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THE EFFECT OF ProBio Original™ (EM-Farming™) ON THE COMPOSTING PROCESS OF BIODEGRADABLE WASTE; ITS INFLUENCE ON FINAL PRODUCT QUALITY AND QUANTITY

Summary

The aim of this experiment was to establish the effect of the ProBio Original™ preparation (hereinafter "preparation") on the composting process of biologically degradable waste in garden composters. The first stage of research was focused on the effect of different concentrations of the preparation onto the composting process in garden composters. Monitored parameters were the effect of the preparation on the course of temperatures during the composting process, material volume decrease and effect on the quality of the composted material. The input raw material was freshly cut grass provided by Centrální kompostárna (Central Composting Plant) Brno, a.s.

The experiment was carried out in five garden composters (290 L) for a period of 13 weeks. Three composters were enriched with the preparation at different concentrations, two of them were reference composters.

During the experiment, the course of the composting process was monitored (temperature, loss in material volume) as well as the compost quality (C/N ratio, nutrients, heavy metals).

During the experiment, a positive influence was observed of the preparation on the course of temperature in the composters. The enriched composters reached in the mineralization phase the thermophilic temperature ranges for a period of two weeks.

The rate of composted material volume reduction in the composters with the preparation was higher than that in the reference composters.

Moreover, a positive effect of the preparation was observed on the compost quality. As compared with composts from the reference composters, Ca and Mg concentrations in the resulting compost from the enriched composters were higher.

The effect of the preparation on the concentration of other nutrients was not demonstrated.

Key words: composting process, bioactive additives, organic matter

INTRODUCTION

Council Directive 1999/31/EC on landfills imposes to decrease the amount of biologically degradable communal waste deposited in landfills so that the proportion of this component in 2010, 2013 and 2020 is max. 75%, 50% and 35%, resp. mass percentage of all BDCW produced in 1995. Although the Ministry of Environment in cooperation with other sectors attempts at the application of various legal measures in the Czech Republic (the requirement imposed by the Directivebeing an integral part of the Waste Management Plan of the Czech Republic), there is a danger that the country will be sanctioned by the European Commission for default in its fulfilment.

One of the possibilities of how to divert the flux of biologically degradable wastes into the landfills of communal waste and channel the flux of nutrients and energy back to the soil is seen in education and in the promotion of household composting. Household composting can make use of a range of preparations for a more efficient composting process. Manufacturers of such additives promise mitigation of undesirable effects such as bad odours, accelerated composting process or improved quality of final product. There are at least eighteen preparations of this kind on the Czech market at present, whose prices range from tens to thousands CZK. Usefulness of these additives has been permanently discussed between experts and non-professionals. Several works were published that studied both positive and negative effects on the course of the composting process and on the quality of the resulting compost (Himanen et al. 2009). Kollárová (2004) experimented with two commercial additives in the compost fills. In this experiment, a positive effect was demonstrated on the reduced production of NH_3, CO_2, CH_4 and H_2S emissions in the compost fills. Razvi and Kramer (1996) experimented with seven additives for composting and showed that the additives were no more effective than good soil or mature compost.

The paper describes the first phase of long-term research into the effect of ProBio Original^{TM} preparation (hereinafter "preparation") on the course of the composting process of biologically degradable wastes in garden composters.

The aim of the first stage of research was focused on the effect of different concentrations of the preparation onto the composting process in garden composters. Monitored parameters were the effect of the preparation on the course of temperatures during the composting process, volume decrease of material and effect on the quality of the composted material.

MATERIAL AND METHODS

Preparation used in our experiment was ProBio ORIGINAL^{TM} (EM-Farming^{TM}). Material for the experiment was freshly cut grass originating from public areas in the city of Brno, which was provided by Centrální kompostárna (Central Composting Plant) Brno, a.s.

This material was chosen for its unambiguous definability.

The experiment was carried out in five garden composters of 290 L in volume. Two composters (2 and 5) were used for reference. Three composters (1, 3 and 4) were enriched with the preparation at different concentrations after compost filling. Another aim of this experiment was to determine the effect of the preparation on the composting process in dependence on its concentration. Each composter was therefore enriched with a different amount of the preparation. Composter 1 was added the preparation at 1 L/m^3, Composter 3 at 10 L/m^3 and Composter 4 at 20 L/m^3.

