher education of the country. It is followed by a complete campus tour.

Day 3: The members of the team evaluating the professional characteristics examine the work of the departments and clinics of their relevant area. Certain members analyse the finances, the library, the informatics, the student welfare and the activity of other units involved in the education (teaching farm, slaughter house, etc.). Members responsible for quality assurance carry out discussions with the management, different staff members and students in order to assess the quality assurance systems regarding the teaching staff, teaching environment, curriculum, post graduate education, research, public relations, clinics and laboratories.

Day 4: The Stage 1 team has plenary discussions with (i) the senior and (ii) the junior academic staff, (iii) students and (iv) the administrative and support staff. In addition the team receives anybody to confidential discussions. The Stage 2 team inquires on quality assurance through meetings with department heads, trade union leaders, and officers of the student associations and examines the quality management documentations of the school.

Day 5: At the final open meeting attended by the students and staff members of the visited school, the chair summarises the preliminary results and conclusions of the team underlining the deficiencies, including possible major deficiencies.

During the site visit the members of the visiting team can ask anybody in order to get information on the details of the work at the school, in these discussions certain points mentioned in the SER can be clarified or verified, and their background can be understood. Opinion of students is especially highly appreciated. Information and impressions of the team members are discussed every day serving as a basis to the opinion of the team. All schools are evaluated according to uniform standards. The differences in the gross national income, the budget of the education, the income and the infrastructure of the universities are well known, but the requirements are the same.

The visiting team summarises its statements, opinion and

suggestions in a report, which does not contain the data provided by the SER, so the two documents are complete together. After correcting the factual mistakes and misunderstandings by the school, the report is evaluated by the European Committee of Veterinary Education (ECOVE). It is composed of seven members, 4 of them are nominated by EAEVE and 3 by FVE, so it represents the opinion of the European schools and the most important veterinary professional organisation in Europe. If no major deficiency is identified in Stage 1, ECOVE approves the school, one major deficiency results conditional approval, while in case of more major deficiencies the school is categorised as non approved. In the field of quality assurance, a school without major deficiency is accredited, with one major deficiency it is assigned to conditionally accredited and with more deficiencies to non accredited schools. The final report together with the SER is made public on the homepage of EAEVE. If the school does not accept the opinion of the ECOVE, there is room for appeal. When the deficiencies are rectified the establishment can become approved or accredited after a successful revisit. Receiving approval or accreditation is obviously an acknowledgement of the work of the school; however a decision on conditional or non approval/accreditation can also be beneficial, because by using the results of the international evaluation to argue for extra financial support from the local or national government to rectify the deficiencies, can be successful.

The 227-year-old Faculty of Veterinary Science Budapest is unique among the similar establishments, since it is the only veterinary school in Europe, where veterinary training is provided in three languages, Hungarian, English and German. A complete evaluation of the school including Stage 1 and Stage 2 was carried out in February, 2014. The two SERs were sent in late 2013 to the members of the two teams representing different countries. Stage 1 SER contained detailed data of undergraduate and postgraduate education and research, Stage 2 SER summarised the structure and the function of the quality assurance and quality management system of the establishment. The two teams visited the faculty on the last week of February and through visits to the different units, discussions with different people at the university including students, senior and junior academic and support staff verified the data presented in the SERs.

No major deficiencies were found by the teams, and they emphasised the high level of commitment of students and staff members, the strong ties of the 1500 Hungarian, English and German speaking students to the "Alma mater" was especially impressive for them. The high level of research output was also highly appreciated. These strengths are especially important for us, since our budget is much lower than that of the other accredited schools, and only the high commitment of students and staff members can explain them. The report contained several valuable suggestions; their implementation can further increase the level of education. They are connected with student welfare, faculty administration and the general concept of food safety. Both teams encouraged regaining the sovereign university status and financial independence because of the special nature of veterinary training.

ECOVE evaluated the reports of the two teams in May, 2014 and granted approval and accreditation to the only veterinary school of Hungary, the Faculty of Veterinary Science for 10 years. According to the evaluation by EAEVE the veterinary training of the Faculty of Veterinary Science, Budapest meets all the requirements without any major deficiencies. The quality assurance system of the faculty is a guarantee for the international veterinary community, the students and the society that the high level of the education is not only maintained by the school, but through continuous evaluation of teaching, teaching methods and teaching environment and immediate correction of the mistakes, the level of training is continuously increasing. The high level of veterinary training attracts excellent, motivated students and the European accreditation certifies that the level of the Hungarian veterinary training equals to that of the best schools in Europe. Results of the EAEVE evaluation are followed by professional organisations overseas, and the EAEVE accreditation helps to accept the diplomas outside Europe, too.

