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RECOVERY OF AGRICULTURAL WASTE TO OBTAIN COMPOST

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ABSTRACT

The aim of this study is to make compost in a specialized container, using household and agricultural waste from own farm and the physicochemical characterization of obtained compost. The physicochemical characterization of the compost samples was carried out through the following determinations: determination of moisture, pH, determination of total soluble salts, determination of nitrate nitrogen, determination of nitrite, determination of ammonium nitrogen and determination of organic matter content. The compost samples analysed showed a high physicochemical quality. The use of compost offers environmentally friendly solutions with a long-term impact on the environment and quality of life.

KEYWORDS: compost, food waste, recycling

1. Introduction

Food waste can be transformed in many ways to produce different organic fertilizers and soil amendments. Conversion processes include composting, anaerobic digestion, dewatering, biochar production and chemical hydrolysis. Some food waste products can be used to remediate contaminated soils, in addition to improving soil properties [1].

Composting is the best method of recovery of organic residues and represents the totality of microbial, biochemical, chemical, and physical transformations that organic, vegetable and animal wastes undergo from their initial state until they reach different stages of humification, a state qualitatively different from the initial one, characteristic of the newly formed product, called compost [2]. Composting is an ancient form of recycling, long practiced by farmers to produce fertilizer material [3]. Compost is a complex of organic matter resulting from biomass waste: plant biomass, wood waste, sewage sludge waste, biodegraded by composting. In the composition of biodegradation products are present: carbohydrates from plant biomass structure, amino acids, simple lipids, fatty acids, carbohydrate end-biodegradation products, amino acid end-biodegradation, lipids, mineral compounds [4]. The chemical composition of the compost is influenced by the chemical composition of the composted materials, the ratio between these materials and the way the composting process was carried out [5].

The composting technique is one of the environmentally friendly waste conversion pathways as it returns part of the waste components to the environment. In Romania, composting in rural areas is done individually in households. Composting requires monitoring of parameters such as pH, oxygen content, particle size, temperature, time, bulk density, moisture, and C/N ratio to optimize its potential for use as a fertilizer [6].

Compost used as a soil fertilizer contributes to soil C fixation, fertility, biodiversity, soil physical properties by increasing erosion resistance and soil water uptake and retention capacity. The application of compost to soil is of considerable interest as a means of maintaining adequate soil structure and as a means of adding organic material to soil whose organic matter content has been reduced by intensive farming [7]. It is also used to remediate contaminated soils and for the slow release of nutrients from compost which is responsible for increasing crop yields in subsequent years. Due to the complex mechanisms by which compost has many benefits in the soil, it is necessary to take a brief look at soil structure and the correlations that are established between compost and soil [8]. Long-term use of compost for crop cultivation indicates that it has an equalizing effect on annual and seasonal fluctuations in soil water, air and heat balance, plant nutrient availability and therefore on final crop yields [9].

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2. Materials and methods

The composting method consisted mainly of organizing composting platforms. At the bottom of the compost heap a 10-15 cm layer of thin branches and straw was formed to ensure drainage and aeration of the heap. The composting substrate consisted of vegetable residues from the agricultural crops of corn, alfalfa, straw, leaves, grass and animal manure, which were mixed and moistened. The composting time was 6 months and samples were obtained in 2019, 2020, 2021. The block diagram on unit operations for composting is shown in Figure 1.

