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Full length Research paper

Nutrient status of composted and vermicomposted kitchen wastes

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Composting and vermicomposting are processes of production of ordinary compost and vermicompost through biodegradation of organic wastes by microorganisms and earth worm respectively. Both play a significance role within a given ecosystem. The objective of this study was to evaluate the nutrient status of composting and vermicomposting kitchen wastes. The study was conducted and samples data were collected in Jimma University, College of Agriculture and Veterinary Medicine. The composted and vermicomposted kitchen wastes were prepared following laboratory procedures and analyzed at Jimma University Soil Laboratory. The analysis results were pH (7.4%), Organic Carbon (3.71%), Available Phosphorus (12.35ppm), Total Nitrogen (0.60%)and Carbon Nitrogen Ratio (20.58) in compost while pH (7.23%), Organic Carbon(8.5%), Available Phosphorus(20.15ppm), Total Nitrogen (1.70%) and Carbon Nitrogen Ratio (11.56) were obtained in vermicompost kitchen waste. Vermicomposting had higher Organic Carbon, Available Phosphorus and Total Nitrogen while higher pH and C: Nratios were found in composting. Therefore the study recommends that awareness of local communities should be made so as to use vermicomposting for agricultural production. The study also recommends that attention should be given to transfer the technology of vermicomposting and use of kitchen waste as organic fertilizer rather than polluting the environment.

Key Words: Composting, Eisenia Fetida, Kitchen Waste, Nutrient content, Organic waste, Organic fertilizer, red wigglers, Vermicomposting

INTRODUCTION

Conventional compost and vermicomposting are prepared from organic materials containing low amounts of nutrient, but they slowly release available essential elements which can improve the physical condition of the soil (Tolera, 2020). The use of organic wastes through conventional compost and vermicompostingis alternative solution to the difficulties of organic waste disposal (Tesfaye, 2017).Both compost and vermicomposting are being used in agricultural/ horticultural production to improve soil fertility as they significantly enhance soil organic content (Nguyen *et al.,*2012).Composting is biological process of decomposition of organic matter by microorganisms under controlled condition, in which organic matters are converted in to humus rich nutrient material, sanitized and Stabilized for safe application to the soil(Reginald Toussaint 2012). Compost application can improve soil quality and productivity as well as sustainability of agricultural production by replenishing soil organic matter and supplying nutrients. Organic matter is a vital component of healthy soil as it plays an important role in soil physical, chemical and biological activity (TraThiThanh, 2013).

Vermicomposting is the biodegradation of organic wastes using earthworms and microorganisms (Chew *et al.,* 2019).The most common types of earthworms used for vermicomposting are brandling worms (*Eiseniafetida*) and redworms or red wigglers (*Lumbricusrubellus*). Often found in aged manure piles, they generally have alternating red and buff-colored stripes. Redworms and brandling worms, however, prefer the compost or manure environment. Recycled organic wastes are passed through the gut of the earthworm and are excreted as castings, or worm manure, an organic material rich in nutrients that looks like fine-

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textured soil (John Allen, 2016). Fudzagabo and Abdulraheem (2020) stated that vermicomposting technology is a biotechnological process of converting organic waste in to compost using specialized earth warm. Vermicomposting is a potential input and nutritive organic fertilizer rich in humus, macro and micro nutrients, growth hormones (auxines, gibberlins and cytokinins) and beneficial for soil microbes. It is an excellent soil amendment and conditioner (Ali MZ, 2007). It is produced by the fragmentation of organic wastes by earthworms, which have a fine structure and contain nutrients in forms that are readily available for plant uptake(Atiyeh*etal.,*2000). Vermicompost is a nutrient-rich, microbiologically-active organic amendment that results from the interactions between earthworms and microorganisms during the breakdown of the organic matter (Alidadet *et al.,* 2014). Vermicompost has been proven to be much more favorable than compost when the doses applied had the same contents of plant nutrients (Ievinsh *et al.,* 2020).The vermicompost produced from household kitchen waste by means of biotechnological methods using earthworm vermicomposting constitute whole some organic fertilizer of good chemical composition which may answer the nutritional needs of plants (Joanna *et al.,* 2018).Worm compost (vermicompost) is high grade and nutrient rich fertilizer. Like conventional compost, it provides many benefits to agricultural soil, including increased ability to retain moisture, better nutrient holding capacity, better soil structure, and high levels of microbial activity (Abdulraheem and Onifade, 2021).Due to increased rate of mineralization and degree of mummification by the action of earthworm, vermicompost has higher nutritional value than traditional compost (Joshi *et al.,* 2015). Sinha et al., (2010) concluded that vermicompost provided extra nitrogen (2-3%), potassium (1.85-2.25), phosphorus (1.55-2.25%).

