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THE INFLUENCE OF A COMPOST-BASED SUBSTRATE DERIVED FROM HOUSEHOLD BIODEGRADABLE WASTE ON THE GROWTH AND DEVELOPMENT OF TWO RADISH CULTIVARS

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Abstract. *The recovery of biodegradable household waste is an important approach to reduce the volume of domestic waste, while generating useful materials in horticulture. The objective of this study was to identify a method for reusing food and vegetable waste through composting, as well as to evaluate the potential of using the resulting compost as a component of the growing substrate for radishes. The compost was obtained by cold composting biodegradable household waste, including food waste and vegetable matter. Subsequently, this compost was used in an experiment aimed at the cultivation of two radish cultivars, designated C1 and C2. Four experimental variants were analyzed, corresponding to the cultivation of each variety on two types of substrates: garden soil (used as a control) and a volumetric mixture composed of 50% garden soil and 50% compost. Plant development was assessed by measuring the accumulation of fresh biomass and tuberized root mass – the latter representing the edible part of the plant and an essential indicator of the productive value of the crop. The results indicated a higher fresh biomass and higher tuberized root mass for both varieties, when they were grown on the compost-enriched substrate. In addition, the C1 variety showed a higher productivity than the C2 variety on both types of substrates. In conclusion, the use of compost derived from biodegradable household waste—accounting for 50% of the substrate volume—had a favorable effect on the growth and development of early-maturing radishes, demonstrating the potential of this valorization method in horticultural production.*

Keywords: *compost, biodegradable waste, growing medium, Raphanus sativus L., plant growth, fresh biomass.*

INTRODUCTION

The continuous growth of the urban population leads to a proportional increase in the demand for food and the generation of waste resulting from food loss and waste (FANG et. al, 2023). The undesirable consequences of these trends include improper or inadequate waste management, the depletion of agricultural resources, and a decline in soil fertility. (FANG et. al, 2023; CORDELL et al., 2009). A nutrient deficit in the soil, caused by a lack of fertility necessitates the adjustment of nutrient levels through the addition of inorganic fertilizers. (CORDELL et al., 2009). These fertilizers enhance the productivity of crops and vegetables and help improve the soil's water-retention capacity. (HAZRA, 2016; CHEN et al., 2018). However, the excessive and inappropriate use of chemical fertilizers can, in turn, cause pollution. For instance, applying nitrogen in amounts exceeding plant requirements promotes the formation of nitrates in the soil and their leaching into the groundwater. Furthermore, the transport of chemical elements via surface runoff can lead to the eutrophication of water bodies. Additionally, the annual use of the same synthetic fertilizers can acidify the soil and affect or alter the activity of microorganisms (BIJAY-SINGH & CRASWELL, 2021).

The inadequate management of biodegradable plant and household waste, as well as other types of decomposing organic matter (such as manure), can have environmental

consequences. During the degradation process, anaerobic decomposition occurring within open landfill spaces contributes to the emission of greenhouse gases (methane, CO_2), while leachate can affect groundwater. Therefore, the most recommended alternative to the landfilling of the biodegradable fraction is its recovery (valorization) (OKAREH et al., 2014; THI et al., 2015; AHMED & ABDULLA, 2018; HAMID et al., 2019; ZAMAN et al., 2022).

A practical strategy for sustainable agriculture involves valorizing food waste by biologically transforming it into organic compost. Residues from fruits, vegetables, bakery products, and other sources of organic matter can be incorporated and effectively converted into this new product, which possesses agronomic potential. (MA & LIU, 2019) In this context, there is a growing trend toward reducing the use of synthetic fertilizers and replacing them with products based on vermicompost and compost derived from food waste. (HAZRA, 2016) These are capable of naturally enhancing soil fertility and facilitating the reintegration of organic matter into the agricultural cycle. (MA & LIU, 2019; CHEN et al., 2018) If food waste is not integrated into the circular economy through the production of compost and vermicompost, it is destined for landfills, where it contributes only to pollution and the progressive degradation of environmental quality (REHMAN et al., 2023).

From a functional perspective, compost can play a role in the biostimulation and biofertilization of crops. During the composting process, microorganisms transform organic matter into mature organic compounds. The decomposition processes carried out by these microorganisms yield humic substances and essential nutrients. (TAN, 2014) Furthermore, certain hormone-like molecules secreted by bacteria can act as plant biostimulants. (ZACCARDELLI et al., 2012) The composition of the compost microbiome is a decisive factor in establishing the complex interactions that occur within the rhizosphere (HADAR & PAPADOPOULOU, 2012).