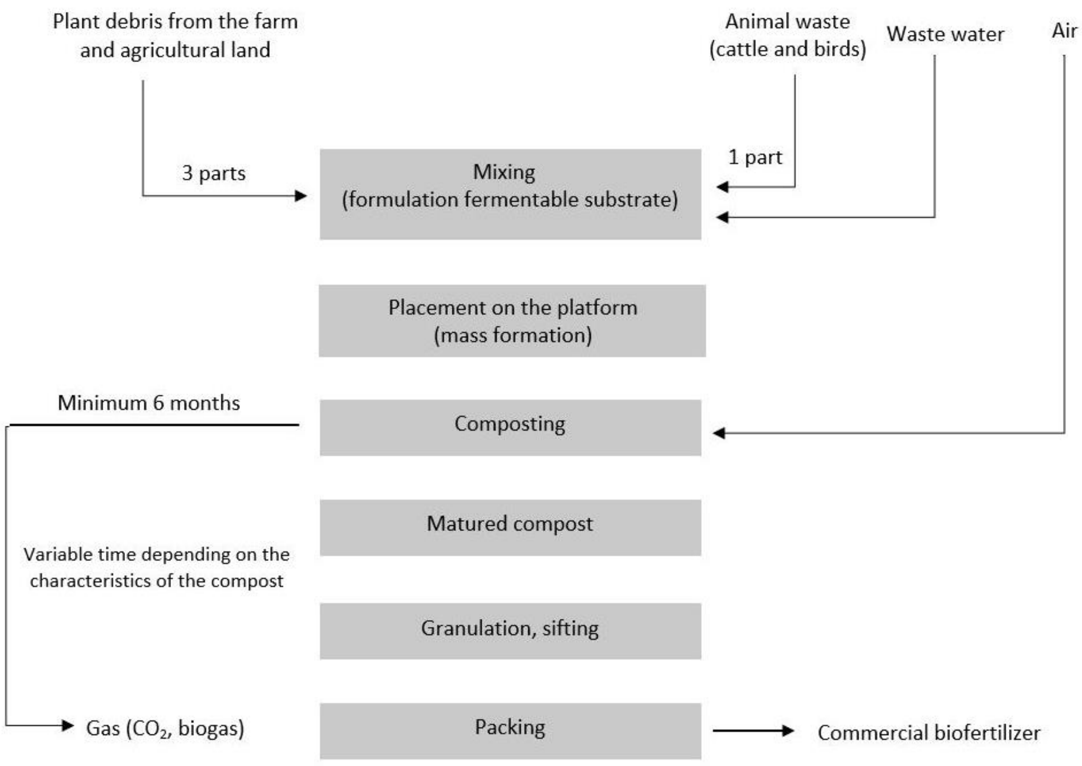

***Fig. 1.** The block diagram on unit operations for composting*

2.1. Moisture determination

Compost moisture can be analysed on both freshly harvested and air-dried samples. The principle of the method is based on measuring the weight loss of a pre-air-dried sample after complete removal of water by drying at 105 °C, for 5-6 hours in the oven.

2.2. pH determination

The pH was measured using a Thermo Scientific Orion Star 4-pH meter.

2.3. Determination of total soluble salts content

Preparation of compost extract: distilled water was used to make the aqueous extract in order not to alter the solubility of some constituents in the compost. 50 g of compost is added to a container with 250 mL CO_2-free distilled water. The suspension is stirred for 15 minutes using a stirrer and then filtered. The extract obtained is homogenized and used for the determination of total soluble salts and for the separate analysis of anions and cations.

The determination of the total amount of soluble salts in the compost was carried out by the conductometric method. The principle of the method is to measure the electrical conductivity of the aqueous compost extract obtained.

2.4. Nitrate-nitrogen determination

The extract was obtained by extracting nitric nitrogen with potassium sulphate solution. The nitrate- nitrogen determination was conducted by the colorimetric method using 2,4-phenoldisulfonic acid in alkaline conditions.

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2.5. Nitrite determination

Nitrite analysis was performed by the colorimetric method using Griess reagent.

2.6. Determination of ammonia nitrogen

The principle of the method is based on the reaction between ammonium ions and Nessler reagent when yellow mercuric amidochloride iodide is formed. The intensity of the yellow colour is directly proportional to the concentration of ammonium ions in the extract analysed. The analysis is determined using a colorimetric method.