With the exception of Sample 2, all composters were hoed for aeration and moisture content in the material was established.

In order to accelerate the beginning of the composting process, all composters were added 20 litres of inoculate – industrial compost originating from Central Composting Plant Brno.

The input material was sampled at filling the composters and the parameters to be determined by the analysis were as follows:

a) dry matter
b) combustibles
c) total nitrogen
d) C/N ratio

and subsequently the concentrations of Ca, Mg, K, P, Ca, Cu, Pb, Zn and Hg.

Concentrations of other hazardous elements were not determined as no reason existed for the occurrence of their increased concentrations in the input material.

During the composting experiment, regular measurements of temperature in the composters (depth 50 cm) and of ambient temperature were made by the digital contact thermometer; also volume loss of the material was regularly measured. The temperature measurements were taken once a week. In two cases, the temperature was measured two times a week. The experimental monitoring lasted 13 weeks.

The end of the composting process was followed by the chemical analysis of all output results, which were subsequently compared.

RESULTS AND DISCUSSION

Temperature

The course of temperatures is shown in Fig. 1. The greatest temperature changes were recorded in the first two weeks of the experiment – in a so-called stage of mineralization. While the temperature increase in the reference composters was low, the composters enriched with the preparation reached the thermophilic zone of temperatures, which was sustained for two weeks.

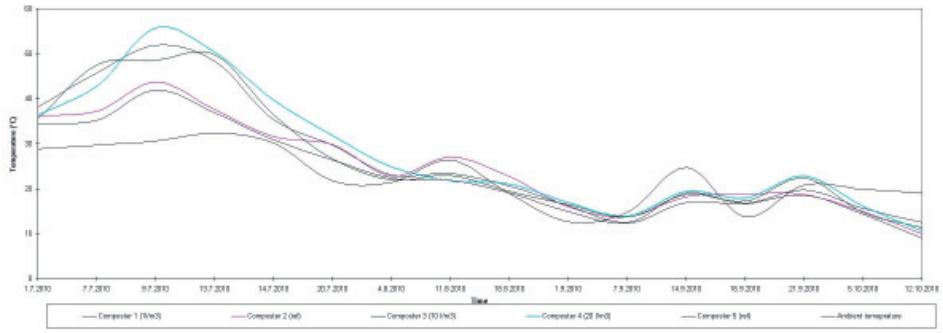

Figure 1. Development of temperatures in composters and in ambient environment

The measured data of temperature development in the composters indicate that the ProBio Original^{TM} preparation had a positive effect on the course of temperature during the composting process. The stage of mineralization was longer in all composters with the applied preparation and was more intensive. The composters enriched with the preparation solution reached thermophilic temperatures already during the first stage of composting and the temperatures were maintained for two weeks.

Maximum temperature values were recorded in all composters during the second experimental week – reference composters 2 and 5 (43.7^{o}C and 41.9^{o}C, resp.), experimental composter 1 c = 1 litre/m^3 (51.9^{o}C), experimental composter 3 c = 10 litres/m^3 (49.7^{o}C) and experimental composter 4 c = 20 litres/m^3 (55.8^{o}C).

Volume change of the composted material

It was expected that the increased microbial activity would result in a more rapid loss of volume of the composted matter. The hypothesis was corroborated by the experimental measurements. The volume change of the composted material is shown in Fig. 2.

The applied preparation had a positive effect on the volume loss of the composted grass. The greatest loss of the composted material was recorded in Composter 3: 82.9% at the end of the experiment. The second highest material loss was observed in Composter 4 (75.7%) and the third highest loss of the composted material was detected in Composter 1 (65.7%).

The volume change in the composters without the preparation was lesser. The lowest volume change was recorded in Composter 2. This composter had been not hoed, only the material moisture content was checked and modified during the experiment. However, it should be pointed out here that in spite of

the normal course of temperatures inside the compost fill, the composting process was very slow. It seems that worse aeration conditions led to low microbial activity in the compost fill. However, this is only a hypothesis because the rate of oxidation-reduction processes was not measured and will be studied only in the second part of the experiment.

