EARTHWORM BIOHUMUS CONDITIONING FOR PELLET PRODUCTION

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Abstract. Vermicomposting is widely being used for bio-conversion of organic wastes into bio-fertilizers through the use of worms, bacteria, and fungi. By managing vermicomposting we are essentially speeding up the natural process of breaking down organic matter. In Latvia, vermicompost has been applied as a bio-fertilizer in its raw form. This has challenges in terms of storage and packaging for sale, especially when there is mass production of vermicompost. This study therefore focused on the suitable technologies of pelleting vermicompost in small and medium scale vermicomposting farms. Experiments to determine the moisture content of SIA Bioorganic Earthworm Compost biohumus were carried out. Vermicompost pelleting process parameters depending on the moisture content were investigated. Total moisture content of vermicompost is in the range of 42…51 %. Bulk density of vermicompost pellets (diameter 6 mm) is 750-780 ± 20 $kg \cdot m^{-3}$.

Keywords: vermicompost, pellets, density, moisture content.

Introduction

Vermicomposting is a special type of composting, which uses certain earth worms. The earthworm species most often used are Red Wigglers. These species are only rarely found in soil and are adapted to special conditions in rotting vegetation, compost and manure piles.

Vermicompost is a bio-fertiliser that is obtained from bio-conversion of organic waste. Vermicompost is the end-product of breakdown of organic matter by some species of earthworms. Vermicompost is a nutrient-rich, natural fertilizer and soil conditioner.

The benefits of vermicompost to seedling vigour and plant health are attributed in large part to high concentrations of plant available macro- and micro nutrients, plant growth promoting organic acids and high microbial activity, all of which may confer tolerance to stress [1].

The possible compaction of these composted solids into pellets further homogenizes and dehydrates their organic matter enhancing. Its uniformity and fertilizing properties as well as densification, such as pelleting, is a solution for these problems, which increase the bulk density, improve storability, reduce transportation costs and make these materials easier to handle [2].

Vermicompost (VC), which is produced by the fragmentation of organic wastes by earthworms, contains nutrients in forms that are readily available for plant uptake [3].

SIA Bioorganic Earthworm Compost produces high quality earthworm compost or biohumus using the technology VERMIC 3.5 acquired in Austria (Fig. 1). The raw materials for compost, which is fed to the earthworms, come from clean, unpolluted surroundings, superiorly from organic certified farmers. Compounds are composed of cattle manure, green grass, mainly lucerne (alfalfa) and straw.

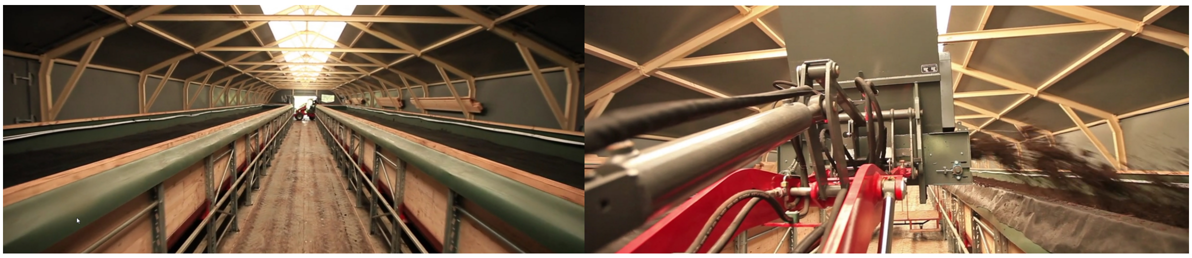


Fig. 1. **Ltd Bioorganic Earthworm Compost (source: http://www.bioec.lv)**

Biohumuss is widely used for production of various vegetables. However, its use is difficult in places such as recreation, sports, golf, and football fields. Humus uneven distribution across the field promotes grass growth at different speeds. The result is not acceptable. Therefore, to develop vermicomposting end product usability there is a need to work in several directions.

One of the directions is to develop the possibility of humus evenly spreading across the field, to develop a new or improve the existing technology, which allows doing it with minimal impact on the product quality.

Granular vermicompost can be called concentrated fertilizer, because the recycling process reduces the volume of material more than 10 times, due to water removal and material thickening while extruding [4].

When transporting it larger distances and storing, it is desirable that the moisture content is minimal, because it affects both the mass of the products, as well as microbial activity. It is therefore necessary to examine the humus moisture content and determine the energy needed for drying it.

The density of the product also improves transport efficiency, so the solution could be vermicompost granulation. Pellets are easier to be dosed and spread on the field.

In cooperation with the company Ltd. Bioorganic Earthworm Compost discussions about the appropriate granulation technology for medium-sized company took place. Therefore, in this article possible vermicompost granulation technologies and their advantages and disadvantages will be analysed.

