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RESEARCH ARTICLE

Vermicomposting of leaf litter ensuing from the trees of Mango *(Mangifera indica)* and Guava *(Psidium guujuvu)* leaves

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Abstract

The leaf wastes Mango *(Mangifera indica)* and Guava *(Psidium guujuvu)* collected from the Sri Parasakthi College campus of Tirunelveli District, Tamilnadu, premises was vermicomposted by using the earthworm *Eudrilus eugeniae* and Physico- Chemical features of leaf wastes before and after composting was analyzed, which showed that macro and micro nutrients as well as physico chemical features of leaf wastes compost before and after composting was analyzed, which showed that macro and micro nutrients as well as physico - chemical features increased after vermicomposting.

Introduction

Leaf litter, if left on the soil, contributes significantly towards protecting and enriching the soil (Dash, 1993). But leaf litter accumulating in the urban and suburban locations such as sidewalks, lawns, and playgrounds is not only an unseemly sight but adds to the overall problem of municipal solid waste (MSW) disposal. In India and several other countries in the Southern hemisphere, leaf litter is often piled-up and set on fire. The resulting ash returns some of the NPK content of the litter to the soil but much of nitrogen, phosphorous, and organic carbon gets lost. The burning of litter also adds to air pollution (Abbasi, and Ramasamy, 1999).

Leaf litter can be composted and the compost used as a fertilizer or soil conditioner but the market value of the compost is not high. Due to this factor, few people in urban /suburban localities take the initiative of collecting leaf litter and generating compost from it. Vermicompost is priced about three times higher than compost and is a favorite soil conditioner of the farmers, especially in developing countries. Apart from providing to the soil organic carbon and NPK, which compost does, vermicompost is believed to have additional attributes of providing enzymes and hormones which stimulate plant growth (Abbasi and Ramasamy, 1999). Vermicompost is also believed to be more pathogen-free than compost. In view of this we have explored the possibility of generating compost followed by vermicompost from leaf litter.

The present study deals with the vermiconversion of leaf waste of mango and guava leaves into vermicompost by using the earthworm *E. eugeniae*. During the study, the waste biomass of mango and guava leaves was mixed with cow dung. (Yadav and Garg, 2009; Kaushik and Garg, 2003) for evaluation of the role of cow dung in decomposition as well as quality and quantity of the output.

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Materials and Methods

Earthworm cultures

Eudrilus eugeniae was obtained from a vermicomposting unit of Sri Parasakthi College for Women, Courtallam. The stock culture of the earthworm was maintained in plastic containers using partially decomposed bio-waste and cow dung as growth medium in laboratory condition. This was further used in the vermicomposting experiment.

Organic wastes

The leaf wastes used in the experiment were dried at 60 ºC chopped and sieved (< 2 mm). The selected materials were mixed with other supplement material in different ratio to provide three treatments (dry weight proportion in plastic containers).

Experimental design

The vermibeds were prepared using Mango leaves and Guava leaves in plastic containers and watering was done regularly to moist the medium. The substrates for vermicomposting were prepared by 1:1 ratio of mango leaves and guava leaves in plastic containers were taken for vermicomposting materials; The partially dried mango and guava leaves were mixed with nutrient supplement cow dung 1:1 ratio; 100% Cow dung (C) control; The plastic containers were filled with 1.5 cm thick sterilized soil layer at the bottom as soil is considered as an important supporting material for vermicomposting (Yadav *et al.*, 2010), Control and treatments were triplicate.

To each plastic container, 10 adult 40 days old earthworm's *E. eugeniae* were introduced from the stock culture after pre-composting of the raw materials. The experiment was conducted in dark room in ambient temperature. The moisture levels in the experimental containers were maintained at 70±10% (Yadav and Garg, 2009).

The vermibeds were prepared using leaf wastes in plastic containers and watering was done regularly to moist the medium. Mulching was done by using paddy straw to prevent evaporation. The experimental containers were arranged in a shadow to avoid direct sun light.