The suggestions of the report are welcomed by our faculty; their implementation will further help the development of veterinary education in Hungary. Accomplishing these suggestions and further development of the quality assurance and management methods will be top priorities of the next years.

The successful accreditation shows that the faculty management, the students and the whole staff are and were at all times dedicated to high quality veterinary training, in spite of the changing financial and social environment. Without the self-sacrificing work of the faculty management, and the commitment of the Hungarian and international students the accreditation process could not have been successful, which is highly acknowledged.

* A similar paper was published in the Magyar Állatorvosok Lapja (2014. 136: xxx-xxx.).

ECOLOGICAL RECONSTRUCTION OF MOUNTAIN HABITATS – CASE STUDY ON THE ACTIVITIES OF RENATURATION WITH CREEPING MOUNTAIN PINE SEEDLINGS IN RETEZAT NATIONAL PARK

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ABSTRACT

This study begins with presentation of the preservation plans of the unique natural landscape, named Retezat National Park, located in Meridional Carpathians (Romanian Southern Carpathians) and continues with the description of the natural distribution of the mountain pine (Pinus mugo) populations and their associated herbaceous and woody species in the Retezat National Park. Focusing on the mountain pine (Pinus mugo), establishing the methods of maintaining or protecting of non degraded populations, and the methods of restoration of degraded populations, within a conservative management of the alpine habitats belonging to Retezat National Park, are the aims of the present study. Between the natural and artificial regeneration methods applicable to restore the degraded mountain pines populations, the regeneration by plantation seems to be the only reasonable method, having in view that the natural regeneration is difficult and require long period of time. The renaturation with mountain pines seedlings, within the case study regarding an ecological restoration in Retezat National Park, methods, remarks and predictable results are presented. Also, the study offers details concerning the ecological principles of the destroyed habitat's artificial regeneration, such as: the planted area, seedlings, seedling production and their transportation to the planting area and effective plantation.

keywords: Retezat Mountains, alpine habitats, mountain pine (Pinus mugo), habitat restoration, artificial regeneration, afforestation

INTODUCTION

The Retezat National Park, located in Meridional Carpathians (Romanian Southern Carpathians), encompasses Romania's highest mountain ranges and one of Europe's last remaining pristine forests. Established in 1935, the Retezat National Park Reservation protects an exceptional floral diversity for high mountainous area with steep slopes, raised from ancient forests. The existence of more than a third of the Romanian flora in this area, sheltering around 1190 superior plants species of the 3450 species known in Romania, is one of the reasons for which it was declared a National Park (Report 2008; Report 2009; Report 2012; Report 2013).

The Retezat National Park has a great diversity of forms, which makes the landscape peculiarly spectacular. The protected area occupies the centre of the mountain. The first area with full protection has a scientific character (11466 ha), being prohibited any exploitation (mining, grazing, hunting, fishing, gathering fruit, hiking, and camping). In this area, the access is allowed only with authorization from the Natural Monuments Preservation Commission, on certain routes and territories. The second area has a less rigorous protection, grazing being allowed two months per year. With a wide variety of endangered and endemic plants and spectacular wildlife, the Retezat National Park is included in the UNESCO network of biosphere reserves.

Since the 1990s, the grazing activity has increased considerably, and damages brought to nature in Retezat National Park have increased worryingly. Every summer, sheep were climbing to alpine meadows, endangering

the flora and fauna of the area (as a result, the chamois number is decreasing every year). Because of this, in the last decade of the past century, the pasture area in Retezat decreased considerably, and for years, at the end of each summer remained eroded lands and much stevia, as a result of sheep grazing. Due to overgrazing, the characteristic species of natural grasslands have been completely degraded or gradually replaced by species that eliminate the other cohabiting plants (Hodor 2008; Report 2012; Report 2013).

Following a study on grasslands in Retezat Mountains (Retyezát–hegység), the Retezat National Park Administration concluded that their area has decreased drastically due to overgrazing (Report 2012; Report 2013). The alpine habitats in Retezat National Park are abused by overgrazing, an example in this respect being Drăgşanului Ridge (Dréksán–nyereg), where the biodiversity is very low, being correlated with the abandonment of former grazing areas, which requires careful management measures.

Figure 1: The Retezat Mountains view on the Drăgşanului Ridge (Dréksán–nyereg)

The preservation of the unique natural landscape, undisturbed, is a priority activity which brings benefits both in terms of biodiversity and tourism attractiveness. During 2008, it has been developed a monitoring protocol for the priority habitat of the creeping mountain pine and juniper shrubs in Retezat Mountains, aimed at the maintenance of natural processes deployment and elimination, or at least reduction of the factors hindering the deployment of these processes (Report, 2012; Report, 2013). So, certain direct actions have been supported for stopping the destructive processes, within a conservative management of the alpine habitats belonging to Retezat National Park (Hodor 2008; Report, 2012; Report, 2013).

