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HOW TO APPLY THE CONCEPT OF CIRCULAR ECONOMY AT HOME: SIMPLE - MAKE VERMICOMPOST FROM KITCHEN AND GARDEN WASTE

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Abstract

Using waste as a resource - this may be the definition of the concept of circular economy that we have tried to put into practice. The reuse and transformation of organic waste from the kitchen and garden can be transformed by biological and biotechnological processes in which microorganisms and decomposing worms are used.

Composting is a microbial successional process which have progression in breakdown of substrates and the resulted product, work as a substrate for next successive population, whereas vermicomposting is a biotechnological process in which certain species of earthworms (Lumbricus spp. And Eisenia foetida) are used to enhance the process of waste degradation.

It is a mesophilic process that comprises bacterial and fungal degradation with the help of earthworms; all of them are active at 10°C–32°C. Initial degradation takes place in the gut of the earthworm so it is a fast process. Earthworms are often called as friends of farmers because they convert waste into gold. The dominant phyla in vermicompost are dominant uncultured Acidobacteria, Chloroflexi, Bacterioides and Gemmatimonadetes. Highly active bacterial as well as fungal populations are found in compost and vermicompost.

Vermicompost amendment helps plant soil sodicity and salinity and encourages multiplication of microbial biocontrol agents in disease suppressive soils and suppress a variety of diseases.

Earthworms (phylum Annelida), usually red wigglers (Eisenia foetida) or European night crawlers (Eisenia hortensis), are used to compost organic materials, such as pig and cattle manure, agricultural and yard waste, and food waste (e.g., cafeteria, coffee shop, restaurant, and groceries). The worm castings result in organic fertilizer that can be applied to the land. The process of composting is usually odorless. There is a growing group of vermiculture enthusiasts and advocates within the organic food, locally produced food, and urban agricultural movements.

The beneficial effects of earthworm feces and worm casts on crops have been known for more than a century, however, there has been a significant increase in applications of vermicompost in certain types of agriculture over the last decade because of the identification of specific plant growth–promoting properties. The technique of vermicomposting also helps to recycle plant material waste, municipal wastes and animal manure. The use of vermicompost is vital in sustainable agriculture since it is an inexpensive method of managing agricultural wastes, in particular. Vermicompost maintains a stable physical soil structure because of the presence of soil macropores and organo-mineral complexes that allows adequate porosity, good aeration, water holding capacity, microbial activity, balanced mineral nutrients, and colloidal buffering capacity. These properties are due to the presence of humic and fulvic acid. Biostimulatory effects can be obtained from vermicomposts, which can be utilized in agriculture and horticulture to replenish nutrients and improve plant resistance toward abiotic stresses.

There are various formulations of vermicompost available in the commercial market such as their leachates (i.e., the liquid runoff that settles in or below the vermicompost), teas (vermicompost water extracts), and other extracts which are darkly colored, odorless, and rich in nutrients.

This paper presents the results obtained in the research conducted for the case study included in the Bachelor's Thesis. All experiments underlying this study were performed in the laboratory of Ecology and Environmental Microbiology within the Faculty of Land Reclamation and Environmental Engineering within the U.S.A.M.V. Bucharest. In this paper we present the results obtained by testing the vermicompost we produced from organic household waste.

Key words*: earthworms, kitchen and garden waste, Lumbricus spp. And Eisenia foetida, physicochemical and microbiological analyses, vermicompost.*

INTRODUCTION

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Vermicompost is a product of the decomposition process produced by worms such as red wigglers (*Eisenia Andrei* or Eisenia fetida), European nightcrawlers (*Eisenia hortensis*) and the red earthworm (Lumbricus *rubellus*). The beneficial effects of earthworm feces and worm casts on crops have been known for more than a century. However, there has been a significant increase in applications of vermicompost in certain types of agriculture over the last decade because of the identification of specific plant growth–promoting properties. The technique of vermicomposting also helps to recycle plant material waste, animal manure, and municipal wastes. The use of vermicompost is vital in sustainable agriculture since it is an inexpensive method of managing agricultural wastes, in particular.

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Vermicompost and its formulations have gained popularity in both the domestic and industrial sectors because of their versatility—they can be combined with plant growth media (e.g., soil, water, and perlite) or soil conditioners and ameliorants (e.g., biochar coffee grounds, compost, compost tea, manure, coir, straw, peat, sphagnum moss, vermiculite, and hydro absorbent polymers) (Theunissen et al., 2010). VCL (vermicompost leachate) contains large amounts of salicylic acid, benzoic acid, and ACC but low concentrations of jasmonates, cytokinins, and proline (Benazzouk et al., 2020). Garden waste–derived VCL contains plant growth regulators such as, cytokinins, auxins, abscisic acid, gibberellins, and brassinosteroids which could be responsible for its biostimulatory activity. VCL improved plant growth and reduced the impact of salinity on leaf senescence along with Na+ accumulation in salt-stressed (125 mM sodium cyanide) tomato plants (Benazzouk et al., 2020). This was related to its impact on endogenous phytohormones rather than to a passive absorption of exogenous hormonal compounds (Benazzouk et al., 2020). VCLs have been reported to stimulate several physiological responses in a number of treated crops, e.g., banana, red kidney bean (*Phaseolus vulgaris*), and tomato. VCL is applied either as a soil drench, or as a foliar spray at low concentrations; however, it is recommended that VCL is diluted when using it as a foliar spray, as the high-nutrient content may cause burning of the leaves. Many researchers do not recommend VCL for foliar applications, preferring to use a soil drench, after dilution. Vermicompost extracts are also used as media for seed imbibition (Arancon et al., 2012). VCL contains large amounts of nutrients and therefore has the potential to be used as a liquid fertilizer, as well as in various types of hydroponic and aquaponic systems (Narayanan et al., 2017).