Characteristics of the Composts

After 60 days from the date of commencement of the experiment the vermicompost produced by the earthworms was harvested for analysis. The physical parameters such as pH, electrical conductivity, bulk density and the chemical parameters such as Total nitrogen, Total Phosphorus, Total Potassium, Organic Carbon and C:N ratio were analyzed.

The vermicompost was harvested after the appearance of black granular structure on the surface of the composting medium. Watering of the composting medium was discontinued four days before the harvesting. Vermicompost output from each treatment was calculated on dry weight basis.

Growth of the plants

Vermicompost prepared from leaf wastes and organic nutrients employing *E.eugeniae* was used for plant growth study. Vermicompost was mixed thoroughly with the garden soil in a ratio 1: 5 and filled in to the pots. The pot size was 3 L. To each pot healthy seeds of red gram, were sown. In each pot 10 seeds were sown at a depth of 2 cm and with a distance of 7 cm. The pots were watered every alternate day (1 L).

Growth Parameters

The sampling was done during the 35^{th} day of crop cultivation. From the triplicate pot a plant from each pot was randomly picked out carefully and examined for its various growth parameters. From the triplicate for each parameter mean value was calculated. The growth parameters including root length, shoot length, number of nodules, leaves, fresh weight, dry weight were observed.

Statistical analysis

Paired sample t-test was used to analyze the differences in vermicompost production in different treatments. The same test was used to compare the mean values of different chemical parameters of the compost (control) and vermicompost generated in the two treatments.

Results and Discussion

Physico-chemical changes in waste mixture during vermicomposting the earthworm caused significant changes in the chemical char-acteristics of waste mixtures during vermicomposting process. The worm-worked material was more stabilized, odour free, and dark brown substance with high range of plant available forms of soil nutrients. There was significant reduction in pH value of all waste mixtures after vermicomposting process (Table 1). The range of pH in vermicompost material was 7.02–7.25 (Table 1). pH of relatively higher in initial substrate materials, especially in CD . In vermicompost waste mixtures pH shifted towards to downward scale and this could be due to the pro-duction of CO_2, ammonia, NO_3^- and other intermediate organic acids during waste decomposition processes. Pramanik *et al.* (2007) suggested that decomposition of organic material leads to the for-mation of ammonium (NH_4^+) and humic acids. The combined effect of these two oppositely charged groups actually regulates the pH of vermicomposting substrates. The difference in pH for different experimental containers may be attributed to degree of mineralization and microbial activities which directly affects the production of intermediate compounds during waste stabilization process. pH of substrate also importance because it directly affects the colonization of major decomposer (bacteria and fungi) in decomposing waste feed stocks. Electrical conductivity (EC) showed significant changes after vermicomposting process in all waste mixtures. The EC values were found towards the 60^{th} day of vermicomposting. The initial value of EC ranged from 0.18 to 0.24mS/cm.The minimum EC value of 0.18 ± 0.04 mS/cm in treatments (T_1) and the maximum EC value of 0.24± 0.02mS/cm was noticed in (T_3) .On 60^{th} day of vermicomposting the EC values were found to be decreased from the initial value. Karmegam and Daniel (2009) reported a similar decreased trend in the level of electrical conductivity. Total organic carbon (TOC) showed decrease than initial contents in all vermibeds after decomposing wastes through earthworms. The maximum increase was 37.60% in (T_3) followed by 37.50% (T_1), and 32.73% (T_2), The loss of carbon as CO_2 due to microbial respiration and assimilation of simple carbohydrates leads to TOC reductions from waste mixtures. Moreover, carbo-hydrates and other polysaccharides which are considered major source of carbon are digested rapidly by earthworms and some fraction of digested substances is then assimilated into worm biomass. The greater TOC reduction in CD (T_1) may be due to microbial richness of substrate materials. In such beddings the microbial respiration may leads to rapid C loss through CO_2 production. Also, earthworm fragments the waste feedstock into fine fractions which results in increased sites for microbial hydrolytic enzyme actions. The biological mutuality between earthworms and associated microbes is primarily responsible for C loss from the organic wastes. Kaviraj and Sharma (2003) reported 20–45% reduction in OC contents of vermicomposted municipal solid waste mixed with CD. Similar observations have been reported by Prakash and Karmegam (2010) during vermicomposting of press-mud from sugar industry. There was increase in total N contents in all vermibeds as compared to initial levels after completion of vermicomposting process (Table 2). The total N content in vermicomposted waste mixture was in the range of 1.05 % (T_1) –1.23 % (T_2). The maximum increase in total N content was in T_2 (76.5% higher than initial) followed by T_3 (58.8%), and T_1 (48.7%), The N enrichment process during vermicom-posting depends upon the microbial populations and proportion of industrial wastes which contains microbial growth retarding. The results revealed a reduction of C:N ratio during the compost formation. The initial to final value of C:N ratio varied from 31.50±0.25 to 40.40±0.12. The C:N ratios of substrate material reflected the organic waste mineralization and stabilization during the process of decomposition. A decrease in C:N ratio was observed during experimental period and this could be attributed to the loss of carbon as carbon dioxide through microbial respiration and simultaneous addition of nitrogen by worms in the form of mucus and nitrogenous excretory material (Atiyeh *et al.*, 2000; Suthar, 2006). Studies also revealed that C:N ratio, which is one of the most widely, used indicators of compost maturation, decreased sharply during vermicomposting process.