Two ecological restoration actions have been proposed – the ecological reconstruction of eroded slopes and reforestation of some degraded ecosystems – destroyed areas located within the creeping mountain pine and juniper habitat. The reforestation action has been cancelled, because it was seen the natural regeneration of juniper in the affected areas, while the ecological restoration was made in Drăgşanului Ridge area, on a highly eroded torrent found in the juniper habitat, where a total of 1600 creeping mountain pine seedlings were planted, obtained from seeds collected from the Park, thus stopping the severe soil erosion phenomena over an area of approx. 1.5 ha. (Report 2008; Report 2013).

In the summer of 2007, it was started the destruction of stevia, and in the subsequent have been started the ecological restoration projects (Report 2008; Report 2013). In the years that followed, direct actions have been taken to restore the valuable alpine habitats belonging to the Park, resulting in the development of pilot projects for ecological restoration of some mountain pine tree habitats. In this regard, for the rehabilitation of some degraded areas in the mountain habitat, a series of actions have been conducted to review the perimeter planted, in soil beds, with 2–3 years old seedlings of creeping mountain pine shrubs originated from natural populations (Report 2008; Report 2013).

MATERIAL AND METHODS

Location

The Retezat Mountains is part of the Carpathian Eco–Region and is considered a severely threatened eco–region. Of Retezat Mountains area, approx. 2/3 is located at over 1600 m height and approx. 1/4 at over 2000 m (Greenpeace 2012; Report 2013). At the level of these areas, located at 2000 – 2200 m altitude, the people can easily circulate on paths without large ups and downs.

The relief is mainly shaped in accordance with the geologic structure. Retezat means "split mountain" in Romanian, and according to legend, a giant's bludgeon once hit the ridge, splitting it into two halves: The Retezatul Mare, or the "Big Retezat" in Romanian, with its high granite alpine landscape and the Retezatul Mic, or the "Little Retezat" in Romanian, dominated by rounder and softer mountains replete with limestone caves and Alpine meadows.

Because Retezat Mountains consist of two long chains, with different geological structures, they were called Retezatul Mare (Northern Retezat Mountains) and Retezatul Mic (Southern Retezat Mountains). The first, located in the north, is known for the large number of plants that can be found within relatively small areas, while the second, extended to South, is rich in flora species.

The mountain Retezatul Mic (Kis–Retyezát) is located in the southern part of Retezat Mountains, whose southern ridge extends them to the west, making the connection with Godeanu Mountains (Godján–hegység). The relief appearance detaches these mountains, key reason for which they are considered a separate mountain group making the transition between the Retezat and Godeanu mountains. This smoothing surface affects the main ridge, at altitudes above 1800 m, especially Drăgşanu Ridge. There is an asymmetry in the development of valleys: those on the southern side are longer, with lower slopes, and those on the north side are steeper, but shorter.

Unlike Retezatul Mare (Northern), with peaks cut in granites, with numerous clear streams and about 80 glacial lakes (of which 58 are permanent), arranged in buckets on

slope steps, in complexes or isolated, Retezatul Mic consists almost entirely of limestone, the broadest spread of this type in Romania being here. Retezatul Mic (Southern) has its own original, spectacular, hardly known relief. The surface water circulation is poor and intermittent, and the shallow groundwater is mostly confined in the alteration crust of the screes, and in areas with limestone deposits. The limestone were heavily fissured, and the absence of a thick vegetal carpet makes the water to seep into the depth, where they are gathering strand by strand, stream to stream, forming a powerful underground river, which after a journey of about 14 km in a straight line, by way of unknown galleries, breaks out just in Cerna Spring (Cserna–forrás).

The valleys have a big density, creating a considerable horizontal fragmentation of the relief. The heavy rains may cause landslides, due to the steep slopes. In August 1999, a uncommon rain determined major morphologic modifications on most of the valleys in the Retezat Massif. It is estimated that such phenomena of nature happen quite often, once in 50 – 100 years (Untaru et al. 2012; Report 2013).

The creeping mountain pine and juniper habitat in Retezat Mountains

The mountain pine (Pinus mugo) are dominant in the Retezat Mountains, spread over the entire subalpine floor, from the upper limit of the spruce forest (Picea abies), found at about 1500 – 1600 meters, up to an altitude of 2300 meters (Candrea Bozga et al. 2009; Radu 2004.; Hodor 2008). The large hedges covering the subalpine slopes, the mountain pine habitat, are mostly composed of creeping mountain pine (Pinus mugo), which grows either alone or associated with other arborescent woody plant species (especially spruce – Picea abies) or shrubs (especially juniper – Juniperus ssp.).

