Uttar Pradesh Journal of Zoology

Volume 45, Issue 22, Page 193-204, 2024; Article no.UPJOZ.4349
ISSN: 0256-971X (P)

Optimizing Vermicomposting of Coffee and Tea Wastes Using the Indian Earthworm *Lampito mauritii*: A Sustainable Waste Management Approach

V. Kavitha [a++*] and R. Anandhan [a++]

[a] *Department of Zoology, Annamalai University, Annamalai Nagar Tamilnadu, India.*

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.56557/upjoz/2024/v45i224673

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://prh.mbimph.com/review-history/4349

Original Research Article

Received: 20/09/2024
Accepted: 22/11/2024
Published: 09/12/2024

ABSTRACT

The rapid generation of coffee and tea ground wastes poses significant environmental challenges, particularly in urban areas. This study evaluates the potential of the Indian earthworm *Lampito mauritii* to vermicompost these wastes, aiming to identify optimal substrate ratios for maximizing compost quality and plant growth. Five treatments combining soil substrate with coffee and tea wastes in 3:1 and 1:1 ratios were tested. Results showed that the 1:1 ratios of coffee (T2) and tea (T4) wastes significantly enhanced biomass (52.43 g/kg for T2) and hatchling production (58 in T2).

[++] *Assistant Professor;*
**Corresponding author: Email: kavisamikshaa@gmail.com;*

Cite as: *Kavitha, V., and R. Anandhan. 2024. "Optimizing Vermicomposting of Coffee and Tea Wastes Using the Indian Earthworm Lampito Mauritii: A Sustainable Waste Management Approach". UTTAR PRADESH JOURNAL OF ZOOLOGY 45 (22):193-204. https://doi.org/10.56557/upjoz/2024/v45i224673.*

Vermicompost from these treatments exhibited enriched macronutrient levels (nitrogen 20.1 g/kg, phosphorous8.4 g/kg, potassium 19.7 g/kg in T2) and boosted rose plant growth, with plants in T2 growing to 110 cm and producing 7 flowers. This study highlights vermicomposting as an efficient, low-cost method for organic waste recycling and sustainable agriculture.

Keywords: L. mauritii; soil; coffee ground waste; tea ground waste; biomass; bacteri.

1. INTRODUCTION

In worldwide the coffee and tea consuming people are also increased day by day to refresh them. Therefore, coffee and tea grounds waste generation are increased. The proper management system is need to disposal of the wastes as biofertilizer in garden plants. Waste of coffee and tea grounds disposal need low cost and pollution free method. So, the vermicomposting is suitable for the waste disposal. Earthworms can play a significant role in the management of various organic wastes. Vermicompost is not only valuable compost and a biocontrol agent but also an effective way of solid waste management. Vermicompost is rich in microbial activity and contains antagonistic organisms to control plant pathogens, therefore it is an effective biocontrol agent. Vermicompost has been described as an excellent soil amendment through a number of studies along with the reasons which make it best organic fertilizer and more eco-friendly as compared to chemical fertilizers. Vermicompost is a finely-divided mature peat-like material which is produced by a non-thermophilic process involving interactions between earthworms and microorganisms. It has high porosity, aeration, drainage, and water-holding capacity (Edwards and Burrows 1988) leading to bioxidation and stabilization of organic material (Aira et al., 2000). "Presence of microbiota in vermicompost particularly fungi, bacteria and actinomycetes makes it suitable for plant growth" (Tomati et al., 1987). "Nutrients such as nitrates, phosphates, and exchangeable calcium and soluble potassium in plant-available forms are present in vermicompost" (Orozco et al., 1996). "Plant growth regulators and other plant growth influencing materials produced by microorganisms are also present in vermicompost" (Tomati et al., 1988; Grappelli et al., 1987). Production of cyto-kinins and auxins was found in organic wastes that were processed by earthworms (Krishnamoorthy and Vajrabhiah 1986). Patriquin et al. (1995) supported that organically grown plants being more resistant to pathogens and pests. Soil amendments which can manipulate physic-chemical and microbiological environment of soil can be helpful for the suppression of soil borne pathogens.