Incorporating compost into plant growing media is of particular interest for improving crop production, as it allows for the utilization of biodegradable waste while simultaneously enabling an assessment of its effect on plant growth and development. The plant response can be influenced both by the characteristics of the growing medium and by the biological traits of the specific species or cultivar being grown (GRUDA, 2019; PRASAD & MAHER, 2001).

The radish (*Raphanus sativus L.*), a species belonging to the Brassicaceae family, is a horticultural crop with a relatively short growth cycle, for which the development of the foliage and the formation of the tuberized root serve as key indicators of plant performance. Both the root and the above-ground parts of the plant possess nutritional value, owing to their content of bioactive compounds and mineral elements (MAHMOUD et al., 2019).

Cultivation in protected environments provides more favorable conditions for plant development; this technology is used to secure stable horticultural yields, even amidst current challenges such as climate change and the depletion of agricultural resources (PEERA et al., 2020).

Against this backdrop, the present study aimed to evaluate the influence of a compost-based growing medium—derived from biodegradable waste—on the growth and development of two commercial radish cultivars, C1 and C2, grown in containers within a protected environment. The effect of using compost was evaluated by analyzing morphological and biometric plant parameters, such as total height, length of the tuberized root, mass of the tuberized root, and total plant mass.

MATERIALS AND METHODS

The compost used in this study was produced in a composting setup utilizing a specialized container designed for the composting process, equipped with side ventilation openings and a top lid. The composting process was carried out using the cold composting method. During the initial weeks, the organic material was periodically moistened to maintain an appropriate moisture level, which is essential for biological decomposition processes.

The material subjected to composting consisted of biodegradable organic waste, primarily plant-based residues and food scraps (figure 1): potato peels (30%), shredded dry grapevine leaves and canes (30%), tomato residues (9%), watermelon rinds (5%), fruit peels and cores (5%), shredded green grass (10%), crushed eggshells (4%), and coffee grounds (2%).



Figure 1. The process of adding biodegradable household waste to the composting container

After a period of approximately 12 months, a sufficient quantity of the resulting compost was collected for laboratory analysis and for use in an experiment evaluating its application as a growing substrate for radishes.

The compost was characterized by determining its pH, as well as the concentrations of nitrates and phosphates. The pH value was measured using laboratory pH-meter and the concentrations of nitrates and phosphates in the analyzed extract were determined using a NANOCOLOR Advance spectrophotometer, with wavelengths of 585 nm for nitrates and 436 nm for phosphates.

The biological material used in the experiment consisted of two varieties of spring radish (C1 and C2). C1 is characterized by a short growing period and the ability of its roots to remain tender even after reaching or exceeding the stage of consumption maturity. The tuberized roots are round in shape and bright red in color. (Agrosel, n.d.-a) C2 also has a short growing period, and its roots retain their tenderness after reaching consumption maturity. The tuberized roots are elongated and purplish-red, becoming white toward the tip. (Agrosel, n.d.-b)

The experiment was initiated on March 20, 2026, in the locality of Chiscani, Brăila County, inside an unheated greenhouse (polytunnel). For each experimental variant, three planters were used, corresponding to three replicates. Each planter measured 50 × 20 × 10 cm, with a geometric volume of 10 L. Ten plants were grown in each planter, arranged in two rows with five plants per row. The plants were kept under these experimental conditions until they reached harvest maturity. The experiment included two radish varieties, coded C1 and C2, grown on two types of substrate: garden soil and a mixture of compost and garden soil. In total, four experimental variants—resulting from the combination of the two varieties with the two types

of substrate—were evaluated and are presented in Table 1. The variant grown on garden soil served as the control for each of the two varieties.

Table 1

The experimental variants included in the study

Variant	The radish cultivar	The culture substrate used
V1	C1	100% (v/v) garden soil
V2	C1	50% (v/v) compost + 50% (v/v) garden soil
V3	C2	100% (v/v) garden soil
V4	C2	50% (v/v) compost + 50% (v/v) garden soil

To evaluate the parameters under analysis, 5 representative plants were selected from each replication, resulting in a total of 15 plants analyzed for each experimental variant. The mean values of the determined parameters were calculated based on measurements taken from the 15 plants corresponding to each variant. Fresh biomass accumulation was assessed by determining the mass of the tuberized root and the total fresh mass of the plant. The data obtained were compiled and processed using Microsoft Excel.