Figure 2: The creeping mountain pine habitat in the Retezat Mountains

Figure 3: The juniper habitat in the Retezat Mountains

The mountain pines are found from the upper limit of the spruce forest, up to the contact with the alpine meadows, physiognomically characterizing the subalpine floor Candrea Bozga et al. 2009; Doniță et al. 2005; Untaru et al. 2012). The mountain pines scrubs are becoming compact with increasing altitude, the boundary spruce forests thinning gradually. The clumps of stunted mountain pines and juniper bushes can be found at altitudes far beyond the limit of the compact mountain pines trees, on alpine meadows and rocks. With increasing altitude, the mountain pines compact thickets are crumbling, making way increasingly for undergrowths of 30–50 cm height, such as rhododendron species (Rhododendron ssp.).

The mountain pines tree subfloor (1700 – 2300 m) is, undoubtedly, interesting in terms of vegetation and landscape in Retezat National Park, consisting of juniper and creeping mountain pine trees, found in clumps or spreading carpets. Clumps can be seen on the northern slopes below 1700 m, as modest shrubs can withstand the climate at altitudes over 2300 m. The largest carpets of mountain pine are spreading between 1700 and 2100 m, as is the case of Drăgşanu Valley's forests and thickets.

Brief overview and motivation of renaturation in Retezat National Park – case study

A shorter erosion stage is observed on the northern slope of the mountain, on Drăgşanu Ridge (approx. 1600 – 1800 m altitude). A land in Retezat Mountains, degraded by overgrazing, located at 1600 m altitude, was strengthened by planting creeping mountain pine and junipers supplied by Retezat National Park Administration. Thus, a severely damaged forest area in Retezat National Park will be ecologically reconstructed (Report 2008; Report 2013).

Within the ecological restoration, five tons of creeping mountain pine and juniper seedlings (1600 seedlings) were transported in Retezat National Park by Retezat National Park

Figure 4: Degraded land by overgrazing in Retezat Mountains (Drăgşanu Valley)

Administration, for the renaturation of a degraded area. The objective of such ecological restoration is to restore the mountain pine natural habitat in Drăgşanu Ridge area, part of Retezatul Mic, belonging to Retezat National Park, located between 1600 m and 1950 m altitude, on the northern slope of Retezatul Mic. In this area, the priority habitat has been destroyed, and the habitat area reduction occurred in the past due to deforestation activities in favour of extending the grasslands, using mountain pine and juniper as firewood by shepherds and tourists, and the intense adjacent grazing.

Why was mountain pine and juniper required in Drăgşanu area? There, because of gullies dug by the sheep hooves, strong soil erosion occurred, phenomenon that favoured the formation of a torrent. This has resulted in landslides and degradation of the area, and the slope was severely affected. The mountain pine remained only in proportion of about 30% of the area. Because of the tree vegetation disappearance and the steep slope, which in some sections even reached 45°, an avalanche corridor has been formed.

All these led to the need to restore the former natural habitats, recovery consisting of strengthening by planting creeping mountain pine and juniper (seedlings). In these conditions, some ecological terraces have been made, on which creeping mountain pine was planted, for strengthening the soil. The planting of creeping mountain pine seedlings was organized by camps at altitude, with volunteers, with the support of Retezat National Park Administration and the assistance of Deva Forestry Directorate. To be noted that this is only one of the actions conducted within the conservative management activities aiming the alpine habitats of Retezat Național Park. Restoration works would target around 130 ha of valuable alpine habitats, mountain pine (*Pinus mugo*) habitats and alpine wetlands, and soil erosion would be prevented on several locations.

In the last few years, similar actions for the degraded grassland restoration have been started, through the implementation of pilot projects for ecological restoration of some mountain pine habitats. In Retezat National Park, the reconstruction actions will continue in the coming years, by planting mountain pine and juniper seedlings. Just like before, the planting will be made in compost pits, with 2–3 years old seedlings, supplied by Deva Forestry Directorate, a branch of National Forest Administration, from the nurseries of the Forest Research and Management Institute (ICAS).