Vermicompost produced by the activity of earth-worms is rich in macro and micronutrients, vitamins, growth hormones, enzymes such as proteases, amylases, lipase, cellulose and chitinase and immobilized micro flora(Margit Olle, 2019).

Objective of the Study

The overall aim of the study was to evaluate nutrient status of composted and vermicomposting kitchen waste in Jimma University, South West Ethiopia

Specific objectives

Specifically the study attempts to evaluate

- ✓ Nutrient status of composting on soil pH, Organic Carbon, Available phosphorus, Total Nitrogen, and C: N ratio;
- ✓ Nutrients status of vermicomposting kitchen wastes on soil pH, Organic Carbon, Available phosphorus, Total Nitrogen, and C: N ratio.

MATERIAL AND METHODS

Description of the Study area

The study was conducted in Jimma University College of Agriculture and Veterinary Medicine, Southwestern Ethiopia. Jimma is located at 352km from Addis Ababa, the capital city of Ethiopia. Geographically it is situated at 7^{o}13$^{'}$and 8^{o}56$^{'}$ Nlatitudeand 35 ^{o} 52$^{'}$and 37 ^{o} 37$^{'}$E longitude. Its altitude ranges between of 1720 and 2110MASL. The mean annual temperature ranges from 12 to 28^{o}C. The mean annual rain fall range is 1332.1mm (National Meteorological Agency, 2013). The soil type of the study area is predominantly dominated by Nitosol.

Methods of Data collection and experimental details

The samples were collected from Jimma University College of Agriculture and Veterinary Medicine composting and vermicomposting experimental area.These samples were dried, grinded and taken to Jimma University soil laboratory for chemical analysis. Accordingly, the pH was determined potentiometric in the supernatant suspension of 1:2.5 soils liquid mixtures (soil: water)(Srecko et al., 2007).Organic Carbon was determined using walkely- Balk method with wet combustion of organic matter with a mixture of potassium dichromate and sulphuric acid at about 125^{o}C. The residual dichromate was titrated against ferrous sulphate (FAO, 2019).Available phosphorus was determined using Olsen method after extracting the sample with a sodium bi carbonate solution of pH 8.5. Phosphate extract was determined calorimetrically with the blue ammonium molybdate method with ascorbic acid as a reducing agent (R.S. Manohar, 2012).Total Nitrogen was determined using kjeldahl apparatus after digesting the sample with sulphuric acid and hydrogen peroxide with selenium as a catalyst and where by organic nitrogen is converted to ammonium sulphate. The solution was then made alkaline and ammonium was distilled. The evolved ammonia was trapped in boric acid and titrated with standard acid (Bashour and Sayegh, 2007).Carbon to nitrogen ratio (C: N) was determined by dividing the weight of carbon by the weight of nitrogen.

RESULTS AND DISCUSSION

This part shows the results of analyses of the compost and kitchen waste vermicomposting variation in pH, Organic Carbon, Available Phosphorus, Total Nitrogen and C: N ratio.

Table1:Analysis results of nutrient status of composting and vermicomposting kitchen wastes.

No	Different nutrient status	Composting methods	
		Composting	Vermicomposting
1	pH	7.4	7.23
2	OC (%)	3.71	8.5
3	AVP (ppm)	12.35	20.15
4	TN (%)	0.60	1.70
5	C:N	20.58	11.56

Note: AVP= Available Phosphorus, C: N= Carbon Nitrogen Ratio, OC= Organic Carbon, TN= Total Nitrogen, ppm= part per million

Soil pH

As shown in the Table 1, the pH values of the composting and vermicomposting kitchen waste was 7.4 and 7.23 respectively.Composting had higherpH value thanvermicomposting.The lower value of pH observedduringvermicomposting could be due to production of $Co_2$and carbonic acid during decomposition by earth worms. It could be also attributed to high mineralization of nitrogen during vermicomposting. An increase of soil pH during composting could be due to ammonification and production of NO_3during decomposition organic matter.Moreover the lower pH level of vermicomposting may be also attributed by secretion of NH_4^+ ions. Suthar and Singh (2008) study indicates that higherpH value was recorded during composting when it was compared with vermicomposting.