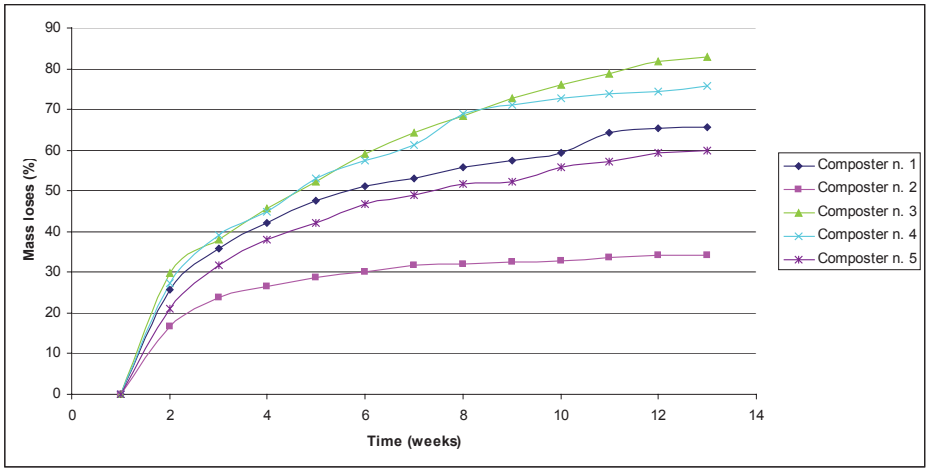

Figure 2. Volume decrease of the composted matter (%)

Although the volume loss of the composted material in Composter 5 was nearly identical as that in Composter 1, it should be pointed out that a large formicary existed at the bottom of Composter 5 and the conditions in this composter were different due to the attendance of this community. This is why the results cannot be compared with other experimental composters.

Chemical analysis

For the purpose of our experiment, a chemical analysis of the input material focused on the attributes mentioned in Section 2 was carried out. Results of the analysis are presented in Table 1.

The end of the experiment was followed by the chemical analysis of the output material. The aim of this measurement was to find out whether the application of ProBio Original^{TM} preparation could affect quality of the resulting material. As the composting process has by itself the effect of nutrients concentration, the positive effect of the additive was considered an increased concentration of nutrients as compared with the reference composters.

The results of the chemical analysis indicate that the input material did not exceed in any of its parameters the concentrations of hazardous elements stipulated in CSN 46 5735. For this reason, the concentrations of these elements were not analyzed in the chemical analysis of the output material.

Table 1. The analysis of input material quality

Parameter		NM	Unit	NM[(1)]	Testing method
Combustibles	85.2	10%	% DM	10%	GRA 04A:ČSN EN 12 879, ČSN 46 5735
Total nitrogen	2.78	10%	% DM	10%	VOL 11A: ČSN 46 5735, ČSN EN 13 342
C:N	15.3				Výpočet ČSN 465735
Ca	16800	20%	mg/kg DM	20%	ICP 04A:ČSN EN ISO 11885
Mg	2840	20%	mg/kg DM	20%	ICP 04A:ČSN EN ISO 11885
K	30000	20%	mg/kg DM	20%	ICP 04A:ČSN EN ISO 11885
Total P	3390	20%	mg/kg DM	20%	ICP 04A:ČSN EN ISO 11885
Cd	0.29		mg/kg DM		ICP 04A:ČSN EN ISO 11885
Cu	11.8	20%	mg/kg DM	20%	ICP 04A:ČSN EN ISO 11885
Pb	2.93		mg/kg DM		ICP 04A:ČSN EN ISO 11885
Zn	60.4	20%	mg/kg DM	20%	ICP 04A:ČSN EN ISO 11885
Hg	0.0258	20%	mg/kg DM	20%	AAS 06-07:ČSN 757440

The results of the chemical analysis of output materials are illustrated in Fig. 3.

The obtained data show that the added preparation did not clearly affect the qualitative parameters of the output material. Positive effect was recorded only in some parameters while some other parameters exhibited a lower increase of the concentration as compared with the reference composters, and in one case the concentration of determined element even decreased as compared with the input material.