Coffee is a genus of flowering plants in the family Rupiaceae. Coffee species are shrubs or small trees native to southern Africa. The two well known species of coffee grown are the Arabica and Robusta. Coffee production in India is dominated in the hill tracts of South Indian states. Coffee beans are used to make various coffee beverages. Used coffee grounds for gardening does not a good compost. The coffee grounds do not add nitrogen immediately to the soil. But during the composting it will immediately add nitrogen to the soil.

India is one of the largest tea producers in the globe and among the top 5 per-capita tea consumers. In India, originally, tea is indigenous to the eastern and northern parts of India, but the tea industry has expanded and grown tremendously over the years, making India one of the largest growers and producers of tea in the world. In urban areas, the used tea powder is throwing away as wet condition. It needs over dumping sites and also causes air pollution. Hence in the study, this type of organic wastes was selected for vermicomposting. Compared with normal composting method, vermicomposting is one of the best methods to convert coffee and tea ground waste into fertilizer. It is low cost and odorless method. The vermicompost is enriched with macro and micro nutrients, digestive and anti-oxidant enzymes and beneficial microbes.

"The available literature on vermicomposting waste of coffee and tea grounds is limited but some studies have evaluated its use as a horticultural amendment, as a mushroom growing medium, as compost feedstock, and as biofuel feedstock" (Barreto et al., 2008; Kondamudi et al., 2008: Liu and Price, 2011). Emperor and Kumar (2015) observed Microbial Population and Activity on Vermicompost of *Eudrilus eugeniae* and Eisenia fetida in Different Concentrations of Tea Waste with Cow Dung and Kitchen Waste Mixture. Sakthivel et al. (2017) studied the physico-chemical analysis of

vermicompost produced from tea leaves waste mixed with cowdung using *Eudrilus eugeniae*. No one study was performed on vermicomposting of coffee and tea ground waste by using *L.mauritii.*

"The anecic earthworm *L.mauritii* is ubiquitous in South India. Many researchers proved that they are well known decomposers by vermicomposting of varieties of organic wastes. They can tolerate a wide range of temperatures and live in organic wastes with a good range of moisture contents" (Edwards and Bohlen, 1996). "Hence the native earthworm, *L. mauritii* has been selected in the study for the following reasons. It is an important south Indian earthworm, commonly available throughout the year, and easily maintainable in the laboratory on cattle dung. This earthworm is responsive to a wide range of toxicants and routinely used for toxicological studies. It is an efficient decomposer of organic wastes and suitable for vermicomposing" (Senapati, 1993). It is anecic in nature and inhabiting upto 20cm depth in the top soil feeding mainly upon organic wastes and highly adaptable to environmental factors like temperature, moisture etc. It has high rate of fecundity and reproduction with moderate biomass production together a long period of survival and reproductive capacity.

During the study, various parameters such as biomass and reproduction of *L. mauritii*, physico-chemical properties and presence of bacterial population in vermicompost were analysed. Finally, to find out the ability of vermicompost, it was applied to rose plants and measured height and number of flower production.

2. MATERIALS AND METHODS

2.1 Collection and Maintenance of Materials

Soil, Cowdung and Specimens of *L. mauritii* were collected from garden in Government College for Women (A), Kumbakonam.

The wastes of coffee and tea were collected from shops at Kumabakonam. It was sundried and stored.