Materials

The plant material consisted of creeping mountain pine seedlings. The habitat restoration was designed based on the principles of genetics, according to which the planting should be made using seedlings with local provenance. This principle could not be strictly observed in case of creeping mountain pine, as this species, although it's well represented in Retezat Mountains area, is very poor in the affected area. Therefore, the seedlings were grown in a nursery of the Forest Research and Management Institute, in Sinaia. The mountain pine seedlings of Pinus mugo were transported by truck from Sinaia, from the nursery of the Forest Research and Management Institute (ICAS), taken over by a helicopter, and brought in the affected area to be planted on Drăgşanu Ridge, in Retezat National Park.

Figure 5: The creeping mountain pine seedlings

Method of action

The plantation at the end of summer in subalpine zones was preferable to the spring one, because the nursery, where the seedlings were produced, is located at about 680–700 m altitude, where the vegetation period usually starts in March. Depending on soil thaw, in Retezat Mountains area the planting process cannot take place until the second decade of June. Until this time, the seedlings have already achieved a significant growth in nursery, and can be broken during transportation and handling. This is why we opted for planting them in late August.

We must note that the slope, associated with the felt formed by the perennial grass carpet roots and the limestone rock fragments, located at the surface or incorporated into the soil, created particularly difficult working conditions.

The habitat restoration with creeping mountain pine, within Drăgşanu Ridge area, depends on the success of this plantation, located in the subalpine zone on the northern slope of Retezatul Mic. Although the mountain pine seedlings may suffer transmutation stress, it is hoped, however, that at least 75–80% of the seedlings will adapt to the new conditions. In this regard, the creeping mountain pine seedlings are brought from the nursery with a sleeve of ground weighing more than 3 kilograms. Also, to prevent the drying during transmutation due to differences in humidity and temperature, the transportation had to last a period as short as possible. According to the inventory made taking into account the sample areas planted with creeping mountain pine, the median survival of the seedlings was even 90% in the previous years, but the survival rate varied from one area to another.

RESULTS AND DISCUSSION

Predictable results

The research and studies carried out in this area are numerous; they have continuity and tradition, and concern fundamental aspects regarding the biodiversity. For this

reason, the maintenance and proper management of this unique national park is a priority. The main objective was to improve the conservation management activities to halt the alpine habitats destruction in the Retezat Mountains would be implemented along with a campaign promoting conservation, especially the long-term preservation of the alpine habitats.

The long–term predictable results of the ecological restoration with creeping mountain pine, performed for supporting some actions aiming the stoppage of the destructive processes, are:

–prevention of avalanches, floods and soil erosion as a result of solid and liquid precipitation retention by the woody vegetation;

–creating the required conditions for natural regeneration and/or restoration of the creeping mountain pine population;

–provision of food, by means of mountain pine seeds, of some mammals (bear and certain species of small rodents), as well as some birds living in the mountain area;

–organising a campaign to promote the green conservative concepts, with a special focus on long–term preservation.

In the medium term, the expected outcomes are to create better conditions for the development of woody and herbaceous plants, along with the wild animals, followed by a normal development in the future. This goal is achieved by establishing a control over the factors that previously contributed to the degradation of the ecosystems consisting of plants and wild animals.

In the short term, the predictable results of this ecological restoration are:

–protection and preservation of flora and fauna;

–ecological restoration of creeping mountain pine and juniper habitats by planting in affected and degraded areas;

–creating normal conditions for natural regeneration of the mountain pine, which is going to spread bit by bit in the surrounding areas, so that the creeping mountain pine population will recover.

CONCLUSIONS

By ecological restoration of these mountain habitats, it is expected that the surface erosion of the degraded woodlands, previously used for grazing, to be fully stopped in 5–15 years after the execution of afforestation works, in accordance with the afforestation species and the nature and intensity of degradation.

Through the direct effect of the protective afforestations with creeping mountain pines, applied for the ecological reconstruction of these mountain habitats, it is expected a regeneration in 5–10 years time of the moderately/highly eroded slopes, and in 8–15 years time of the very strong/excessively eroded slopes.

ACKNOWLEDGEMENTS

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MODERN METHODS TO EXAMINE COMPOSTING PROCESSES

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ABSTRACT

The control of degradation process during composting is essential to produce a quality final product. The examination of deterministic parameters, such as temperature, aerobic/anaerobic conditions is time consuming, especially when laboratory measurements are needed. The aim of this paper is to introduce three methods - surface temperature measurements, reflectance and gas concentration measurements - that give direct information from the prism.

keywords: composting, surface temperature, gas concentration, reflectance

INTODUCTION

The political, economical and social changes of 1990s applied radical changes in the owner and structure system of the Hungarian agriculture. Many micro and small enterprises replaced the previous great plants that resulted the parcel out of properties (Molnár and Farkasné 2003).

