THE ANNALS OF "DUNAREA DE JOS" UNIVERSITY OF GALATI
FASCICLE IX. METALLURGY AND MATERIALS SCIENCE
Nº. 3 - 2024, ISSN 2668-4748; e-ISSN 2668-4756
Article DOI: https://doi.org/10.35219/mms.2024.3.08

# THE RECOVERY OF VEGETAL WASTE IN THE FORM OF HOME-COMPOSTING

**Anca ȘERBAN, Adrian LEOPA**
"Dunarea de Jos" University of Galati, Romania
e-mail: anca.serban@ugal.ro, adrian.leopa@ugal.ro

## ABSTRACT

*Composting the vegetable waste is an ecological alternative to their treatment by incineration or storage on landfills. The recovery of vegetable waste for obtaining compost is a beneficial method both by keeping a clean environment and enriching the soil. The vegetable waste decomposes and leave its intake nutrient in the soil for plants and other crops growth. The paper includes the chemical analysis and testing results of the compost obtained with garden vegetable waste (dried leaves, branches, bark, stems, flowers and herbs).*

KEYWORDS: waste, vegetable, recovery, composting

## 1. Introduction

A common method of vegetable waste management consists in burning plant debris and crop residue or disposing it in landfill. These two approaches are very polluting, the first by releasing large amounts of carbon dioxide in air, and the second with greenhouse gases and odor in air, and microbes and chemicals in soil or water [1]. In addition, the compost law namely Law 181/2020 on the management of non-hazardous compostable waste prohibits the burning of dry plant residues in one's own yard since 2021.

Although it is considered a method of recovery of organic waste, composting is associated with the release of greenhouse gases ($CO_2$, $NO_2$, $SO_2$) and odors resulted due to fermentation process. There are concerns among specialists about improving the composting process in terms of controlling the temperature and oxygen concentration, which can reduce the production of greenhouse gases [1].

Thus, an environmentally friendly alternative to organic waste management is composting. Composting is a natural recycling process by which microorganisms (bacteria, fungi) and invertebrates (insects, worms) break down organic matter and turn it into a stable material called compost. The compost can be used in agriculture as natural fertilizer instead of chemical fertilizer, and soil improvement by increasing chemical (nutritive) regime [2].

The composting is very important for the management of organic materials and for the waste flow produced by human activities as: kitchen waste (vegetable and fruit peels, coffee grounds, filter paper, leftovers, bones and eggshells), farm waste (manure, straw), restaurant waste, leaves and vegetable waste from gardens and yards, wood, cardboard products and paper, sewage sludge [2].

The compostable waste can be composted both in households in individual composting units and at industrial level in closed or open installations. In the households are used for composting kitchen waste, vegetable waste from the yard and the streets, bones, wool, insects, leaves and stems of chopped corn and sunflower, rotten feed, faeces. Compost can be implemented for all agricultural crops, vegetable and fruit growing, depending on the nutritional needs of the soil and plants [3].

The organic waste from individual gardens is converted into compost by aerobic method, which is an open system and isolated from the inhabited area due to fermentation odours [4].

## 2. The compost preparation

The compost consists of the mixture in equal parts by volume, between soil (1300 $cm^3$) and plant matter (1300 $cm^3$), using the Berkeley method, to which a quantity of bio enzymes (compost accelerator Biopon) was added for supporting and accelerating the composting process of organic matter. The Berkeley method is an aerobic and very fast method that produces compost in just 18 days and release a small amount of methane into the atmosphere. The method is called "hot composting" and has the advantage of destroying both weed seeds and

THE ANNALS OF "DUNAREA DE JOS" UNIVERSITY OF GALATI
FASCICLE IX. METALLURGY AND MATERIALS SCIENCE
Nº. 3 - 2024, ISSN 2668-4748; e-ISSN 2668-4756
Article DOI: https://doi.org/10.35219/mms.2024.3.08

pathogenic germs. The application of the Berkeley method requires the following requirements to be met: the C:N (carbon: nitrogen) ratio must be 25:1; the temperature in the composting mass can reach 55-65 ºC; mixing materials is a must. At the end of the process, no more undecomposed materials will be found in the mixture [5]. Other sources believe that the C:N ratio of the compost pile is 30:1 and the humidity is 50% [6].