MATERIALS AND METHODS

The garden work steps were as follows:

1. Find a place in the garden where the container for vermicomposting can be placed
2. Construction or buying a container for vermicomposting
3. Arranging the layers of paper, cardboard, earth and wetting them
4. Adding layers of vegetable waste from the kitchen: potato peelings, carrots, celery, onions, etc., eggshells, tea bags, coffee grounds and those from the garden: leaves, grass, dried plants, etc.
5. Adding earthworms

The laboratory work steps were as follows:

1. Observation of the vermicompost extract suspension under an optical microscope.

   To highlight some morphological characteristics of microorganisms (the size, shape, and arrangement of cells, types of microorganisms – bacteria or fungi) we prepared living, unstained preparations as a wet mount.

2. Observation of the vermicompost with a stereomicroscope.

   We used the stereomicroscope to observe earthworm cocoons

3. Determination of physicochemical properties of vermicompost.

   To determine N, P, K we used the Hanna Instruments analysis kit and followed the manufacturer's recommended operating instructions. (https://hannainst.ro/produse/teste-chimice/single-parameter)

4. Determination of pH with WTW laboratory pH meter

RESULTS AND DISCUSSIONS

In vivo experiments

Figures 1, 2 and 3 show the different areas of the box for vermicomposting. Three distinct areas can be observed.

Zone 1 is represented by the upper part of the box for vermicomposting in which the activity of earthworms is observed.

Zone 2 is represented by the middle zone of the box for vermicomposting in which the stratification of the decomposed organic matter and transformed into compost is observed.

Zone 3 is the basis of the pile for vermicomposting. In this area you can see the cessation of the activity of earthworms, which allows the extraction of vermicompost and its use in the garden for plant cultivation.

Figure 1. Zones 1, 2 and 3 of the box

In vitro experiments

Figure 2 shows different macroscopic and microscopic aspects of the vermicompost sample (left) macroscopic aspects of the vermicompost sample and (right) the cocoon of earthworm in the vermicompost sample by stereomicroscope.

Figure 2. Different macroscopic (left) and microscopic (right) aspects of the vermicompost sample

Figure 3 shows the microorganisms in the vermicompost sample. The presence of bacteria, fungi and protozoa can be observed by light microscope.

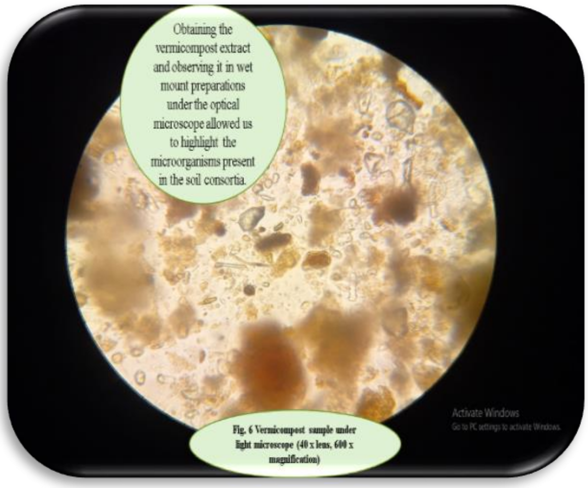

Figure 3. The microorganisms in the vermicompost sample

Results obtained after testing the vermicompost sample using the soil analysis kit from Hanna Instruments. It can be seen that all three macroelements nitrogen, phosphorus and potassium are present in high concentrations in the vermicompost sample.

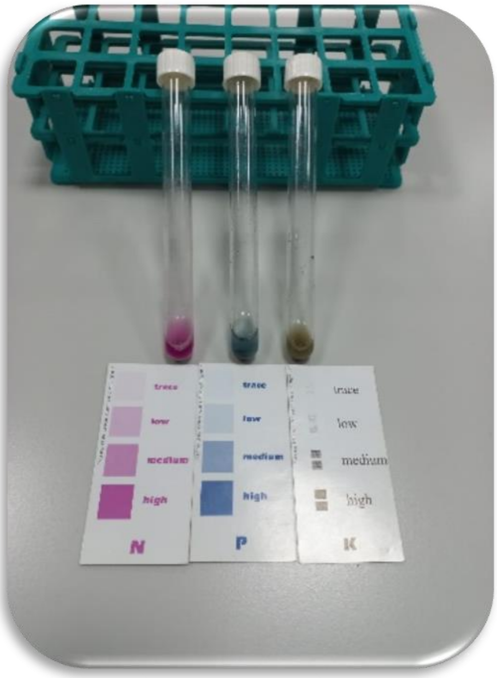

Figure 4. Vermicompost extract results for N, P, K

We obtained the pH value of the vermicompost sample using the WTW laboratory pH meter.

Figure 5. pH value of the vermicompost sample

CONCLUSIONS

The results obtained in this experiment allow us to draw the following conclusions:

The process of obtaining vermicompost is simple to follow and allows the recycling of vegetable waste from the kitchen and garden.

Observations under the light microscope revealed the existence of an abundance of microorganisms in the vermicompost sample.

Microscopic observation of the vermicompost sample revealed the presence of bacteria, filamentous fungi and protozoa.

Results obtained after testing the vermicompost sample using the soil analysis kit from Hanna Instruments.

It can be seen that all three macroelements nitrogen, phosphorus and potassium are present in high concentrations in the vermicompost sample.

The pH value of the vermicompost sample was 7,320 pH unit.

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