2.2 Preparation of Experimentel Media

Five experiments were designed for the study. They were control, T1, T2, T3, and T4. Soil was mixed with cowdung in the ratio of 3:1. It was used as soil substrate. 1kg of soil substrate was taken in plastic trough (40x40 cm size). It was mixed with appropriate amount of water. It was considered as control (C). Soil substrate was mixed with coffee grounds in the ratio of 3:1 was kept as T1 whereas soil substrate was mixed with coffee grounds in 1:1 ratio. It was known as T2. Next to this, 3:1 ratio of soil substrate and Tea waste mixture was kept for T3 whereas 1:1 ratio of soil substrate mixed with tea waste was taken as T4. For each treatment, 3 replications were maintained. After preparation of experimental media, the required quantity of water was added. The media was allowed to pre-decomposition (for microbial decomposition it decreases the odour of coffee and tea ground wastes) for 5 days prior adding of earthworms. The clitellum developed 10 *L. mauritii* was introduced into each experiment (C, T1, T2, T3 and T4). The troughs were covered by nylon net to prevent predation. It was maintained at aeration and 27± 2 º C room temperature.

2.3 Biomass of *L. mauritii*

It was measured in terms of increase in biomass (weight). Once in 10 days, upto 60 days, the worms were collected from C,T1,T2,T3 and T4. They were weighed by placed on a piece of filter paper in an electronic balance.

2.4 Hatchlings Production

At the end of the experiment (60^{th} day), hatchlings were collected and counted in C,T1,T2,T3 and T4.

2.5 Nutrient Analysis

The vermicompost was collected from C,T1,T2,T3 and T4 on 60^{th} day of experiment. It was air dried, sieved and stored in polythene bags for NPK and OC analysis.

2.5.1 Estimation of total nitrogen (N)

The total nitrogen content of vermicompost was estimated by the Kjeldahl method, as detailed by Tandon (1993). This method was carried out by two steps (i) digestion of the sample to convert the N compound in the compost sample to NH_4^+ form and (ii) distillation and determination of NH_4^+ in the digest.

Digestion of the sample: To a 100 ml kjeldahl flask, 0.5g dried vermicompost was transferred. Twenty ml of the sulphuric salicylic acid mixture was added and swirled gently so as to bring the dry sample in contact with the reagents. It was allowed to stand overnight. Next day 5g of

sodium thiosulphate was added and heated gently for about 5 minutes. Care was taken to avoid frothing. The contents were cooled to which l0g of sulphate mixture was added and digested on kjeldahl apparatus at full heat for 1 hr. Bumping during the digestion can be avoided by adding glass beads. When the digestion was completed, the digest was cooled, diluted and distilled as detailed below.

Distillation by kjeldahl method: To vacuum jacket of micro-kjeldhal distillation apparatus, 10 ml of digest was transferred. In a conical flask, 10ml of 4% boric acid solution was taken, containing bromocresol green and methyl red indicators, to which the condenser outlet of the flask was dipped. After completion of distillation the colour of the solution changed into green. Then this solution was titrated against 0.1N standardized H_2SO_4; appearance of pink colour was the end point.

Calculation:

[Weight of the sample = 0.5g

Volume of digestion = 100ml; Aliquot taken = 5ml

Titre value (TV) = Sample TV = Blank TV

N (%) $\frac{TV \times 0.00007 \times 100 \times 100}{0.5 \times 5.0}$ (1ml of N/10 H_2SO_4 = 0.00014 gN)

(or) N (%) = TV x 0.28]

2.5.2 Estimation of total phosphorus (P)

Total phosphorus content of vermicompost was estimated as per Tandon (1993) by colorimetric method.

2.5.2.1 Diacid digestion

Above method was carried out using a 9:4 mixture of HNO_3: $HClO_4$. The procedure was as follows: 1gm of ground vermicompost was taken in 1000 ml of volumetric flask. To this, 10ml of acid mixture was added and the contents of the flask were mixed by swirling. The flask was placed on low heat hot plate in a digestion chamber. Then, the flask was heated at higher temperature until the production of red NO_2 – fumes cease. The contents were further evaporated until the volume was reduced to about 3-5ml but not to dryness. The end of digestion was confirmed when the liquid become colourless. Then cooling the flask to which the condenser outlet of the flask was dipped. After adding the aliquot digest, the funnel of the apparatus was washed with 2.3 ml of deionised water and 10ml of 40% NaOH solution was added. 5ml aliquot was distilled to the flask containing 10ml of boric acid. After completion of distillation, the boric acid was titrated against N/200 H_2SO_4. Blank was also carried out to the same end point and as that of the sample.