The vegetable waste used were dry leaves, branches, stems (carbon source), peels, flowers, medicinal plants (mint) (nitrogen source) (Fig. 1). The compost preparation was carried out in a plastic box (Fig. 2) equipped with evenly distributed ventilation areas.

***Fig. 1.*** *Preparation of soil and plant material samples*


***Fig. 2.*** *Preparing the compost in layers with the addition of green leaves to observe the transformation process*

THE ANNALS OF "DUNAREA DE JOS" UNIVERSITY OF GALATI
FASCICLE IX. METALLURGY AND MATERIALS SCIENCE
Nº. 3 - 2024, ISSN 2668-4748; e-ISSN 2668-4756
Article DOI: https://doi.org/10.35219/mms.2024.3.08

The first layer placed in the box consists of gravel with sand, followed by the mixture of soil and plant material to which 100 g of process accelerator (bio enzymes) has been added. The vegetable matter consisting of green leaves of mint, raspberry, currant and lettuce were introduced into the mixture so that the transformation process could be observed with the naked eye. Water spraying was done by spraying in sufficient quantity to start the process. The compost mixture was watered daily and mixed for aeration using a small rake or other gardening tool. The compost mixture was kept in a shady place, because the organic matter oxidizes under the sun's rays.

### *2.1. The compost pile treatment*

Day 1:

- Mix the materials and lay them in alternate layers, the dry ones with the green ones.
- Water the compost heap abundantly with water.
- As activators can be used (in the middle of the pile) teas of horsetail, valerian, mouse tail.

Day 4:

- The first four days the pile is left to start the decomposition process.
- The pile is opened and mixed so that the materials that were on the outside reach the inside and vice versa.
- The mixture should be moist so that 1-2 drops can be squeezed out of a handful of composted material.
- Excess moisture should be avoided by adding a few branches as drainage.

Day 6 and 8:

- Break up the sides and build a new pile next to it, placing the decomposed material at the surface.
- The heat inside can be sensed and can be measured with a thermometer.
- The optimal temperature should be of 55-65 $^{o}$C.
- The pile is turned every 2 days, avoiding overheating of the pile.

Day 18:

- The appearance of earthworms in the compost is a sign that the process has ended.
- The resulting compost is brown and smells like damp.

## 3. Evaluation of compost quality

### *3.1. Analysis methods*

The physical and chemical quality indicators of the compost obtained from garden soil mixed with crushed plant matter were determined.

The moment the composting process was completed, we took a sample of compost to carry out the following physical and chemical analysis:

- Reaction or pH.
- Humidity or moisture.
- Total Soluble Salts (TSS) in soil.
- Bicarbonate ions content $HCO_3^-$.
- Chloride ions content $Cl^-$.
- Calcium and Magnesium ions content $Ca^{2+}$, $Mg^{2+}$.
- Soil organic carbon and humus concentration.

The pH and TSS were determined using potentiometric methods by mean of the pH meter and the TDS meter respectively. The ions of bicarbonate, chloride, calcium and magnesium were identified by volumetric methods according to current analysis norms.

The determination of soil organic carbon is based on the Walkley & Black chromic acid wet oxidation method. The humidity was determined by gravimetry (at 105 °C). The parameters' measurement units were pH units, milli Siemens/cm for electrical conductivity EC, total dissolved solids in g/Kg dw (dw = dry weight), the ions in g/Kg dw, humidity H, humus content and organic carbon in percentage.

***Fig. 3.*** *The mixture of soil and plant material transformed into compost*

### *3.2. Results and discussions*

It was found that on the 9$^{th}$ day, the composition had an earthy aspect where the plant matter had completely decomposed, thus the composting process was reduced from 18 days to 9 days due to the application of the bio enzyme accelerator.

The compost must be a stable and homogeneous product, contain no seeds or contaminants, and the particle size must be less than 1.2 cm. The compost reaction is recommended in the range of 6-7.8, and humidity below 50%. The compost law does not provide the optimal quality parameters of the compost, but the values can be used as a reference: pH = 5.5-7.5; salt content (as conductivity < 5

THE ANNALS OF "DUNAREA DE JOS" UNIVERSITY OF GALATI
FASCICLE IX. METALLURGY AND MATERIALS SCIENCE
Nº. 3 - 2024, ISSN 2668-4748; e-ISSN 2668-4756
Article DOI: https://doi.org/10.35219/mms.2024.3.08

mS/cm); humidity (35-55%); 0.04% accessible nitrogen (as nitrate) and 0.8% organic nitrogen [7].