Materials and methods

In the experiment natural vermicompost was used. Moisture content of vermicompost used in the sieve analysis was ~4 %, but density 264 kg·m^{-3}. Sieve analysis (according to LVS EN 15149-1) showed that there are just 1 % particles that did not pass through the sieve with the hole diameter 3 mm (Fig. 2).

Visual estimation of particles (Fig. 3) let us state that dried vermicomopost is a homogenous material. Just in finer particles some small grains of sand – white colour – can be detected.

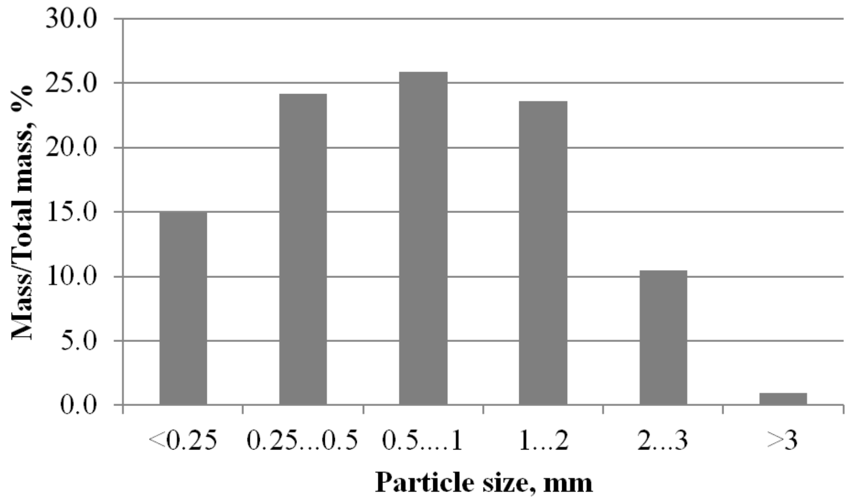


Fig. 2. **Particle size distribution of vermicompost**

Fig. 3. **Vermicompost particles after sieve analysis**

Granulation experiments let us evaluete the quality (density, moisture content) of pellets, the required moisture of vermicompost and temperature in the pelleting process. Granulation was carried out with the small scale 4 kW flat die granulator ZLSP150B for sawdust granulation (Fig. 4).

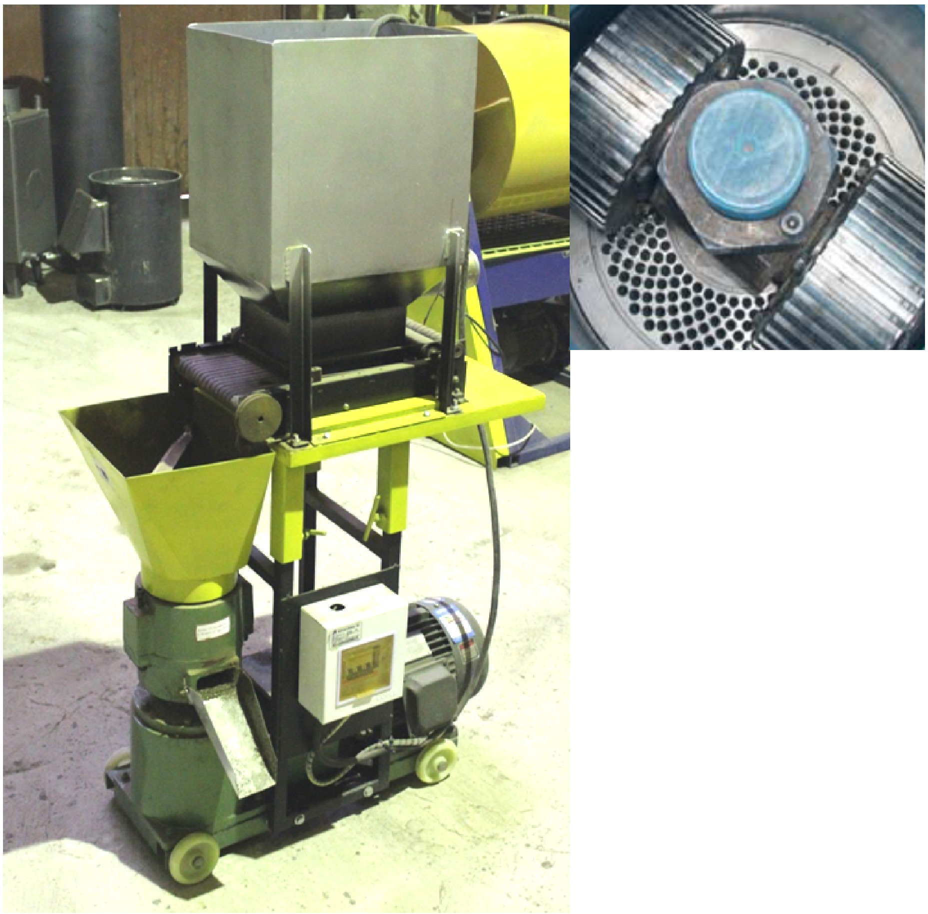


Fig. 4. **Flat die extrusion granulator ZLSP150B**

Vermicompost with different moisture content was granulated. The particle density of pellets and the moisture content (according to LVS EN 14774) as well as the bulk density of pellets (according to LVS EN 15103) were determined.

