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Studies of the active substance before and after the process of composting in the bioreactor using the green and separately collected organic waste

This document describes the presence of the active substance before and after the composting process using bioreactor technology operating in MUT-Herhof. The results show that, despite the use of green waste and separately collected municipal waste to composting presence of active substances are different. The article examined the occurrence of plant hormones KA, GA 6-BA, PAA, IAA before and after the process of composting in a bioreactor. Were also tested the total amounts of phenolic compounds.

Introduction

Prolonged usage of chemical fertilizers in agriculture has negative impact on soil productivity and quality of environment therefore there is growing interest in usage of organic fertilizers. One of most popular natural fertilizers is compost. Production doesn't require high financial outlay while prize is getting more attractive in agriculture. Compost is also used to fertilize green areas and urban greenery [1,2] as well as in soil remediation [3].

Composting is aerobic process during which occurs decomposition of organic fraction with participation of aerobic microorganisms [4]. There are two systems of composting: open system in which the bioreactor is not being used, and closed system in which the organic matter is being transformed in a bioreactor [2]. During the both process there can be distinguished two phases [5]:

- thermophilic phase (intensive composting) during which occurs hygienisation of compost and the fresh compost is received,
- tezophylic phase (compost maturing) in this phase substances heavily biodegradable are decomposed and stable humus structures are formed.

Compost is a source of nutrients, vitamins and growth promoting substances [8-11]. It improves soil structure due to increased soil sorptivity [12] and has the effect on fertility by increasing organic matter content and the water holding capacity of the soil.

In order to determine maturity of compost we focus on indicators such as [6,7]:

- temperature,
- loss of organic matter,
- ratio C:N,
- ratio Cl:N,
- quantity of fungus of the genus *Cheatomium.*

During whole process hygienisation of entire mass is important in order to eliminate pathogenic organisms [4]. It is also relevant to monitor temperature during entire process so that hygienisation phase (temp. >50˚C) would last as long as possible.

Raw material obtained during composting is effective in crops growth and receiving higher yield [13]. It can also contribute to neutralization of crops pathogens [14] which have detrimental influence on growth. Research conducted [15] on the chemical composition of different types of compost indicate that compost produced from green waste fraction give better results than manure. It is worth noticing that yield achieved using compost give similar results to yield that was fertilized using mineral fertilizers [16].

Composting is an industrial process, therefore, attention should be paid to the research on the contents of phytohormones in mixtures composted in a composting mass. Despite maintaining the percentage of waste for composting and structural material, they differ in terms of the maintenance of fixed quantities of the same material (difficult to maintain the same compound).

Research [17], which was conducted to compare different composting blend in terms of degradation of organic substances indicate that blend of selectively collected kitchen and green waste give best results in terms of achieved temperature, CO_2 release, ammonification and nitrification as well as accumulation and disposal of low weight carboxylic acids to comparative with another composition in whole research.

The difficulty in determining content of hormones in composts that stimulate the growth of plants is related to the heterogeneity of composting mass before and after the composting process.

Practical parts and conclusions

Researchers undertook a study on the identification of growth promoting substances contained in the compost mass before and after the process of composting in the bioreactor working in technology MUT-Herhof located in Zywiec. The samples were tested for the presence of stimulants. Four of them were colected before placing in the bioreactor (labeled with “a” and other four collected after placing in the bioreactor for 9 days).

Beside the occurrence of growth promoting substances, compost is a source of phenolic compounds (Table 1), which have antioxidative properties. The simplest but not the most accurate method to determine this substances is spectrophotometric method using Folin-Ciocalteu protocol. The samples were tested using this method described in [18] with some modifications. Calibration curve was prepared by using gallic acid monohydrate solutions in a range of concentrations 1-10 µg/ml. Samples were tested in triplicate using 760 nm wavelenght.

Differences between samples are caused by their diverse content of green parts of plants eg. leaves, grass.

Table 1. Total phenolic compounds

Sample	Total phenolics compounds in mg/g of extraction residue expressed as equivalents of gallic acid monohydrate
1 a	15,78 ± 0,05
1 b	6,49 ± 0,05
2 a	11,22 ± 0,05
2 b	11,75 ± 0,05
3 a	7,14 ± 0,05
3 b	15,62 ± 0,05
4 a	6,67 ± 0,05
4 b	11,44 ± 0,05

There is no regularity in content of total phenolic compounds considering the fact of placing the samples in bioreactor. For samples which were collected after bioreactor higher content was estimated except sample 1 in which the amount of this group of compounds was higher for the part collected before bioreactor.

High Performance Liquid Chromatogrphy with UV detection was used to determine the presence of plant hormones in collected samples. This method can be used for liquid samples, that is why extraction in methanol was performed for all samples. After, all of the extract were evaporate to dryness and 0,1 g of the residue was dissolved in 10 ml of methanol (HPLC grade). To prepare the samples for the analysis, they were trickled through nylon syringe filter, obtaining transparent yellowish solutions. Pattern compounds used to identify were used as follows: auxins: IAA - indole-3-acetic acid, PAA - phenylacetic acid, gibberellin GA - gibberellic acid, cytokinins: KA - kinetin, 6-BA - 6-benzylaminopurine. Method described in "Separation of Abscisic Acid, Indole-3-Acetic Acid, Gibberellic Acid in 99 R (Vitis berlandieri x Vitisrupestris) and Rose Oil (Rosa damascena Mill.) by Reversed Phase Liquid Chromatography with some modifications was used to separate the compounds. The flow was 1 ml/min and injection of 20 µl. Column used in the analysis was Luna C-18 100A, 150x4,6 mm, 5 µm, purchased from Phenomenex. Time of the analysis was set for 10 min for patterns and 20 min for samples. Detection was carried out in UV mode, using wavelenghts of 208, 254 and 280 nm.
The results are shown in Table 2.

Table 2.

Summary of the likely presence of plant hormones in the samples based on HPLC analysis
+ - detected
X-not detected

sample	KA	GA	6-BA	PAA	IAA
1a	+	X	+	+	X
1b	+	X	+	X	X
2a	X	X	+	+	X
2b	X	X	X	X	X
3a	X	X	X	+	X
3b	X	X	+	+	X
4a	X	X	X	X	X
4b	X	X	+	X	X

Although preliminary studies indicating the presence of substances that stimulate plant growth specimen to identify their content in samples composting mass should pay attention to the heterogeneity of composted masses. Therefore, further work is needed to define their research on the amount of the composting mass.

Determination of contents phytohormones in further studies will determine the mature compost that can be used as a plant growth stimulator. So far, the compost was only classified as a fertilizer or soil improver. The presented article was intended to draw attention to the possibility of the use of compost as a fertilizer not only organic but also the possibility of using it as a plant growth stimulant. Therefore, it was the aspect of the content of phytohormones in composts and compost operation level growth.

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