By the reformation of the properties a gap between the two main area of agriculture occurred which also decreased the profitability of the enterprises. Accordingly, the depression of efficiency caused a decrease of animal stock. The number of pig and cattle decreased more than 40% comparing with the level of the 1970s (Baranyai and Takács 2007).

These changes resulted lower amount of organic manure as well. In the 1970s approximately 15 million tons of organic manure was utilized annually. Meanwhile, in 2005 this number was only 5 million tons. The propagation of artificial fertilizers boosted up this. The increase of fertilizer dozes not just only enlarge yield but affect soil characteristics and soil ecology.

The fertilizer dozes that shaped to plant needs fulfill the demand of plants but in a long term are not added to the sustainability of organic matter content of soil. Furthermore, the demand of microorganisms are not taken into consideration during the plan of dozes. According to this the microorganisms fulfill the needed nutrients from the soil and decrease the organic material base of soils. The extraction of organic compounds and humus may cause soil degradation or makes soil cultivation impossible (Dobos 1999).

To avoid these consequences and to sustain optimal soil characteristics the addition of organic compounds is needful. A possibility to ensure organic material demand is composting. By choosing raw materials, controlling degradation process and checking deterministic parameters an organic fertilizer is produced (Filep 1999). The broad selection of raw materials gives the possibility of waste disposal as well.

The efficiency of degradation is primarily determined by the amount and mixing rate of raw materials (wood dust, wood clipping, grass cutting, etc.). Next to the mixing rate the homogeneity, oxidative characteristics, moisture content and the C/N ratio affect the quality of final product (Petróczki and Késmárki 2003).

In the last decade one of the main research areas of the Institute of Water and Environmental Management was the examination of various biological waste treatment technologies - such as composting and biogas production.

Because a wide selection of composting technologies are available on the national and international markets the main aim is not to introduce new technologies but to improve the available ones, improve their efficiency and produce a final product with the same quality. To increase effectiveness it is important to explore the degradation process with economic and direct measurement methods.

Our institute is working on development of direct gas measurements, surface temperature measurements and utilization of reflectance during composting.

MATERIAL AND METHODS

The gas concentration of compost prisms gives information of the effectiveness of degradation and gives the possibility to control homogeneity and determine maturity. In practice the oxygen concentration only measured in closed composting technologies, however the connected measurements of CO_2 and O_2 gives an overview of aerobic/anaerobic circumstances. If the analysis is supported by ammonia and methane concentration measurements the degradation can be examined more precisely.

The basic equipment of measuring is an on-field, portable multigas analyzer, and OLDHAM MX 21 (Figure 1., [A]). The measurable gases are categorized into 4 groups: flammable gases, toxic gases (CO; HS; Cl; NH_3; etc.), CO_2 and oxygen. With the sensor cells 4 different gases can be measured simultaneously (Figure 1., [A/3]). The result is projected on a led screen (Figure 1., [A/1]) in ppm and in the case of flammable gases in percentage. The analyzer is equipped with a pump system and a gas injector cover Figure 1., [B]).

To measure the gas concentration directly inside the prism the mentioned gas analyzer had to be supplied with a developed stainless steel, acid proof measuring pole (Figure 1., [C] - inner diameter 14 mm , maximal measuring depth 1,5 m. For easier use the pole ends in spike (Figure 1., [C/3]) and equipped with a special handle (Figure 1., [C/1]). To avoid the contamination the measuring end of the pole is covered with a filter (Figure 1., [C/2]).

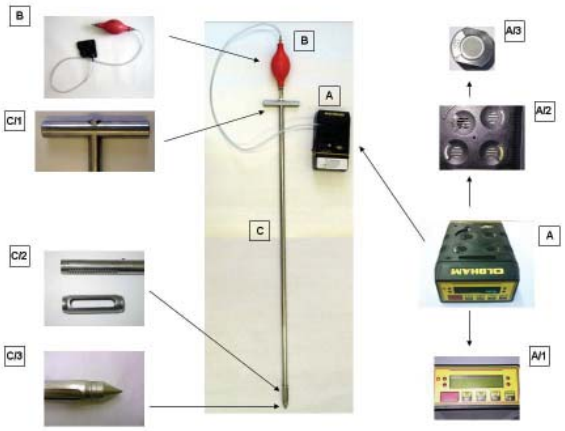

Figure 1: OLDHAM MX 21 portable gas analyzer
Legend:
A: OLDHAM MX 21 gas analyzer; **A/1**: Alfanumeric LCD screen
A/2: Top with sensors; **A/3**: Sensor cell; **B**: Pump system
C: Measuring pole; **C/1**: Special handle; **C/2**: Spike; **C/3**: Filter

The equipment measures 4 gases simultaneously. According to this the oxygen, carbon dioxide, ammonia and methane concentration can be measured in the same time. To evaluate degradation is better to handle CO_2 and O_2 together. The oxygen/carbon dioxide ratio is a number with which we can examine the aerobic/anaerobic conditions of degradation. Anaerobic conditions are confirmed by the increasing amount of methane and ammonia.

