Research Article

Compost Preparation from Different Organic Wastes: Their Biochemical Analysis and Effect on Growth of Bottle Gourd

Tanvi Taneja[1], Indu Sharma[2], Mukesh Kumar[1], Mahesh Kumar Rana[3], Raj Singh[1,*]

[1]Department of Bio-Sciences and Technology, Maharishi Markandeshwar (Deemed to Be University), Mullana, Ambala, Haryana, INDIA.
[2]Department of Biotechnology, NIMS Institute of Allied Medical Science and Technology, NIMS University Rajasthan, Jaipur, Rajasthan, INDIA.
[3]Department of Agriculture, Maharishi Markandeshwar (Deemed to Be University), Mullana, Ambala, Haryana, INDIA.

Submission Date: 22-09-2023; Revision Date: 13-11-2023; Accepted Date: 12-12-2023.

ABSTRACT

Aim: A study was carried out to prepare from the different organic wastes and to assess their effect on bottle gourds. **Background:** Composting is a crucial agricultural process that aids in the recycling of agricultural and farm wastes. Beneficial microbes and plant nutrients are abundant in high-quality compost. It is a natural process to break organic matter, like leaves and food scraps, into useful manure, which is then used as manure to enrich the soil with carbon and nitrogen, phosphorus, potassium and especially micronutrients, essential for the growth of the plants. **Materials and Methods:** Four types of compost were prepared from (i) leaves (ii) fruits and vegetables, waste (iii) cow dung 2 years old (iv) cow dung 4 years old which were analyzed for pH, electrical conductivity, moisture content, bulk density and ash content. These composts were also analyzed for nitrogen, phosphorus and potassium content. **Results:** Out of the four composts, the compost prepared from leaves had the maximum pH (7.69), electrical conductivity (8.44 S/m), moisture content (55%) and bulk density (0.57 g/cm^3) as compared to the rest of the three composts. Compost prepared from fruits and vegetable wastes had the maximum concentration of nitrogen (1.5%), potassium (1.2%) and phosphorus (0.8%) as compared to compost prepared from leaves, vegetables and cow dung. The study also revealed the significantly positive effect of composts on vine length and number of leaves per plant of bottle gourd (*Lagenaria siceraria*) 10, 15, 30, 50 and 70 days after the application of composts. **Conclusion:** Composting recycles a variety of organic materials, which would otherwise be considered garbage. These processes play a significant role in sustainable agriculture and organic farming.

Keywords: Bottle gourd, Compost, Plant nutrients, Soil carbon, Plant growth.

Correspondence:
Raj Singh
Department of Bio-Sciences and Technology, Maharishi Markandeshwar (Deemed to Be University), Mullana, Ambala, Haryana, INDIA.

Email: dr.rajsingh09@gmail.com

INTRODUCTION

Well-decomposed organic wastes, also known as compost, are used as a manure or soil amendment. The conversion of organic materials into a dark rich substance occurs naturally. The organic wastes after being composted by aerobic microorganisms replenish nutrients in the soil. Heat, aeration, water content and pH are all impacted by this process.[1] This process is regarded as the most efficient way to decompose the organic wastes. The resulting compost may be used as a natural and organic source of plant nutrients in soil. In underdeveloped countries, composting and agricultural waste management are both common practices. Composting is a method of recycling organic wastes, in which, the microbes under regulated conditions break down the organic wastes to prepare the products, which may be useful to the soil, crop plants and the environment. Fungi, bacteria and actinomycetes are the active microbes that are involved in the process of degradation and conversion of organic wastes into useful compost. Among the microbes, play very