2.5.2.2 Determination of phosphorus

Reagents:

Ammonium – molybdate – ammonium vandate in HNO_3

In 400 ml of distilled water 22.5g $(NH_4)_6$ Mg_7 O_{24}. $4H_2O$ was dissolved. Also 1.25 g ammonium vandate was dissolved in 300ml boiling distilled water and added to molybdate solution and cooled to room temperature. After that 250ml of conc. HNO_3 was added and diluted to 1 litre.

2.5.2.3 Phosphate standard solution

In distilled water 0.2195g of analytical grade KH_2 – PO_4 – potassium dihydrogen orthophosphate was dissolved and diluted to 1 litre. This solution contains 50ppm of phosphate.

2.5.2.4 Preparation of standard curve

To obtain 0, 1, 2, 3, 4 and 5 ppm, standard P solution was pipetted out into 25ml volumetric flask. Then 10ml of vanadomolybdate reagent was added to each flask. The volume was made up with deionized water and mixed thoroughly. In about 30 minutes, yellow colour developed. The absorbance of the solution was read at 420nm in the UV – VIS spectrophotometer [Model SL – 159 Elico). Then the standard curve was prepared by plotting absorbance (in Y axis) against concentration P (in x axis).

2.5.2.5 Phosphorus content of sample

The aliquot from sample digestion (5ml) was pipetted out to 25ml volumetric flask and the procedure detailed for standard curve preparation was followed. The phosphorus concentration was determined using the prepared standard curve.

2.5.2.6 Calculation

P_2O_5 in % = sample concentration (ppm) x $\frac{1}{weight\ of\ sample}$

$$\frac{100}{\text{aliquot (ml)}} \times \frac{\text{Final volume (ml)}}{1000}$$

2.5.3 Estimation of total potassium (K)

Total potassium content of the vermicompost was determined by Flame Photometric method as described by Tandon (1993).

2.5.3.1 Standard stock solution of K

To prepare a standard stock solution of K, in a 1000ml standard flask, 1.91 g of analytical grade KCl salt was dissolved in distilled water and made up to 1 liter. This contains 1000 ppm of K. From this stock, 10, 20, 30, 40 and 50 ppm of K solutions were prepared by appropriate dilutions.

2.5.3.2 Preparation of standard curve

The flame photometer (Model C1 – 22D) was started and distilled water was first atomized, the galvanometer reading was adjusted to 0.0 (zero). Again fed 50 ppm solution and galvanometer reading was adjusted to 100. Then 10, 20, 30, and 40 standard K solution were subsequently fed and corresponding galvanometer readings were recorded. A standard curve was drawn by plotting flame photometer reading on Y axis and K concentrations on X – axis.

2.5.3.3 K content of sample

The unknown sample was atomized into the flame photometer and the reading was recorded. The potassium concentration was determined using the prepared standard curve, and multiplied with dilution factor.

Calculations:

$$K\ (\%) = \frac{x}{10^6} \times \frac{100}{10} \times \frac{100}{1} \times 100$$

Here, volume of extract = 100ml

Aliquot taken = 10ml

$\frac{100}{1}$ = dilution factor

2.5.4 Estimation of organic carbon (OC)

The determination of organic carbon was carried out as per the procedure of ISI Bulletin (1982).

1g of oven dried sample (at 105°C) was placed in constant mass silica crucible and heated in an electrical furnace (muffle furnace) at 550°C for 2hr. The crucible was allowed to cool down and again weighed.

$$\text{Total carbon (\%)} = \frac{\text{Initial mass - Final mass}}{\text{Initial mass taken}} \times 100$$

$$\text{Organic carbon (\%)} = \frac{\text{Total carbon (\%)}}{A}$$

A = a constant 1.724

2.5.5 Calculation of C:N ratio

The ratio of the percentage of carbon to that of nitrogen ie., C/N ratio was calculated by dividing the percentage of carbon estimated for the sample with the percentage of nitrogen estimated for the same manure sample.