2.7. Determination of organic matter content in compost

The principle of the method is based on dry mineralization of organic matter by calcination at 800 °C.

3. Results and Discussion

3.1. Physicochemical characterization of compost

All the waste products used, in solid form (plant residues and droppings) from the farm were used as raw material for composting. Cattle manure used for composting, when mixed with bedding has particularly good composting qualities. Poultry droppings need to be mixed with carbon-rich materials, preferably low nitrogen materials such as sawdust and straw. As substrates rich in carbon were used: wheat straw, corn cobs, bean and pea stalks, sunflower stalks, grass, and leaves. They were chopped to a size of 2-5 cm to obtain the best possible homogenization with the residual product, to ensure the largest possible contact surface and good aeration of the canopy. All the organic waste from the farm was deposited in the compost heap. A mixture was calculated to give an optimum moisture of 65%.

The compost samples showed a specific aspect, namely: the first sample had a black colour, loose structure, the second sample had a dark brown colour, slightly loosened structure, untransformed residues less than 20% and the third sample had a brown colour, compact structure, more than 20% transformed residues.

The results of the analysis of the compost samples obtained by evaluating moisture, pH, organic matter content, total soluble salts in the compost, nitrate nitrogen and ammonium nitrogen content are shown in the following Figures 2-9. All measurements were performed in duplicated, and the data presented represent the mean values of these replicates. The results were expressed as average values together with standard deviations. Statistical analysis of the data was conducted using Microsoft Excel.

Moisture values are slightly variable between samples and composting period and correlate with dry matter content. The results show that the pH has alkaline values, towards the upper limit of the standardized range. Following analysis, the dry matter was more than 50%, favourable result.

Fig. 2. *Moisture variation of compost obtained in different time periods*

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A reduced number of soluble salts is observed in the compost samples obtained in 2019, due to the compositional variation of the composting substrate and composting conditions.

An exceptionally low content of organic matter in the compost is observed in the compost obtained in 2020. Samples I and III showed an organic matter content greater than 25%, favourable, the exception was sample II.

The samples analysed showed high values of nitrate content, but below 1 g/100 g dry compost, demonstrating the efficiency of the nitrification and denitrification steps. The lowest nitrate nitrogen values were observed in the 2021 samples. This is in direct correlation with the biochemical processes taking place, especially the biotransformation steps of nitrogen compounds. Nitrite content had very low values, but higher than 0 as recommended. The results indicate that aeration of the pile is necessary. The ammonia nitrogen content was exceptionally low, and the nitrate nitrogen/total mineral ratio was greater than 0.5, a favourable result.

As can be noticed, the quality of the compost is variable from year to year and from barge to barge and is correlated with three categories of factors that have a particular impact on the biochemical processes, such as: substrate composition, microorganisms involved in biotransformation and the intrinsic and extrinsic physicochemical conditions of the composting environment.