SCAN QR CODE TO VIEW ONLINE

www.ajbls.com

DOI: 10.5530/ajbls.2023.12.62

essential role in the conversion of organic wastes into compost. The effectiveness of this technique also depends on the characteristics of the organic waste since composting is acceptable only for agricultural wastes.[2] Composting provides numerous advantages, *i.e.*, reducing waste volume, weight and water content and causing hazardous organisms to go dormant. Thus, compost can greatly reduce the demand for fertilizers by improving levels of nutrients in the soil, which are necessary for the growth and development of terrestrial plants. Compost application can rejuvenate the soil, increase organic carbon content, strengthen the soil structure, and improve the ability to retain water and tilt when used as a soil supplement. A variety of composting techniques, such as vermicomposting, aerobic composting and anaerobic composting, have been studied in several researches to prepare manure.[3] Organic matter is converted into compost by oxygen-dependent bacteria.[4] The compost prepared by aerobic composting matures quickly and is the most effective method of decomposition.[5] A solid pathogen-free compost is ideal for agriculture and forestry since it supports the activity of thermophilic bacteria.[5] A non-oxygen technique called anaerobic composting involves the stacking of biodegradable materials in a tight space. The majority of the anaerobic composting processes are controlled by anaerobic bacteria. However, pathogens and weed seeds are not affected by the intermediary compounds.[6] Composting with worms is a technique used to break down the organic wastes by earthworms as well as human activities.[7] An earthworm may consume organic wastes equivalent to its body weight each day. For instance, a 0.1 kg earthworm can consume 0.1 kg of organic waste every day.[8]

Compost contains specific chemical elements, often known as plant nutrients.[6] Macro- and micro-elements are the two categories of plant nutrients. Macronutrients include carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium and sulphur, while micronutrients include iron, copper, zinc, boron, manganese, molybdenum, chlorine and cobalt, which are responsible for the growth and development of crop plants in soil.[7]

Bottle gourd (*Lagenaria siceraria*) belonging to the family Cucurbitaceae is an important vegetable in Indian kitchen gardens, which is known as a poor man's vegetable. It is an African annual climbing plant that grows very quickly.[9] It can be eaten as a vegetable after cooking. The cucurbit veggies are a decent source of thiamine and riboflavin. It is good for cardiac patients since it is a very good cardiac-tonic and easily digested.[10] Jaundice can be treated well with the decoction prepared from its leaves. Its fruits are utilized in cholera and have a cooling effect.[11] Night blindness is treated with its juice as it contains vitamin A. Therefore, bottle-gourd fruits are in great demand across the nation. The present study was planned to assess the effect of prepared compost on the growth and development of bottle gourd.

MATERIALS AND METHODS

An experiment was conducted at the Research Farm of Maharishi Markandeshwar (Deemed to be University), Mullana-Ambala (Haryana) India. For the preparation of compost 1 litter compost (T_1), the fallen dry leaves of *Gravillea*, *Psidium*, *Azadirachta* and *Syzigium* were used, while for the preparation for compost 2 Kitchen waste (T_2), the food waste and kitchen scraps were used. Using the pit method, these organic waste materials were transformed into compost. The composting process was carried out as per the method of Azim *et al.* (2018).[12] Manure 1 (1 years old) (T_3) and Manure 2 (2 years old) (T_4) were collected from the village adjacent to MMDU, Mullana, Ambala.

These samples were analyzed for physicochemical parameters, including pH, electric conductivity and content of moisture, nitrogen, potassium, phosphorus, *etc*. For the determination of pH, 5 g compost was taken in a beaker of 1000 mL, and 150 mL of deionized water was added to it. The mixture (water and biomass) was allowed to stand for 10 min before being filtered. Buffer solutions with pH values of 4.0, 7.0 and 9.2 were utilized to calibrate the pH meter.

For the estimation of electrical conductivity, a 2-4 mm sieve was used to filter a fresh sample of organic compost. A ratio of 1: 5 resulted from the addition of 2 g of sample to 20 mL of distilled water. Approximately 1 hour of stirring was performed periodically. The 0.01% potassium chloride solution was used to calibrate the electric conductivity meter.

For the determination of moisture content, an oven, hot plate, field stove or similar device was ideal for drying moist samples at a uniform temperature, not exceeding 115ºC. The accurately weighed 5 g of sample was dried in an oven for 3 hr at 110ºC temperature. Thereafter, the sample was allowed to cool for 5 min and then weighed. The difference between the original and final weight was considered the moisture content. A humidity level of less than 20% is recommended.

For the determination of bulk density, the clean dry specific density bottle was weighed and then, the water was poured into the density bottle up to the brim, and

Table 1: Physico-chemical characterization of different types of compost.