2.5.6 Calculation of C:P ratio

The ratio of the percentage of carbon to that of phosphorus ie. C/P ratio was calculated by dividing the percentage of carbon estimated for the manure sample with the percentage of phosphorus estimated for the same manure sample in the present study.

2.6 Culture of Bacteria

The total number of bacteria were estimated by serial dilution plate method (Allen, 1953). 10 grams of vermicompost sample was taken from C, T1, T2, T3 and T4 on 30th day of experimental period. Each sample was transferred to a 250 ml conical flask with 100 ml of distilled water and mixed well. 10 ml of the sample was mixed with 90ml of sterile water. The serial dilutions of each mixture were made by using sterile deionised water and dilution of the vermicompost sample is 10^{-6} for bacteria. 1 ml of 10^{-6} serial diluted sample was spread in sterile petriplate aseptically and dispersed in Nutrient Agar medium (Anonymous, 1977). Plates were rotated gently three times in clockwise and anticlock wise direction to ensure uniform distribution of the manure mixture. The

petriplates were incubated at room temperature (28ºC). The colonies were developed. On 3rd day colonies were counted by using colony counter and expressed the population per gram of oven dried sample.

2.7 Plant Study

Rose plants were selected for observation of growth stimulative effect of vermicompost. At the end of the experiment (60th day), the vermicompost was collected from C, T1, T2, T3 and T4. They were dried in shadow place thereafter allowed for 1 week for acclimatization in the environment. After acclimatization 1/4 Kg of vermicompost was applied to 5 plants were sown in separate pot containing soil. Once in 15 days the vermicompost was added to the plants. The height of the plants were measured and recorded The total number of flowers were also noted.

2.8 Statistical Analysis

By using computer, mean values ($\bar{X}$) with standard error (SE) were obtained for the data. The statistical significance between treatments were analysed using 't' test.

3. RESULTS

The biomass was recorded for 60 days at the interval of 10 days (10, 20, 30, 40, 50 and 60 days). Growth and reproductive performance of earthworms were determined by its biomass and rate of multiplication. In control, the initial biomass of *L. mauritii* was 11.11±0.06 gKg^{-1}. The biomass was continuously gradually increased upto 60 days (24.11 ± 0.02 gKg^{-1}). Whereas in T1, the initial biomass was 11.57±0.03 gKg^{-1} and slowly gained 23.04±0.05 gKg^{-1} on the day 60. In T2, the initial biomass was 11.79±0.02 gKg^{-1} and 52.43±0.04 gKg^{-1} on 60th day. In T3, the initial biomass was 11.32±0.08g^{-1}. On the day 60, the biomass was 20.78 gKg^{-1}. In T3, the initial biomass was11.10±0.02 gKg^{-1}. At the end of the experiment, it was 21.41±0.06 gKg^{-1}. The *L. mauritii* gained maximum biomass in T2 followed by T4, C, T1, and T3 (Table 1).

At the end of the experiment, total number of hatchlings were recorded. In control, 32 hatchlings were recorded whereas 28 hatchlings in T1, 58 in T2, 21 in T3 and 50 in T4. The maximum number of hatchlings production was observed in T2 followed by T4, C, T1, and T3 (Table 2).