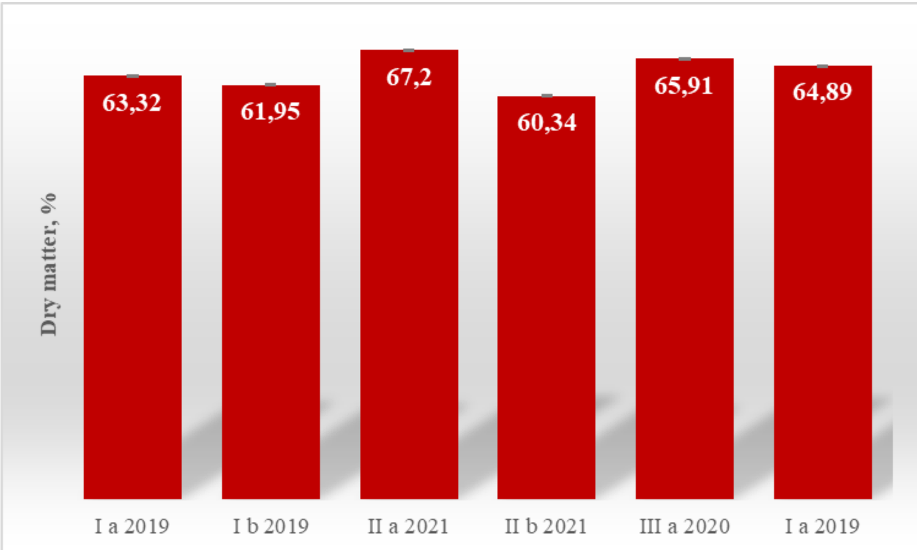

Fig. 3. *Dry matter of compost samples*

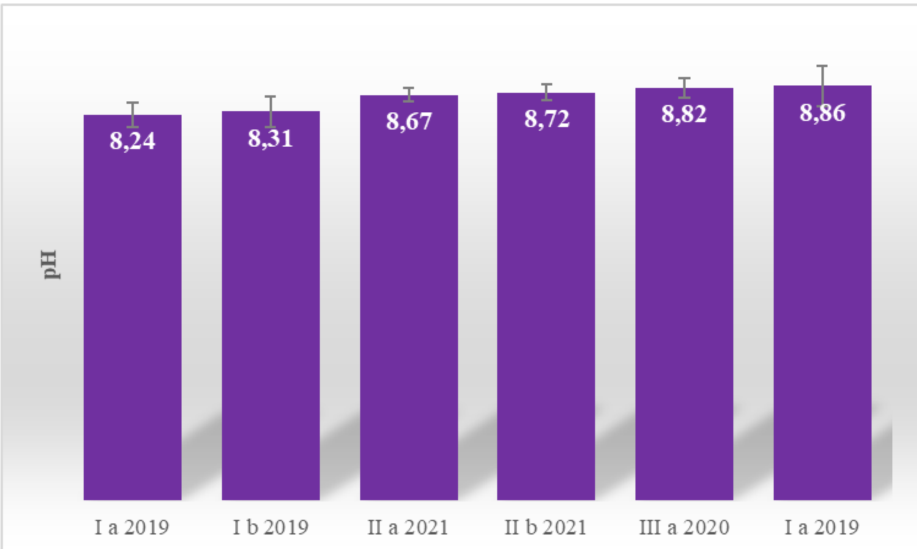

Fig. 4. *pH variation of compost samples obtained in 3 different years*

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Fig. 5. *Variation of total soluble salts in compost*

Fig. 6. *Variation of organic matter content in compost*

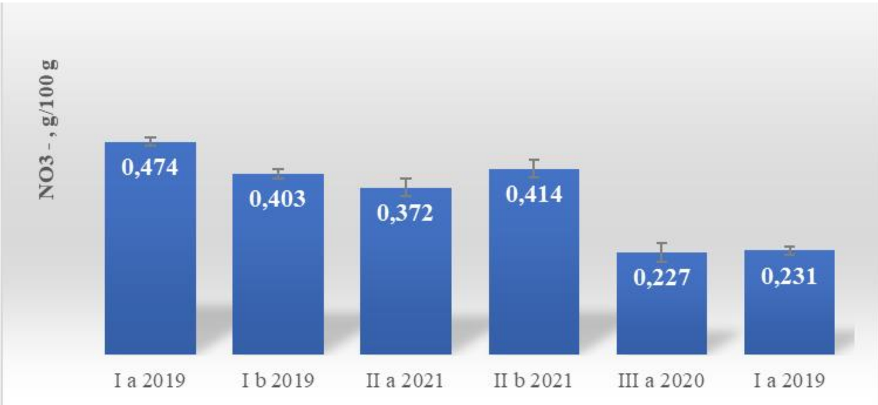

Fig. 7. *Variation of nitrate nitrogen content*

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Fig. 8. *Variation of ammoniacal nitrogen content*