Sr. No.	Sample	pH	Electrical conductivity (S/m)	Moisture content (%)	Bulk density (g/cm^3)	Ash content (%)
1	T_1: Compost 1	7.51	2.21	51	0.48	6.11
2	T_2: Compost 2	7.69	8.44	55	0.57	5.54
3	T_3: Dry manure 1	4.31	7.21	14	0.44	6.27
4	T_4: Dry manure 2	4.60	6.10	6	0.54	4.07

The Physiochemical analysis of different samples T_1, T_2, T_3 and T_4 revealed that, pH values 7.51, 7.69, 4.31, 4.60 T_1 and T_2 are basic in nature or T_3 and T_4 are highly acidic. The Electrical conductivity of these sample ranges lie 2.21, 8.44, 7.21, 6.10 and moisture content in %age are 51, 55, 14 and 6. The bulk density of these samples in g/cm^3 0.48, 0.57, 0.44 and 0.54 ash content %age in these sample are 6.11, 5.54, 6.27, 4.07.

the volume of water was measured. Thereafter, the biomass was gradually put into a density bottle, and it was weighed again and bulk density was determined.

For the determination of ash content, the sample was burnt. The amount of solid left over after burning the sample was the amount of ash.

The NPK content in samples was determined by using a standardized method (Government documented manual 2009).[13] The Bray method was used to extract the plant-available P content, and a UV-Vis spectrophotometer was used to measure the P content. The K concentration was determined by using a flame photometer (Shimadzu, Japan) and the sieve method was used to determine particle size.

RESULTS

Physicochemical Characterization

As per the standard procedure, four types of compost were prepared from the collected litter waste (T_1), kitchen waste (T_2), Manure 1 (T_3) and Manure 2 (T_4). The Table 1 reveals the physicochemical parameters, *i.e.*, pH, electric conductivity, moisture content, bulk density and ash content, and the Table 2 shows the content of nitrogen, phosphorous and potassium. The Tables 3 and 4 demonstrate the effect of composts on vine length and number of leaves of bottle gourd. Table 5 demonstrate the effect of compost on bottle gourd flower and fruit attributes Figures 1 to 4 depict the N, P, K contents, pH, electric conductivity, bulk density, ash content, moisture content and number of leaves per plant.

Table 2: Percentage nutrients of N, P, K among different compost samples.

Sl. No.	Sample	Nitrogen (%)	Potassium (%)	Phosphorus (%)
1	T_1: Compost 1	1.0	0.9	0.6
2	T_2: Compost 2	1.5	1.2	0.8
3	T_3:Dry manure 1	0.9	0.6	0.4
4	T_4: Dry manure 2	0.7	0.5	0.4

These Table 2 shows the N: P: K value of different sample the highest value of N: P: K in Compost 2 (T_2) i.e. 1.5:1.2:0.8 in comparable to other three samples that are Compost 1 (T_1) 1.0:0.9:0.6, Manure 1 (T_3) 0.9:0.6:0.4 and Manure 2 (T_4) 0.7:0.5:0.4 on the basis of N: P: K value it clear that the kitchen waste compost are highly effective (Figure 5).

Table 3: Effect of compost (T_1 to T_4) on growth on bottle gourd on the basis of vine length (cm).

Sl. No	Interval (days)	Vine length (cm)				
		T_0	T_1	T_2	T_3	T_4
1.	10	5.60	5.90	8.61	6.00	6.50
2.	15	17.61	18.50	25.36	19.50	20.62
3.	30	220.60	225.76	270.65	236.70	245.60
4.	50	346.23	350.60	385.76	374.62	378.90
5.	70	450.61	470.70	516.23	487.68	493.50

Table 4: Effect of compost (T_1 to T_4) on number of leaves per plant in bottle gourd.

Sl. No	Interval (days)	Number of leaves per plant				
		T_0	T_1	T_2	T_3	T_4
1.	10	3	3	4	4	3
2.	15	6	6	9	7	7
3.	30	18	19	25	22	23
4.	50	55	60	70	59	63
5.	70	83	89	108	94	96

Table 5: Effect of compost on bottle gourd flower and fruit attributes.