. The maximum increase in P was noticed in T_1 (44.8%) feed mixture. The percent increase in P was in the order of T_2> T_3> T_1. The Phosphorus (P) was significantly higher in the vermicomposting than the initial. When organic matter was passed through gut of earthworms, some phosphorous being converted with more availability to plants (Lee, 1992). This might be the cause for the increase in phosphorous content of the vermicompost in the present study. The increase in phosphorus to direct action of worm gut enzymes and indirectly by stimulation of the micro flora. Increase in P during vermicomposting was probably due to mineralization and mobilization of Phosphorus as a result of earthworm gut phosphates and further release of phosphorus might be by P-solubilizing microorganisms in casts (Le Bayon and Binet, 2006). K decrease from 4.3% to 28.5% at the end of vermicomposting in different feed mixtures. The percent increase in K was in the order of T_2 > T_1> T_3. Suthar (2008) concluded that when organic waste passes through the gut of worm some quantity of organic minerals are then converted into more available forms (i.e. exchangeable forms). This may be due to the use of potassium by earthworm during metabolic activity. The results of this study agree with previous reports that the vermicomposting process accelerates the microbial-mediate mineralization in waste and subsequently enriches the end product with more available forms of nutrients of agronomic importance.

Plant growth

The growth parameters of Red gram observed at 35^{th} day of pot culture studies are tabulated in the table 3. The maximum root length of 18.87±0.77 cm was observed in guava leaf manure applied pot. The minimum root length of 11.7±0.71cm was observed in control pot. The guava leaf manure applied pot (T_3) was recorded maximum shoot length of 25.9±1.20.88cm. The number of nodules was maximum in guava leaf manure applied pot (T_3).The value is 29.67±2.73. The number of leaves, fresh weight and dry weight values are also maximum in guava leaf manure applied pot. The respective values are13±0.58, 12±0.4 and 2.7±0.15.the growth parameters like root length, shoot length, number of leaves, number of nodules, fresh weight and dry weight are get minimum value in the control pot (T_1). Table 3 present the morphological characteristics of the red gram seed germination (study) with the two different vermicompost on the 35th day of germination respectively. From these experiments it is observed that only 70%and 85% of germination was achieved with the vermicompost of T_1 and T_2 respectively. In the T_3, the percentage of germination was 100%. It was concluded that relatively less percentage of germination obtained with the control and 100% guava leaf waste could be due to the slightly alkaline pH and lesser content of nutrients like an available nitrogen, phosphorus and potassium. That vermicompost manure induces good rooting and yield responses.