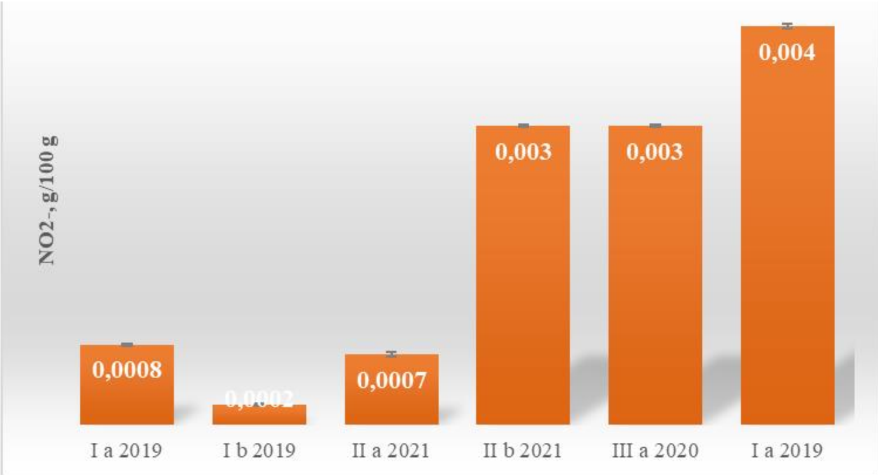

Fig. 9. *Variation of nitrite content*

3.2. The use of compost as a biofertilizer in the greenhouse for tomato culture

The compost was considered complete when the temperature in the composting mass had stabilized at a value close to that of the ambient environment and the oxygen concentration in the middle of the pile remained at values above 5% for several days. These measurements were made when the compost mass had a moisture content of no more than 50% and sufficient volume for the heating process not to occur. In order to be applied as a biofertilizer during the growing season the compost must be properly decomposed. Organic matter with a high C:N ratio competes with plant roots for accessible soil nitrogen. Microorganisms that mine carbon from organic matter have a higher affinity for nitrogen than plant roots. Testing of compost as a biofertilizer was carried out under greenhouse conditions in an experimental tomato plot where it was found that organic matter and soil pH increased in relation to use rates. Compared to the control soil, beneficial influences were observed in the one supplemented with compost. Plants developed faster and stronger and with higher production because the compost supplemented the soil with nutrients and essential microelements necessary for plant growth. The speed of nutrient transfer has been reduced, the compost binds nutrients, ensuring that they are released and used over a longer period of time. Nutrient fixation reduces nutrient leaching to groundwater and surface water during rainfall and irrigation. Soil porosity was improved, microbiological activity is optimal in fertile soils. Microorganisms break down macromolecular organic substances and provide plants the necessary nutrients, but this phenomenon is increased in porous, aerated soils because the biodegradation process is an aerobic process. The water retention capacity was improved, both by increasing soil porosity and by the capacity of compost to absorb water. The resistance of the soil to erosion was improved, by improving the physical characteristics of the soil and the faster growth of plants due to the accessibility of water and nutrients. The application of compost reduced the incidence of pathogens in plant contamination.

4. Conclusion

Composting is a biochemical process of mineralization of organic compounds, which under natural conditions occurs mainly in the soil. The need to compost waste under controlled conditions is dictated by the following considerations: environmental protection, conversion of biodegradable waste into biofertilizer-compost, used as a quality natural fertilizer, improve natural soil quality, increase productivity, plant health and also increases the quality of life and promote the principle of circular economy.

The studies presented in this paper lead to the following conclusions and perspectives: composting waste on the farm is a useful way to reduce the amount of vegetable waste and obtain a valuable biofertilizer under simple conditions. The compost samples analysed showed a high physicochemical quality. The application to tomato greenhouses, it has led to improved productivity and quality of crops and soil. The use of compost offers environmentally friendly solutions with a long-term impact on the environment and quality of life.

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