Sl. No.	Flower and fruit attributes	T_0	T_1	T_2	T_3	T_4
1.	Days to first male flower	46.7	32.4	30.6	37.3	39.5
2.	Days to first female flower	50.4	38.3	32.5	41.7	45.5
3.	Fruit length (cm)	27.3	49.3	53.5	47.5	38.7
4.	Fruit diameter (cm)	7.6	9.8	11.9	8.7	9.7
5.	Fruit weight (kg)	0.99	1.23	1.40	1.0	1.07
6.	Yield per plant (kg)	11.4	16.3	22.7	14.5	13.6

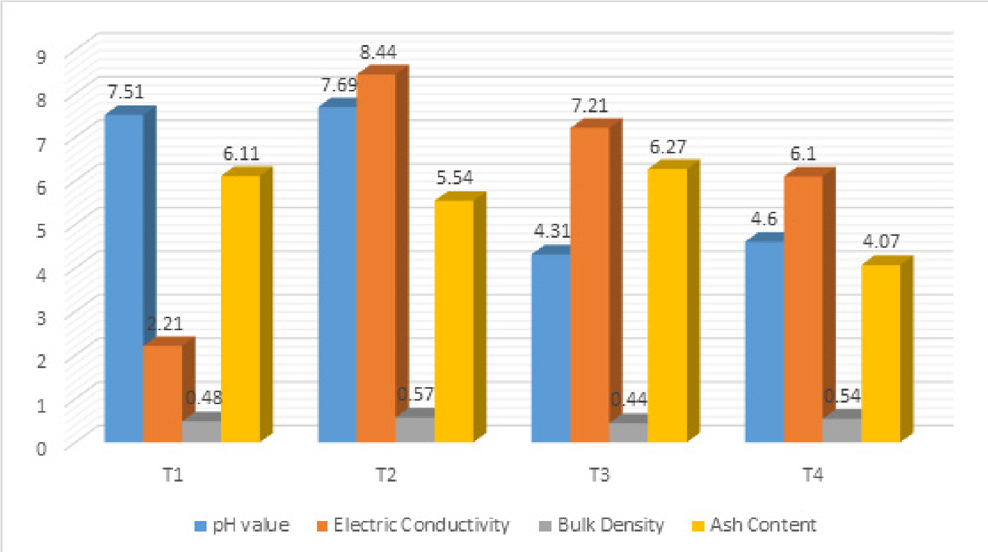

Figure 1: Physico-chemical characterization (pH, EC, MC, BD, AC) of compost samples.

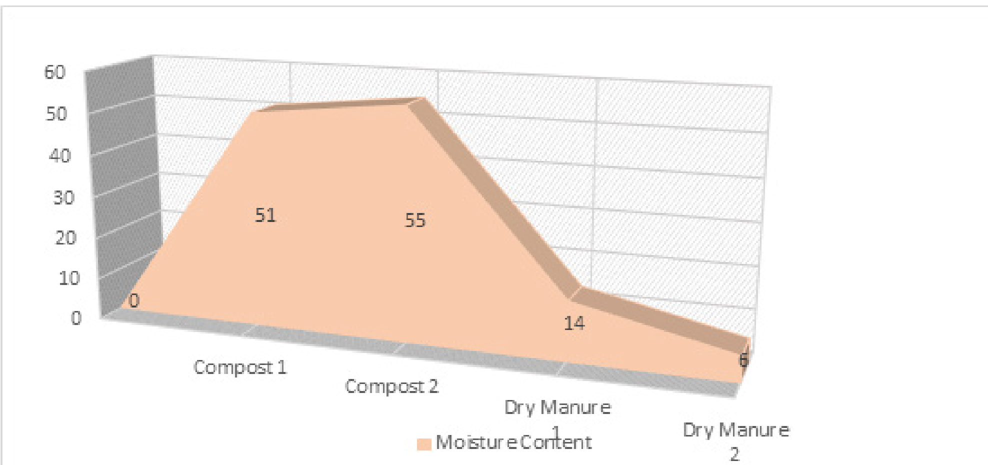

Figure 2: The moisture percentage among different compost samples.