RESULTS AND DISCUSSIONS

The values obtained from the determination of the physicochemical properties of the compost produced from household biodegradable waste are presented in Table 2.

Table 2

Physicochemical characteristics of compost obtained from household biodegradable waste

Parameter	Parameter value	Unit of measurement
pH	6.80	-
NO_3^-	5.30	mg/L
PO_4^{3-}	28.70	mg/L

pH is an essential parameter for determining the quality and maturity of compost. High-quality compost, at the end of the maturation period, typically exhibits a pH value between 6.5 and 7.5. (FCQAO, 1994) The stabilization of pH upon the completion of composting processes is attributed to the biosynthesis of humic substances. (BEN AYED et al., 2005; EL FELS et al., 2014; MAJBAR et al., 2018) The pH value of the compost in this study indicates that the composting processes have reached completion and that the resulting compost is of good quality. Studies conducted on various types of compost have reported pH values of 6.61, 6.80, and 5.90. (OUELD, 2024)

Nitrogen and phosphorus are two macronutrients that play an essential role in achieving high yields. (KUMAR et al., 2021) Regarding nitrogen, nitrate (NO_3^-) and ammonium (NH_4^+) are the two primary forms accessible to plants; however, in both agricultural and artificial ecosystems, these forms are present in limited quantities and fail to meet the plants' requirements. (CRAWFORD and FORDE, 2002) The availability of sufficient nitrogen in the soil can help plants better manage the effects of stressors such as potassium deficiency, salinity, and heavy metal toxicity. (ZHU, 2016) In this context, chemical fertilizers are applied to optimize nitrogen levels. (BAILEY-SERRES et al., 2019) A study from China highlights a correlation between a 300%

increase in the use of chemical fertilizers—containing nitrogen and other nutrients—and a 74% rise in agricultural production; at the same time, it draws attention to the fact that the increase in the amount applied and the resulting yield do not grow proportionally beyond a certain point. (YANG et al., 2024) This occurs because only a portion of the nitrogen supplied to crops via fertilizers is directly utilized by the plants; the remainder is either lost through nitrate leaching from the plant-soil system or becomes immobilized within the soil. Based on datasets from 800 experiments, CHIEN et al. (2009) concluded that, at most, 51% of the nitrogen applied via chemical fertilizers is utilized by cereal crops—with the nitrogen uptake rate decreasing even further when the applied dose exceeds the optimal amount. In an experiment, MAHNOOR HAYAT et al. (2026) demonstrated differences in crop yields based on the type of fertilizer applied. They observed a 62.5% increase in yield for crops treated with compost, compared to only 43.6% for those treated with chemical NPK fertilizers. This finding highlights one of the advantages of using composts rather than chemical fertilizers.

Phosphorus is a fundamental chemical element for plant life, playing a role in photosynthesis, respiration, the biosynthesis of nucleic acids and membranes, and the regulation of various enzymes. (HAWKESFORD et al., 2023; XU et al., 2019) Phosphorus deficiency impairs productivity—both in areas with spontaneous vegetation and on cultivated land—with the greatest impact observed in systems that rely on low input levels. (CONG et al., 2020) Although essential for various plant physiological processes, phosphorus in the soil largely exists in insoluble forms and exhibits low mobility compared to other nutrients. (THEODOROU & PLAXTON, 1993; VANCE, 2001; JALALI and KOLAHCHI, 2005) Consequently, phosphorus supplied via chemical fertilizers applied to the soil surface is utilized by plants only at the time of application. (JALALI and KOLAHCHI, 2005) Therefore, understanding the mechanisms by which phosphorus becomes available to plants is the foundation for the efficient use of this nutrient. In this context, it is noteworthy that plants have evolved adaptations over time that enable them to access insoluble forms of phosphorus. These adaptations include modifications to root morphology and the secretion of exudates (such as phosphatase). (GEORGE et al., 2002; GILBERT et al., 1999; DONG et al., 2004; RYAN et al., 2001) PIERRE and PARKER (1927) determined the average concentration of organic phosphorus in 21 soil samples and found it to be significantly higher than the average total phosphorus concentration. This nutrient can only be made available through hydrolysis, facilitated by phosphatases released by roots or microbial colonies. (GHAHREMANI et al., 2019; LUGLI et al., 2020)

Many chemical fertilizers contain multiple nutrients; however, nitrogen is the primary component, while phosphorus is often prioritized due to the various benefits it provides to plants. Compost contains both and offers the added advantage of being derived from organic matter. Compost produced at home from biodegradable household waste provides a significant supply of nutrients to plants, enriching the medium with 5.3 mg/L of NO_3^- and 28.7 mg/L of PO_4^{3-}.