The organic carbon content in C, T1, T2, T3 and T4 was 460, ,440, 380, 508 and 420 g Kg^{-1}. The nitrogen level was 16.9, 15.8, 20.1, 13.7 and 18.1 g Kg^{-1} in C, T1, T2, T3 and T4. Whereas phosphorus content was 5.4, 4.7, 8.4, 3.1 and 6.7 g Kg^{-1}. Similarly potassium content was 15.7, 13.4, 19.7, 12.9 and 17.3 g Kg^{-1}. C:N and C:P ratio was 27.22,28.61,25.37, 31.39, 26.57 g Kg^{-1} and 85.19, 96.17, 60.71, 138.71 and 71.79 g Kg^{-1} in C, T1, T2, T3 and T4. The pH values were 6.6, 7.5, 6.6, 7.8 and 6.8 whereas EC were 0.78, 1.22, 1.15, 0.77, 1.11in C, T1, T2, T3 and T4. The results showed that the N, P, K level was more in T2 followed by T4, C, T1 and T3. Instead of this, OC, C:N, C:P ratio, pH and EC was decreased in T2 than T4, C, T1 and T3 (Table 3).

Table 1. Biomass of *L. mauritii* during vermicomposting of Coffee and Tea ground wastes

Experimental period (days)	Biomass of *L.mauritii* gKg^{-1}				
	C	T1	T2	T3	T4
1	11.11±0.06 *	11.57±0.03*	11.79±0.02*	11.32±0.08*	11.10±0.02*
10	13.04±0.013*	12.3±0.033*	20.11±.033*	11.8±0.032*	17.11±0.037*
20	16.54±0.017*	14.7±0.017*	26.00±0.017*	13.4±0.017*	20.76±0.017*
30	18.10±0.059*	16.10±0.059*	33.10±0.059*	15.10±0.059*	25.10±0.059*
40	21.48±0.052*	19.66±0.029*	40.76±0.029*	17.28±0.047*	31.7±0.047*
50	23.6±0.04*	22.28±0.04*	48.67±0.247*	20.78±0.025*	39.5±0.018*
60	24.11±0.02*	23.04±0.05*	52.43±0.04*	21.41±0.06*	44.51±0.02*

Values are mean of 3 observations ± S.E
T1- 3:1 ratio of soil substrate and coffee ground.
T2 – 1:1 ratio of soil substrate and coffee ground
T3 – 3:1 ratio of soil substrate and tea ground.
T4 – 1:1 ratio of soil substrate and tea ground
**- Significant at 5% level (P<0.05 for comparison with control)*

Table 2. Total number of hatchlings production

S.No	Experiments	Total number of hatchlings
1.	**C**	**32**±0.58*
2.	**T1**	28±1.16*
3.	**T2**	58±2.10*
4.	**T3**	21±1.82*
5.	**T4**	50±2.22*

Values are mean of 3 observations ± S.E
**- Significant at 5% level (P<0.05 for comparison with control)*

Table 3. OC, N, P, K, C:N ratio and C:P ratio pH and EC of vermicompost

Experiments	Chemical parameters (g|Kg-1)							
	OC	**N**	**P**	**K**	**C:N**	**C:P**	**pH**	**E.C**
C	460±0.10*	16.19±0.03*	5.4±0.02*	15.7±0.05*	27.22±0.04*	85.19±0.08*	6.6±0.06*	0.78±0.10*
T1	440±0.21*	15.8±0.32*	4.7±0.33*	13.4±0.08*	28.61±0.07*	96.17±0.10*	7.5±0.12*	1.22±0.12*
T2	380±0.30*	20.1±0.42*	8.4±0.17*	19.7±0.01*	25.37±0.16*	60.71±0.12*	6.6±0.22*	1.15±0.21*
T3	508±0.31*	13.7±0.52*	3.1±0.06*	12.9±0.12*	31.39±0.18*	138.71±0.20*	7.8±0.30*	0.77±0.30*
T4	420±0.4*	18.1±0.61*	6.7±0.81*	17.3±0.14*	26.57±0.20*	71.79±0.22*	6.8±0.32*	1.11±0.32*

Values are mean of 3 observations ± S.E
**- Significant at 5% level (P<0.05 for comparison with control)*

Table 4. Bacterial population in vermicompot

Experimental period (Days)	Total bacterial Population CFU x 106 g^{-1}				
	Control	T1	T2	T3	T4
10	205	152	226	125	214
20	226	164	265	139	241
30	239	178	281	151	268
40	261	171	310	163	283
50	289	182	332	159	312
60	314	191	375	168	348