The inner temperature measurements are used to follow composting process. The measurement usually done with a stack thermometer, or temperature sensors. The method is applicable to examine the state of degradation, however, the disadvantage is that the measurement is done in points. According to this, if we would like to analyze the whole prism the point density has to be increased. Furthermore, the measurements with stack thermometer does not give information about the surface.

In the case of the mostly used composting technology - open air windrow composting - it is possible to use a thermocamera to analyze surface temperature (Figure 2.).

Figure 2: PYROLATER 12 thermocamera

The reflectance is applicable to determine the mixing rate of composts and to examine the degradation and evaluate compost maturity. The key issue during the utilization of reflectance that the sampling and the measurements are taken in the same place and give direct information of compost. On field measurements can be done with portable ALTA II spectrophotometer (Figure 3.).

Figure 3: ALTA II portable on-field spectrophotometer

RESULTS

The gas concentration of compost prisms is affected by various parameters (moisture content, temperature, C/N ratio, homogeneity, etc.). Although, we can conclude the gas constitution is stable at the end of degradation. According to this the decrease of ammonia and CO_2 concentration indicates compost stability and maturity.

From the trends of gas concentration changes we cannot separate the 4 main stages of degradation but the decrease at the end of composting can be seen. It is suitable to use gas measurements more frequently at the final stage of

degradation. The continuous gas measurements during the whole procedure are to explore aerobic/anaerobic conditions and examine homogeneity.

If we process the images given by the thermocamera areas with different temperature can be seen (Figure 4.)

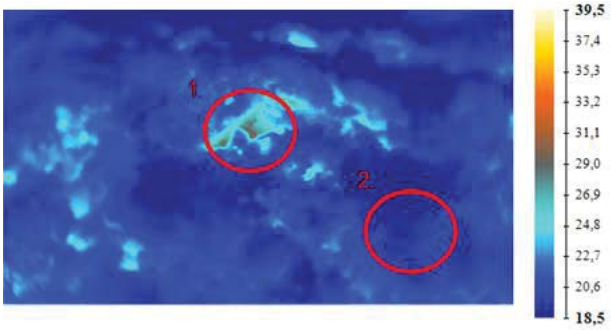

Figure 4: Areas with different temperature occurred on the surface of compost prisms

These differences can be 15-20 °C. The aim of using thermocamera is to analyze the surface and to determine the causes of these differences. The utilization of thermocamera can be economically effective if explore the reasons of these differences and we can alternate costly and time consuming methods.

By the use of thermocamera an overview is given where the characteristics of degradation is different. To determine the causes of various temperatures we took samples from those points where the the temperature was average and higher than average and measured the incineration loss, the C/N ratio and moisture content. There was only strong coherence between surface temperature and incineration loss. We can conclude that the temperature was affected by the organic matter content of the compost. Intermediately the C/N ratio and the moisture content cohered with surface temperature. The conclusion is the various temperature on the surface is a result of improper mixing. By the use of thermocamera there is no need to mix the whole prism only those areas where the temperature is higher or lower than the average.

We examined how the surface temperature affects the distribution of inner sections of the prism. The surface temperature modifies inside temperature of the compost. In the case when wood clipping was used as raw material a 20-30 cm width crust appeared resulting that the inside temperature does not adjust to the surface temperature. When wheat straw was used the inside temperature cohered with the surface temperature till 60 cm depth.

When we would like to determine mixing rate the basis of measurement is given by the different characteristics of raw materials, the dark raw materials (e.g. sewage sludge) have different reflectance than the bright ones (saw dust, straw, etc.). The infrared wavelengths are the most applicable to examine mixing rate, however, if the rate of sewage sludge is higher than 60 v/v% there is no difference in the reflectance values on none of the wavelengths. This does not affect considerably the applicability of the measuring method because in practice - to ensure the maximal effectiveness of composting - the rate of sewage sludge is not higher than 50 v/v%.

The increasing rate of brighter raw material increases the reflectance. The moisture content negatively affects reflectance, after drying the reflectance becomes higher. The method can be applied in the case of dried and wet samples as well, but if it is used for wet samples there is no need for the drying procedure and the samples directly taken from the compost can be measured.