Table1 Physical characteristics of leaf waste and CD (Mean±SEM,n=3)

Treatments	pH		EC (mS/cm)		BD (g/cm3)	
	initial	60th day	initial	60th day	initial	60th day
Control(T_1)	8.5±0.01	7.02±0.15	0.18±0.04	0.02±0.04	1.37±0.07	1.89±0.02
Mango Leaves vermicompost(T_2)	7.48±0.04	7.18±0.03	0.19±0.04	0.07±0.04	1,18±0.02	0.79±0.03
Guava Leaves vermicompost(T_3)	7.5±0.02	7.25±0.01	0.24±0.02	0.03±0.06	1.20±0.01	0.90±0.09

Table 2 Chemical characteristics of leaf waste and CD (Mean±SEM,n=3)

	Total Nitrogen		Total Phosphorus		Total Potassium		TotalOrganic Carbon		C:N ratio	
	initial	60th day	initial	60th day	initial	60th day	initial	60th day	initial	60th day
Control (T_1)	0.91±0 .01	1.05±0 .01	0.44±0 .03	0.54±0 .01	0.41±0 .00	0.55±0 .02	164.73±12 3.13	37.50± 0.17	39.36± 0.36	33.47± 0.19
Mango leaves vermicom post (T_2)	0.94±0 .03	1.23±0 .01	0.57±0 .01	0.75±0 .01	0.44±0 .01	0.64±0 .01	34.06±0.0 3	32.73± 0.12	31.50± 0.25	29.50± 0.12
Guava leaves vermicom post (T_3)	0.92±0 .02	1.17±0 .01	0.35±0 .02	0.68±0 .01	0.45±0 .01	0.54±0 .01	47.59±0.0 5	37.60± 0.21	44.63± 0.27	40.40± 0.12

$P < 0.05$ - Significant * - non – significant

Table 3 Growth parameters of Red gram observed in 35th day of pot culture studies

Treatments	Root length (cm)	Shoot length (cm)	No. of nodules	No. of leaves	Fresh weight (g)	Dry weight (g)
T_1	11.7±0.71	20.67±0.49	27.67±1.45	6±0.58	4.3±0.1	1.41 ±0.1
T_2	15.27±0.17	20.67±0.27	29.27±0.67	6.67±0.33	5.1±0.31	1.62±0.04

T_3	18.87±0.77	25.9±0.88	29.67±2.73	13±0.58	12±0.4	2.7±0.15

T_1- control **T_2- Mango leaf manure applied pot**
T_3- Guava leaf manure applied pot

Accelerated germination (100%) was observed with the vermicompost, especially of guava leaf waste as it was reflected in the root length, shoot length fresh and dry weight of shoots and roots. That vermicompost manure induces good rooting and yield responses in turmeric was reported by Kale (1988). Buckerfield *et al*., (1999) reported similar increased germination trends of radishes in 0–100% mixtures of vermicompost and sand although some vermicompost application rates tended to inhibit germination initially.

Conclusion

The use of leaf wastes as raw material in the vermicomposting systems can potentially help to convert this waste into value added products, i.e., vermicompost. The vermicompost obtained in this study were rich in nitrogen, phosphorus, and potassium, and also hygienically safe as pathogens. Earthworms convert the leaf wastes amended with bulky material into fine and odor-free material containing considerable amount of N, P, K and C/ N ratio of ready product was up to its' acceptable limit, at the end. The study recommends that mango leaf wastes is suitable mix for making vermicompost rich in nutrients and microorganisms which can be used as suitable organic soil amendment. Earthworm cast amendment has been shown to increase plant dry weight and plant N uptake and the importance of the synchronization between nutrient release and plant uptake and showed that slower release fertilizers can increase plant yield and reduce nutrient leaching.

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