Compared with the input material, the composters enriched with the preparation showed an increased concentration of calcium by 108% (Composter 1), 170% (Composter 3) and 194% (Composter 4). In the reference composters, the concentration of calcium increased by 52% (Composter 2) and 110% (Composter 5).

The same effect was recorded in the concentration of magnesium, which increased in the composters enriched with the preparation by 127% (Composter 1), 146% (Composter 3) and 196% (Composter 4) as compared with the input material. In the reference composters, the concentration of magnesium increased by 96% (Composter 2) and 90% (Composter 5).

[1] NM – Uncertainty of measurement is defined as extended measurement uncertainty of significance level at 95%, with the coverage factor k=2 and it does not include sampling uncertainty. Uncertainty is expressed in line with EA-4/16. This uncertainty is not related to results below the lower limit and above the upper limit of determinability.

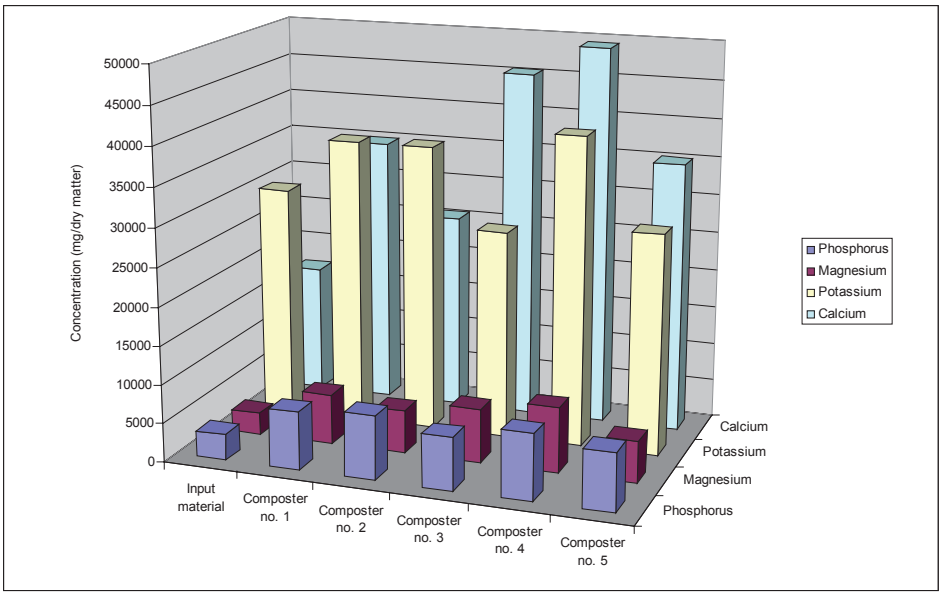

Figure 3. Concentrations of elements in the input and output material

In the case of phosphorus concentration, all samples of output materials showed increased concentrations as compared with the input material. The highest increase of phosphorus concentration was recorded in Composter 4 (153%). The second highest increase was measured in Composter 2 (143%). A 123%-increase was recorded in Composters 1 and 5 and the lowest increase was observed in Composter 3 (101%).

The concentration of potassium in the output material was increased in Composter 4 (24%) and in Composters 1 and 2 (24%) while it decreased in Composters 3 and 5 by 10% and 5%, respectively.

CONCLUSION

The application of the ProBio Original^{TM} positively affected the composting process. Higher activity of microorganisms in the composters, characterized by the achievement of temperatures within the termophilic zones, resulted in a more dynamical process of composting grass matter. Higher volume loss of the composted material and higher concentration of macro-elements (Ca, Mg) in the composters enriched with the preparation were another benefits.

The results from the reference composter no. 5 on the bottom of which a large colony of ants was discovered at hoeing can be taken into account only marginally as the presence of this community might have created non-standard conditions inside the composter.

Based on the experimental results, a concentration chosen for the second phase of the experiment was 10 litres/m^3. In this second phase, the compost fill is more accommodated to the composition of biologically degradable waste from households and the range of measured variables is extended (oxidation-reduction potential, O_2 concentration, conductivity, water-soluble NH_4-N and NO_3-N).

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