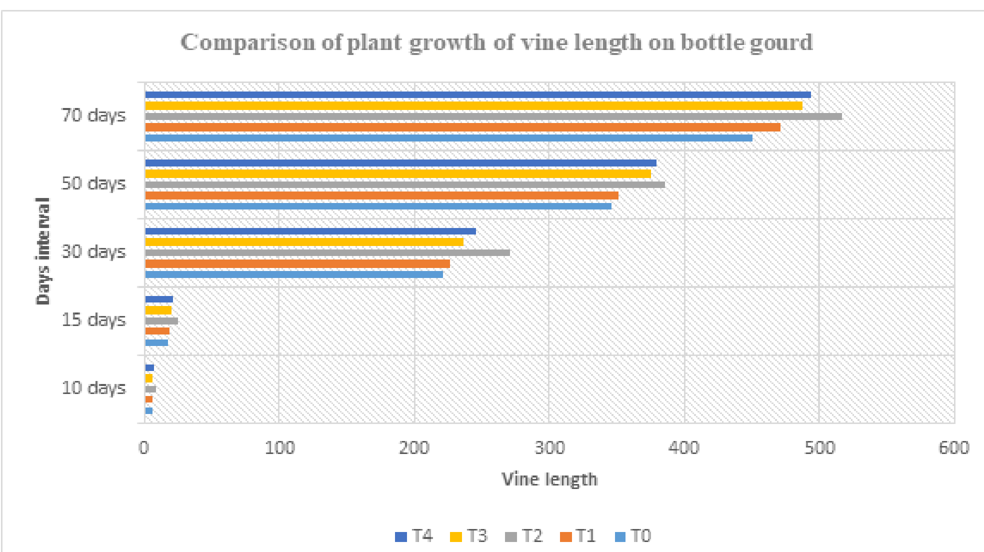

Figure 3: Effect of compost (T_0 - T_4) on plant vine length.

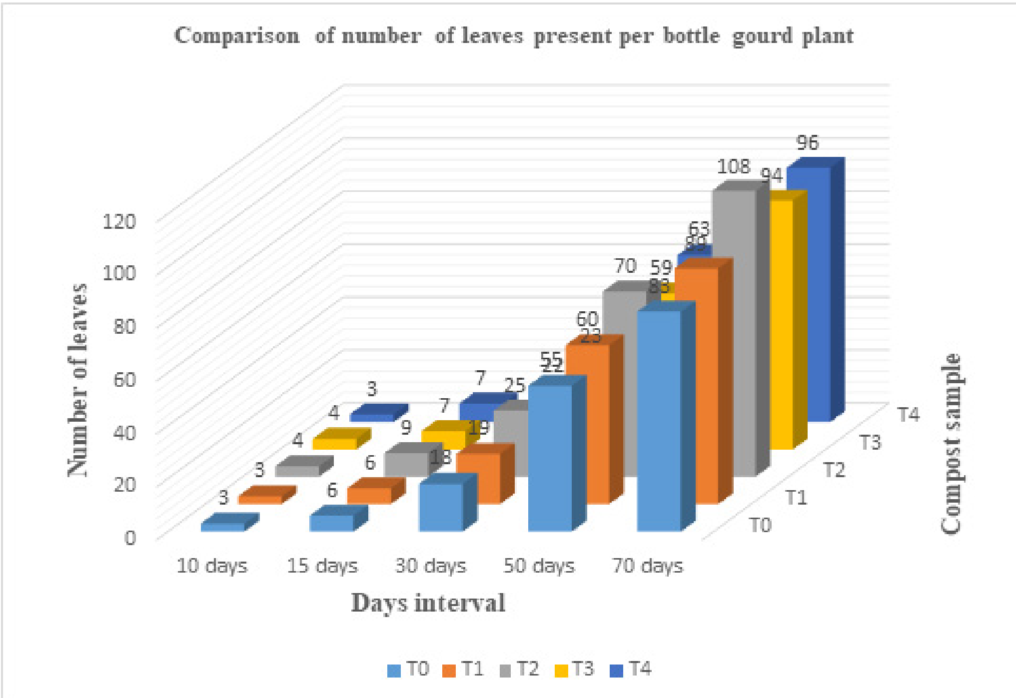

Figure 4: Effect of compost (T_0 - T_4) in number of leaves present on plant.