The reflectance is suitable to determine compost maturity in the case of sewage sludge based open air composting. It is suggested to do the analysis and the temperature measurements simultaneously because the two result give more accurate information of compost maturity. The measurements should be done more frequently in the second stage of degradation (from 25th day) because we can conclude compost maturity and the build up of humic compounds from the experienced increase then decrease of reflectance (Figure 5.).

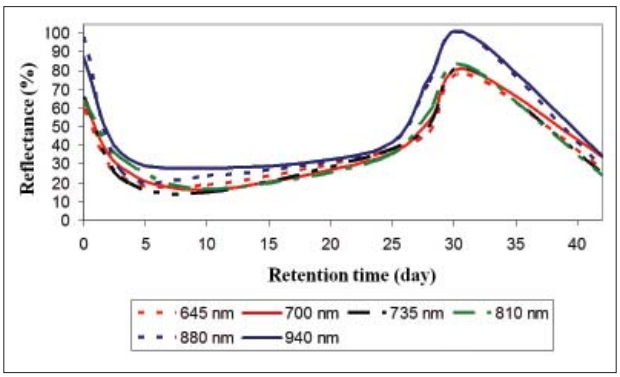

Figure 5: Changes of reflectance during retention time

Examining the trend of reflectance we can separate the degradation into four stages as it is done in the case of temperature measurements. In the beginning of degradation large amount of complex organic compounds are available which is confirmed by the high reflectance. In the second stage because of the intensive degradation simpler compounds are produced - the reflectance is lower. In the third stage by the build up of humus compounds, complex organic materials appear - the reflectance increases again. At the end of the degradation because of the darker color of compost the reflectance decreases to a stable level.

The applicability of reflectance to examine the degradation process is given by the color of compost and the construction of organic compounds. More complex compounds have higher reflectance as it is in the beginning and in the third stage of degradation. The final product, the compost is familiar to soil, has a darker color than the raw materials.

DISCUSSION

The developed technologies were only tested on open air sewage sludge based windrow composting their applicability should be examined for other raw materials or composting technologies. Reflectance and gas measurement methods are suitable to determine homogeneity and maturity but the measurements should be more frequent at the end of degradation.

CONCLUSIONS

The favorable condition effective composting and production of a quality product is the follow of degradation and the examination of the parameters that affect composting. By the analysis and control of deterministic parameters we can influence the efficiency and characteristics of compost. The main aim is to establish, develop utilize measuring methods that gives the possibility to get direct information from the compost prism because during laboratory analyses there is a gap between sampling and measuring.

The use of thermocamera and thermal imagery give an overview of the surface conditions, indicating to explore the areas with different temperature and highlight those areas where mixing is needed. The use of thermocamera is expensive which means that is more economical if more plants use it together.

The examination of the gas concentration gives information of the aerobic/anaerobic circumstances. It needs special equipments but can be automated in the case of closed technologies and gives the possibility to examine homogeneity and maturity.

Reflectance is a possibility to analyze mixing rate, homogeneity and maturity but has to be supplied with temperature measurement or gas measurements. The measurements should be done more frequently in the final stage of degradation. It is advised to use absorbance next to reflectance to detect more effectively compost maturity and stability.

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Voluntary programs in the Ecological Market Garden of Babat-valley

About the Ecological Market garden

The organic training farm near Gödöllő is a demonstration farm of the Szent István University. The farm is operated by GAK Nonprofit Public Utility Ltd., that is a company established and owned by the university.
The Ecological Market Garden in Babat-valley has been working since 2000. The garden and its products are certified organic by Biokontroll Hungaria. Organic farming and research in the garden is carried out on seven acres of land, mainly in the field of vegetable production. The ecological market garden has educational, research, production and sales activities, and offers theoretical and practical studies for students and the general public as well. Volunteers work regularly in the organic garden.

Join our Volunteer Program: spend a day in Babat-valley!

We offer a one-day volunteer program to companies that embrace Corporate Social Responsibility. Groups of 15 people are welcome for our special organic agriculture volunteer day. We deliver the group from their workplace to our ecological garden, where they get involved in harvesting and other horticulture works. The volunteers get acquainted with importance of organic gardening. During the day they have professional guiding and answer to their questions.

Schedule of a volunteer day:

8.15-9.00	Travel to Babat-valley
9.00-12.30	Gardening work
12.30-13.00	Dinner
13.00-13.30	Interactive training about the theoretical and technical questions of organic gardening
13.30-16.00	Gardening work
16.00-16.45	Travel home

The physical activity in nature (Green Care) has an added value for the individuals, as it prevents burn out syndrome and reduces stress levels. The participants get acquainted with ecological gardening and the importance of protecting nature. This event means a team building activity as well, with a positive effect on teamwork.

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