The chemical composition varies, but the average concentrations are of 0.15-0.95% nitrogen, 0.14-1.2% phosphorus, 0.3-1.85% potassium [3]. Thus, the compost mixture was well aerated because the pH is weakly alkaline (pH = 7.76) (Table 1), while poor aeration would have produced an acidic pH of the compost. The compost salt content as conductivity is less than 1 mS/cm, what is below the reference range. If we refer to the specific humus content of the soil, the humus supply class is good (between 4-6%) in the studied compost. The content of ions and cations of compost is very low because of a low concentration of nutrients both in the soil used in the composting mixture and in the plant material.

***Table 1.*** *The compost parameters*

| Parameter | pH | Conductivity EC, mS/cm | TDS [g/Kg dw] | $HCO_3^+$ [g/Kg dw] | $Cl^-$ [g/Kg dw] | $Ca^{2+}$ [g/Kg dw] | $Mg^{2+}$ [g/Kg dw] | H [%] | Humus [%] | OC [%] |
|---|---|---|---|---|---|---|---|---|---|---|
| Value | 7.76 | 0.985 | 3.155 | 2.5 | 1.013 | 0.8 | 0.063 | 32.038 | 4.9196 | 2.8536 |

The compost made from just a mixture of soil and plant material has low nutrient concentrations and moisture below the ideal range of 40-65%. Plant materials are rich in carbon, but the nitrogen content is low. To obtain a compost rich in nitrogen and carbon, food scraps, fruit and vegetable residues can be added to the household in addition to plant materials.

## 4. Conclusions

The results showed that the mixture of soil and vegetable matter in equal parts by volume was completed in 18 days, resulting in a compost with a certain nutritional value. The nutritional value of compost is given usually by nutrients such as phosphorus, nitrogen, potassium, but also by chemical elements such as sodium, calcium, magnesium and others.

The main benefits of home-composting are:

- recycling of organic and vegetable waste;
- reduces pollution with methane from landfills;
- reduces the load from landfills;
- neutralization of biodegradable waste;
- reducing the carbon footprint of the household;
- ecological alternative to the use of synthetic fertilizers;
- simple and effective method and low application costs to reduce waste and support a clean environment [2].

The main effects of compost as organic fertilizer on soils are:

- helps to improve the content of nutrients and minerals in soils;
- enhances the soil structure and the humus amount;
- maintains the water longer in soil;
- regulates the oil temperature;
- prevents erosion and uncontrolled weed development [2].

## References

**[1]. Modupe Stella Ayilara, *et al.***, *Waste Management through Composting: Challenges and Potentials*, Sustainability, 12 (11), 4456, https://doi.org/10.3390/su12114456, 2020.

**[2]. *****, *Practica europeana a compostarii individuale (la domiciliu)*, Black Sea Common borders. Common solutions, Programul Operațional Comun Bazinul Mării Negre 2014-2020, https://blacksea-cbc.net.

**[3]. Roxana Madjar, Velicica Davidescu**, *Agrochimie*, Universitatea de Stiințe Agronomice si Medicina Veterinara București, Facultatea de Horticultură, Specializarea Horticultură, Învățământ la distanță, 2009.

**[4]. Radu V. Pascu**, *Managementul deșeurilor*, Editura Universității „Lucian Blaga" din Sibiu, 2009.

**[5]. Chetreanu Diana**, *Cum îți produci singur compostul: 2 metode explicate pas cu pas*, https://www.cartiagricole.ro/producere-compost/, 11 martie 2015.

**[6]. Bruna Marraccini Precioso de Oliveira, *et al.***, *Chemical and spectroscopy characterization of a compost from food waste applying the hot composting Berkeley method*, International Journal of Recycling of Organic Waste in Agriculture, 11, p. 153-164, DOI: 10.30486/IJROWA.2021.1897439.1052, 2022.

**[7]. *****, Institutul National de Cercetare-Dezvoltare pentru Pedologie, Agrochimie si Protecția mediului, https://www.icpa.ro/documente/coduri/Compostarea.pdf.