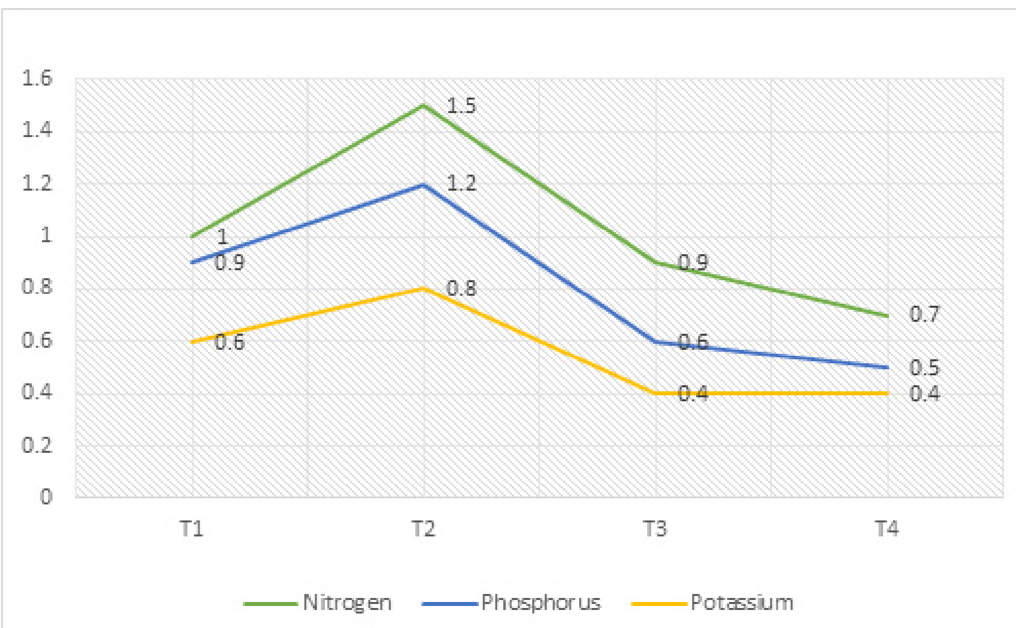

Figure 5: The NPK amount among different compost samples.

Effects of composts on plant growth

The experiment was conducted to determine the impact of compost treatments (T_1 to T_4) on the growth of bottle gourd (*Lagenaria siceraria*) on a farmer's field in Mullana Village, District Ambala of Haryana. The experiment was laid out based on plant growth 10, 15, 40, 60 and 80 days after compost application. Each of the Compost was applied 100 g per set of plants in the field. The growth parameter included vine length, number of leaves per plant and flower or fruit attributes.

Based on observations at different intervals, the maximum vegetative vine length was registered with compost T_2 (516.23 cm) followed by treatment T_0, T_1, T_3 and T_4 (450.61, 470.70, 487.68 and 493.50). The same pattern was observed for several leaves per plant (Tables 3 and 4) and (Figures 3 and 4). The days to the appearance of the first female and male flower investigated, the early female flower appeared from T_2 (32.5 days) followed by T_1 (38.3 days) and T_0 (50.4 days) (Table 5). Early male flowers appeared from T_2 (30.6 days) followed by T_1 (32.4 days). Bottle gourd required a maximum of 50-52 days to a minimum 28-30 days. Fruit length also varied significantly among the bottle gourd. The longest fruit was found from T_2 (53.5 cm) followed by T_1 (49.3 cm) and T_0 (27.3 cm). Bottle gourd showed significant variation in terms of fruit diameter, maximum diameter was found from T_2 (11.9 cm) followed by T_1 (9.8 cm) and T_0 (7.6 cm). Similarly, maximum single fruit weight T_2 (1.4 kg) followed by T_1 (1.23 kg) and T_0 (0.99 kg). Bottle gourd showed significant variation for yield/plant. However, the maximum yield/plant was found from T_2 (22.7 kg) followed by T_1 (16.3 kg) and T_0 (11.4 kg).

DISCUSSION

Compost is a valuable organic material that can have a positive impact on bottle gourd (*Lagenaria siceraria*) growth. Compost, when correctly made and added, strengthens the soil's structure, increases water retention, and enriches the soil with vital nutrients. Thus, bottle gourd plants may become healthier and more fruitful. Compost application increases organic carbon content, and improves soil structure and water-holding capacity.[14] In plants, water plays a variety of purposes and pH of the water is important for the growth of plants.