The diameter and length of 21 pellets from each sample were measured by a digital caliper. The corresponding mass of a pellet was also obtained with a digital balance with an accuracy of 0.01 g. Particle density was calculated as mass and volume proportion.

Results and discussion

For humus granulation more frequently used granulator types are shown in Table 1. This table summarizes the advantages and disadvantages of granulators.

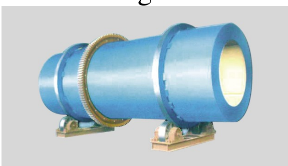
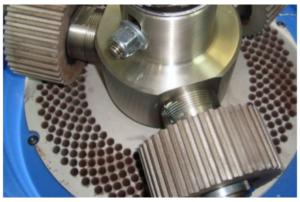
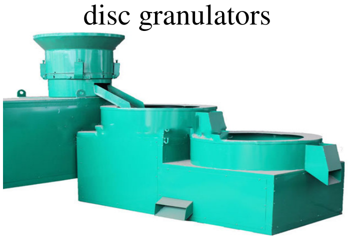
Overall, less investments are necessary for the use of the disc and flat die granulator. If we compare these two, from the point of view of the naturalness of the product, the disk granulator is preferred as flat die granulator in the granulation process on the die surface with high temperature. In our experiment we measured the die temperature 90...95 ºC. Temperature of the pellets in the granulator outlet was 70…80 ºC.

The moisture content of pellets must be less than 20 % [2]. Deterioration of pellets during the storage period is important in order to keep the quality of the compost. More molds generate on the surface of compost pellets than ordinary compost with the same moisture content. It is advised to reduce the moisture content of the pellets to 15 % or less, because deterioration by condensation is caused even at 20 % moisture content [2].

Total moisture content (on wet basis) of vermicompost determined with the oven dry method is in the range of 42…51 %.

Table 1

Types of granulators

No	Type of granulator	Notes
1	Drum granulator  Source: www.alibaba.com	Advantages: • High productivity, durable; • Easy adjustment; • Minimum maintenance. Disadvantages: • Big dimensions and weight [6; 7].
2	Disk granulator  Source: www.feeco.com	Advantages: • Compactness; • Economical; • Possibility of obtaining the required size pellets. Disadvantages: • Productivity depends on the equipment size [6].
3	Flat die extrusion granulator  Source:www.buskirkeng.com	Advantages: • Compactness; • Economical; Disadvantages: • Increased working parts wane; • Time-consuming work of parts replacement [5; 6].
4	Ring Die Pellet Mills  Source: www.stolz.fr	Advantages: • Compactness; • High productivity; Disadvantages: • Increased working parts wane; • Time-consuming work of parts replacement [5; 6].
5	Double roller extrusion granulator  Source: www.longerinc.com	Advantages: • Compactness; • High productivity; Disadvantages: • Time-consuming work of parts replacement.
6	Combined flat die and two disc granulators  www.fertilizer-machine.net	Advantages: • High productivity; • Protecting bacteria at room temperature, smooth granulating path inside the granulating machine. Disadvantages: • Big dimensions and weight; • Increased working parts wane.

The pelleted organic compost fertilizer pellet moisture content was 15-20 % (Fig. 5). If the moisture content is 20 %, in the pelletizing process approximately 5 % moisture evaporates, when the humidity of the mass is higher the volatile water content also will be higher (Fig. 5). The pellet bulk density was influenced by the vermicompost moisture.