Organic Carbon

From the Table 1, the organic carbon recorded during composting and vermicomposting were 3.71% and 8.5% respectively. The analysis result indicates thathigher value of Organic Carbon was recorded in vermicomposting than composting method. The possible reason could be because of a longer thermophilic phase during composting that enhances the loss of carbon as CO_2. In harmony with this finding, Pathma (2012) study shows that higher percentage of organic carbon was recorded during vermicomposting when compared to conventional composting method. Kassa et al., (2014) study further shows that higher value of Organic Carbon was found in vermicomposting than nursery compost.

Phosphorus availability

As indicated on the Table 1, the recorded Available Phosphorus during composting and vermicomposting were 12.35 (ppm) and 20.15(ppm) respectively. The study shows that vermicomposting had higher Olsen extracted available phosphorus content when compared to composting. Like other plant nutrients this variability could be because of the effect of earth warm activity which converts insoluble phosphorus in to soluble forms. Sinha et al., (2010) study compared the benefits of vermicomposting with the conventional composting and concluded that vermi-compost provided extra phosphorus (1.55-2.25 percent). Tesfaye (2017) states that home and market compost had the lower available phosphorus content than vermicomposting. Kassa (2014) study shows that higher available phosphorus percent was found during vermicomposting when compared to the conventional/garden compost)..High value of available phosphorus obtained was alsodue to high phosphate solubilizing bacteria, and actinomycetes in the vermicomposting (Rekha*et al.,*2018).

Total Nitrogen

As indicated in the Table 1, the result of Total Nitrogen observed during composting and vermicomposting were 0.60% and 1.70% respectively. Like Organic Carbon, the study found out that higher value of total nitrogen was observed during vermicomposting than conventional composting.

According to Swati and Reddy (2010), this could be probably due to the coupled effect of earth warm activity as well as a shorter thermophilic phase making the plant availability of most the nutrients higher in vermicomposting than that of composting process.

The increased nitrogen content in the vermicomposting is due to accumulation of mucus, nitrogenous excretory substances, growth stimulating hormones and enzyme secreted by the earth worms (Bagari and Birandar, 2017).The study conducted by Tolera et al., (2020) also shows that higher Total Nitrogen was produced from vermicompos made of various worms. Further Wako (2021) concluded that the highest value recorded in Total Nitrogen from nut, soybean (2.93%) and haricot bean (2.73%)during vermicomposting was the tripled and doubled of TN% available in the soil and conventional compost.

Carbon Nitrogen (C/N) ratio

As indicated in the Table 1, the recorded values Carbon Nitrogen ratios of composting and vermicomposting were 20.58% and 11.56% respectively. Contrary to organic carbon and total nitrogen, higher value of C: N ratio was observed during composting when compared to vermicomposting.The lower value of C: N ratio during vermicomposting could be due tohigher degradation of organic material and the loss of carbon through mineralization and respiration by earthworms. Similar to this finding,lowest value of C: N ratio was recordedduring vermicomposting (Swati and Reddy, 2010).

CONCLUSION

The objective of the study was to evaluate the nutrients status of composting and vermin composting kitchen waste in Jimma University. Specifically it attempts to investigate the status of on soil pH, Organic Carbon, Available phosphorus, Total Nitrogen, and C: N ratio of composting and vermicomposting of kitchen wastes.The result of the analysis showed that theOrganic Carbon, Available Phosphorus and Total Nitrogen were highest in vermicomposting while lowest values were recorded in composting. In contrast, higher values of pH, and Carbon Nitrogen ratio were recorded in composting when compared to vermicomposting. The possible reason of higher pH during composting is due to production of CO_2 and carbonic acid during decomposition by earth worms and high mineralization of nitrogen during vermicomposting.The lower value of C: N ratio is due to earthworm consuming the organic matter and decreases the C: N ratio. The study concludes that vermicompost kitchen waste is richer in plant nutrient than conventional composting.

RECOMMENDATIONS

Based on the finding of the study the following recommendations were made.It is recommended that awareness of local communities should be made so as to use vermicomposting for agricultural production. The study also recommends that attention should be given to transfer the technology of vermicomposting and use of kitchen waste as a fertilizer rather than polluting the environment. This study was only confined to nutrients status (pH, Organic Carbon, Total Nitrogen, Available Phosphorus and Carbon Nitrogen Ratio) of composting and vermicomposting kitchen wastes. Therefore further studies should be done in area of soil physical (soil textures, soil moisture and bulk density),soil chemical (soil exchangeable cations, cation exchange capacity, soil exchangeable acidity) and biological properties of composting and vermicomposting kitchen wastes.

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