Carbon, oxygen and hydrogen are the three elements that plants must have in order to survive, and they obtain these elements from the atmosphere. Nitrogen and other nutrients are typically absorbed from the soil.[12] The macronutrients, *viz.* nitrogen, phosphorus, potassium, calcium, sulphur, magnesium, carbon, oxygen, hydrogen and micronutrients iron, boron, copper, zinc, manganese, molybdenum, chlorine, cobalt and nickel are the most critical mineral nutrients required from the growing medium. The composting of biomass allows to release of all these nutrients and facilitates the proper development of plants.[15] A study conducted by Audu *et al*., (2023) revealed that compost and farmyard manure exert a significant effect on plant height and number of leaves of sweet pepper (*Capsicum annum* L.) in Yola Adamawa State, Nigeria.[16] The present study also expressed the synergistic effects of manure prepared from different substrates. The study also revealed the effect of compost on bottle gourd for botanical attributes.

Essential nutrients like nitrogen, phosphate, and potassium are abundant in compost. Plant development and growth depend on these nutrients. These nutrients are progressively released into the soil when compost is added; giving bottle gourd plants a steady supply of nourishment. The application of compost considerably raised the soil's nutritional content, according to a study by Nasr and Abd-Elmageed[17] which enhanced bottle gourd growth and yield. Compost raises the amount of organic matter in the soil, which improves its structure. This encourages root development and increases soil aeration and drainage, minimizing waterlogging. For plants to absorb nutrients and water, their roots must be in good health. According to research by Clark and Reed[18] soils that had been treated with compost had improved structure and water-holding ability, which promoted the development and fruit output of bottle gourds. Compost's capacity to promote advantageous bacteria may provide it the power to reduce disease. In this way, soil-borne diseases may be kept at bay for bottle-gourd plants. Composted soils showed lower rates of some plant diseases and improved bottle gourd growth and general health.[19] Compost exhibits a well-balanced nutrient profile, a diverse microbial community and positive effects on the growth and development of the bottle gourd. Hence, the preparation of organic compost from waste materials is a promising approach for sustainable agriculture.

CONCLUSION

In the present study, different types of compost were prepared and applied for growth and development of all terrestrial plants. The physicochemical analysis of the compost confirmed the presence of nutrients, which played a crucial role in mineralization and the improvement of soil health through added humus content. Incorporating organic compost as a soil amendment can enhance soil fertility, promote eco-friendly farming and support the cultivation of healthy and nutritious vegetables. However, further research on specific crop and compost interactions, long-term effects and availability is necessary to optimize composting processes and fully realize the potential benefits of organic waste recycling in agriculture.

ACKNOWLEDGEMENT

In this investigation, authors are thankful to Dr. Anil Kumar Sharma, Professor and Head Department of Bio-Sciences and Technology, Maharishi Markandeshwar

(Deemed to be University), Mullana-Ambala, Haryana, India for providing the necessary facilities and Dr. R.K. Behl, Department of Agriculture, Maharishi Markandeshwar (Deemed to be University), Mullana-Ambala, Haryana, India for his valuable suggestions and edited the manuscript.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

T_1: litter waste; **T_2:** kitchen waste; **T_3:** Manure-1; **T_4:** Manure-2; **EC:** Electric conductivity; **BD:** Bulk density; **AC:** Ash content; **MC:** Moisture content.

FUNDING

No funding received from any sources.