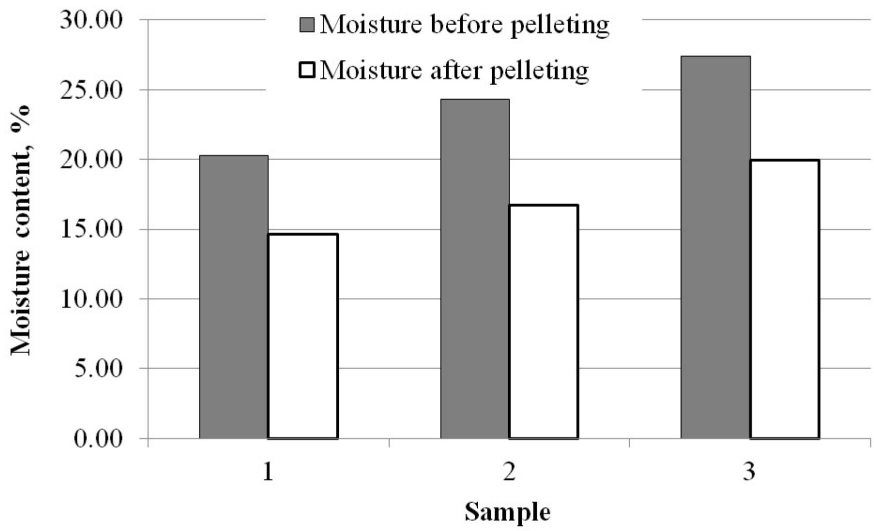


Fig. 5. **Moisture content before and after granulation**

Determined bulk density of vermicompost pellets (diameter 6 mm) in dependence on the moisture content (20, 24, 27 %) was 750-780 ± 20 kg·m^{-3} (Fig. 6). It can be concluded that the pellet density is higher if the mass moisture content is lower than 20 %.

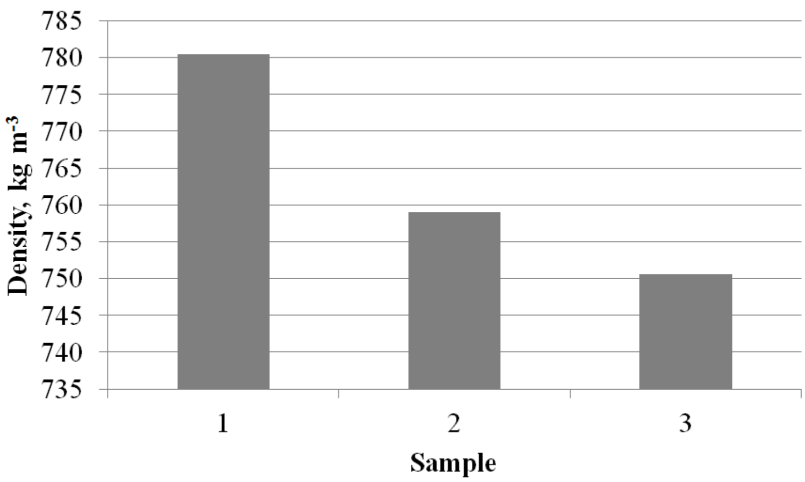


Fig. 6. **Bulk density of pellets**

The obtained particle density of vermicompost pellets in dependence on the moisture content (20, 24, 27 %) was 1480-1600 ± 15 kg·m^{-3} (Fig. 7).

In this study a sawdust pellet mill was used and the flat die surface temperature reached 95 degrees. The study should be continued to investigate the granulated vermicompost fertilizer efficiency after processing at high temperature.

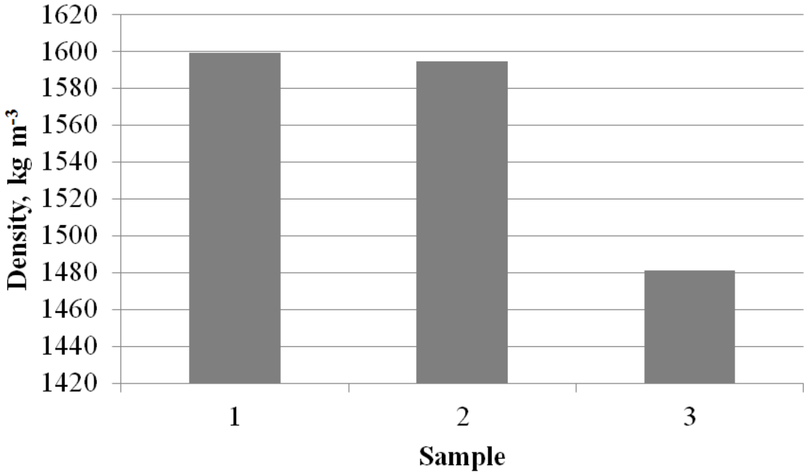


Fig. 7. **Pellet particle density**

Conclusions

1. Total moisture content (on wet basis) of vermicompost determined with the oven dry method is in the range of 42…51 %.
2. Less investments are necessary for the use of the disc and flat die granulator.
3. Disk granulator is recommended instead of the flat die granulator, because in the granulation process on the die surface is high temperature (90 ... 95 ºC).
4. In the pelletizing process approximately 5 % moisture evaporates, if the initial moisture content is 20 %.
5. Bulk density of vermicompost pellets (diameter 6mm) is 750-780 ± 20 $kg \cdot m^{-3}$.
6. Particle density of vermicompost pellets in dependence on the moisture content is in the range of 1480-1600 ± 15 $kg \cdot m^{-3}$.

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