Table 3 presents the mean values for the total fresh mass of the plant and the mass of the tuberized root across the four experimental variants. This data is used to evaluate the influence of the growing substrate on biomass accumulation and the development of the edible portion of the two radish varieties.

Table 3

Total fresh plant mass and mass of the tuberized root for the four experimental variants

Variant	Tuberous root fresh mass (g)	Total fresh plant mass (g)
V1 - C1, 100% garden soil	22.10 ± 1.25	41.25 ± 2.10
V2 - C1, 50% (v/v) compost + 50% (v/v) garden soil	32.48 ± 1.80	62.14 ± 3.25
V3 - C2, 100% garden soil	19.12 ± 0.95	31.78 ± 1.65
V4 - C2, 50% (v/v) compost + 50% (v/v) garden soil	25.64 ± 1.45	42.58 ± 2.35

Growth percentages were calculated using the formula:

$$Growth\ (\%) = \frac{V_c - V_m}{V_m}\ x\ 100$$ (GEORGE BROWN COLLEGE, 2014)

Vc = the mean value of the determined parameter for the variant with compost;
Vm = the mean value of the determined parameter for the control variant.

Based on the formula provided, the percentage increases for the two analyzed parameters were calculated for the variants containing added compost, by comparing them to their respective control variants. For cultivar C1, cultivation on a substrate consisting of 50% compost and 50% garden soil (V2) resulted in a 46.97% increase in the mass of the tuberized root and a 50.64% increase in the total fresh mass of the plant, compared to the control (V1). For cultivar C2, the increases recorded in variant V4—relative to V3—were 34.10% for the mass of the tuberized root and 33.98% for the total fresh mass of the plant.

The results indicate a greater accumulation of fresh biomass in plants grown on a substrate supplemented with compost, compared to those grown exclusively in garden soil, for both cultivars analyzed. Furthermore, cultivar C1 exhibited higher values for both the mass of the tuberized root and the total fresh mass than cultivar C2, in both the control variants and those with added compost. The more pronounced percentage increases observed in C1 suggest that the plants' response to the modification of the substrate varied according to the cultivar.

From the perspective of integrating biotechnologies into horticulture, the composting of biodegradable household waste serves as a method for valorizing organic resources by transforming them into a material that can be used as a component of growing substrates. In the experiment, the incorporation of compost at a rate of 50% of the substrate volume was associated with an improvement in the biomass parameters analyzed and an increase in the mass of the tuberized root—the edible part of the radish. These results highlight the potential for applying the principles of biological recycling in horticultural production by utilizing organic waste to create an alternative substrate for plant cultivation. However, to more fully characterize the agronomic value of the compost, further studies are required regarding the nutritional composition of the final substrate, as well as an evaluation of plant response under broader experimental conditions.

CONCLUSIONS

Composting biodegradable household waste is a method for recovering organic resources, with potential applications in horticulture through the use of compost as a component of the growing medium.

Under the experimental conditions, using a substrate consisting of 50% compost and 50% garden soil resulted in an increase in both the mass of the tuberized root and the total fresh mass of the plants—compared to cultivation in garden soil alone—for both radish varieties analyzed. The highest percentage increases were recorded for variety C1: 46.97% for the mass of the tuberized root and 50.64% for the total fresh mass of the plant. For variety C2, the corresponding increases were 34.10% and 33.98%, respectively.

These results highlight the feasibility of integrating the composting of biodegradable waste into horticultural practices, contributing to the valorization of organic materials and the creation of an alternative growing medium for radish cultivation. To confirm these findings and determine the optimal proportion of compost in the substrate, further research is required; this should include testing various mixing ratios, characterizing the nutritional content of the final substrate, and conducting a statistical analysis of the experimental data.

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