REFERENCES

1. Ventorino V, Pascale A, Fagnano M, Adamo P, Faraco V, Rocco C, *et al*. Soil tillage and compost amendment promote bioremediation and biofertility of polluted area. J Cleaner Prod. 2019;239:118087. doi: 10.1016/j.jclepro.2019.118087.
2. Aruna G, Kavitha B, Subashini N, Indira S. An observational study on practices of disposal of waste Garbages in Kamakshi Nagar at Nellore. Int J Appl Res. 2018;4:392-4.
3. Hřebečková T, Wiesnerová L, Hanč A. Changes of enzymatic activity during a large-scale vermicomposting process with continuous feeding. J Cleaner Prod. 2019;239:118127. doi: 10.1016/j.jclepro.2019.118127.
4. Zhang L, Li L, Sha G, Liu C, Wang Z, Wang L. Aerobic composting as an effective cow manure management strategy for reducing the dissemination of antibiotic resistance genes: an integrated meta-omics study. J Hazard Mater. 2020;386:121895. doi: 10.1016/j.jhazmat.2019.121895, PMID 31884359.
5. Mehta CM, Sirari K. Comparative study of aerobic and anaerobic composting for better understanding of organic waste management: A mini review. Plant Arch. 2018;18(1):44-8.
6. Cáceres R, Malińska K, Marfà O. Nitrification within composting: a review. Waste Manag. 2018;72:119-37. doi: 10.1016/j.wasman.2017.10.049, PMID 29153903.
7. Huang K, Xia H, Zhang Y, Li J, Cui G, Li F, *et al*. Elimination of antibiotic resistance genes and human pathogenic bacteria by earthworms during vermicomposting of dewatered sludge by metagenomic analysis. Bioresour Technol. 2020;297:122451. doi: 10.1016/j.biortech.2019.122451, PMID 31787516.
8. Waqas M, Hashim S, Humphries UW, Ahmad S, Noor R, Shoaib M, *et al*. Composting processes for agricultural waste management: A comprehensive review. Processes. 2023;11(3):731. doi: 10.3390/pr11030731.
9. Buthelezi LG, Mavengahama S, Sibiya J, Ntuli NR. Variation in shoot, peduncle and fruit growth of *Lagenaria siceraria* landraces. Plants (Basel). 2023;12(3):532. doi: 10.3390/plants12030532, PMID 36771617.
10. Zaatout HH, AlShaikh NS, Sallam S, Hammoda H. Phytochemical and biological activities of Lagenaria siceraria: an overview. Egypt J Chem. 2023: doi: 10.21608/ejchem.2023.182665.7373.
11. Mahapatra S, Sureja AK, Behera TK, Bhardwaj R, Verma M. Variability in antioxidant capacity and some mineral nutrients among ninety-one Indian accessions of bottle gourd [*Lagenaria siceraria* (Molina) Standl.]. S Afr J Bot. 2023;152:50-62. doi: 10.1016/j.sajb.2022.11.040.
12. Azim K, Soudi B, Boukhari S, Perissol C, Roussos S, Thami Alami I. Composting parameters and compost quality: a literature review. Org Agric. 2018;8(2):141-58. doi: 10.1007/s13165-017-0180-z.
13. Deva Koresh HJ. Analysis of soil nutrients based on potential productivity tests with balanced minerals for maize-chickpea crop. J Electron Inform. 2021;3(1):23-35. doi: 10.36548/jei.2021.1.003.
14. Aguilar-Paredes A, Valdés G, Araneda N, Valdebenito E, Hansen F, Nuti M. Microbial community in the composting process and its positive impact on the soil biota in sustainable agriculture. Agronomy. 2023;13(2):542. doi: 10.3390/agronomy13020542.
15. Dróżdż D, Malińska K, Kacprzak M, Mrowiec M, Szczypiór A, Postawa P, *et al*. Potential of fish pond sediments composts as organic fertilizers. Waste Biomass Valorization. 2020;11(10):5151-63. doi: 10.1007/s12649-020-01074-6.
16. Audu I, Bello Z, Abakura JB. The Effects of Compost and Farmyard Manures on the Growth, Yield and Yield Parameters of Sweet Pepper *(Capsicum annum* L.) in Yola, Adamawa State, Nigeria [journal]. APRJ. 2018;1(2):1-10. doi: 10.9734/aprj/2018/v1i2595.
17. Nasr HM, Abd-Elmageed TA. Effect of organic and inorganic fertilization on soil properties, growth, yield and quality of bottle gourd. J Soil Sci Plant Nutr. 2017;17(1):47-59.
18. Clark MS, Reed DB. Impact of compost on soil structure and water retention. Int J Agric Biol. 2015;17(1):49-54.
19. Buyer JS, Teasdale JR, Roberts DP, Zasada IA, Maul JE. Factors affecting soil microbial community structure in tomato cropping systems. Soil Biol Biochem. 2010;42(5):831-41. doi: 10.1016/j.soilbio.2010.01.020.

Cite this article: Taneja T, Sharma I, Kumar M, Rana MK, Singh R. Compost Preparation from Different Organic Wastes: Their Biochemical Analysis and Effect on Growth of Bottle Gourd. Asian J Biol Life Sci. 2023;12(3):466-72.