Values are mean of 3 observations ± S.E

**- Significant at 5% level (P<0.05 for comparison with control)*

Table 5. Height and flowers numbers of the Rose plants after application of vermicompost (C, T1, T2, T3 and T4)

Experimental days	Height of the plants (cm)				
	C	T1	T2	T3	T4
0	**44**	**35**	**40**	**30**	**36**
15	**48**	**40**	**71**	**30**	**64**
30	**76**	**44**	**110**	**35**	**95**
No. of Flowers	**3**	**2**	**7**	**1**	**4**

**- Significant at 5% level (P<0.05 for comparison with control)*

The microbial study also showed that a greater number of bacterial populations was observed. in T2 than T4, C, T1 and T3 at all the experimental period. They were 226, 265, 281, 310, 332, 375 CFU x 10^6 g^{-1} in T2 ; 214, 241, 268, 283, 312, 348 CFU x 10^6 g^{-1} in T4; 205, 226, 239, 261, 289, 314 CFU x 10^6 g^{-1} in C; 152, 164, 178, 171, 182, 191 CFU x 10^6 g^{-1} in T1 and 125, 139, 151, 163, 159, 168 CFU x 10^6 g^{-1} in T3 (Table 4).

In plant growth study, maximum height was observed in T2 rose plants (71 and 110 cm in 15 and 30th day) followed by T4, C, T1 and T3. Whereas, maximum number of flower also observed in T2 (7) than T4(4), C (3), T1(2) and T3(1) (Table 5).

Compared with all the biological parameters of the study, the results proved that 1:1 ratio of soil substrate and coffee ground whereas1:1 ratio of soil substrate and tea ground was enhanced the growth and reproduction of *L.mauritii* whereas produced nutrient and bacterial rich vermicompost. The vermicompost highly promoted the growth of rose plants.

4. DISCUSSION

The *L. mauritii* attained maximum biomass and hatchlings production in T2 (1:1 ratio of soil and coffee ground waste) and T4 (1:1 ratio of soil and tea ground waste) followed by C, T1 and T3. In accordance with the results, Khucharoenphaisan Khwanchai and Sinma Kanokkron (2018) observed that the weight of the *Eudrilus Eugeniae* was increased during the vermicomposting of coconut shell's hair, cow dung and coffee ground bedding materials as well as in coconut shell's hair, elephant dung and coffee ground than without coffee ground (coconut shell's hair and cow dung or elephant dung vermicompost).

Similarly, high level of N,P,K and low level of OC,C:N ratio, C:P ratio, pH and EC is observed in T2 and T4. The results were supported by Khucharoenphaisan Khwanchai and Sinma Kanokkron (2018). They reported that the coffee ground mixed vermicompost has more macro nutrients such as nitrogen, phosphorus and potassium and less pH and EC values. Earthworm can accept organic wastes as feed if it is provided with smaller particle size about 5mm (Neuhauser et al., 1980), higher nitrogen content (Edwards and Bohlen,1996), optimal C/N ratio 15:1 to 30:1 (Neuhauser et al., 1980) etc. Quality and availability of food influences the growth and reproductive potential of earthworms. Earthworms consume and require a combination of microbes, nitrogen, cellulose and grit for their maximum growth and reproduction (Flake and Hartenstein, 1984; Edwards and Bohlen, 1996). The results also supported by Ramalingam (2001). They indicated that the vermicomposted sugarcane trash showed insignificant changes in the level of macro and micro nutrients along with

wider C/N (86:1) and C/P (64:1) ratio due to improper bio-degradation. Whereas in the vermicomposted sugarcane trash and pressmud mixture, the level of macro and micro nutrients increased (N(34%), P(80%), K(40%), Ca(46%), Mg(39%), and Mn(11%) significantly over control compost along with reduction in C:N(15:1) and C:P(6:1) ratio due to mineralization brought out by the combined action of earthworms and microbes.

In plant study, T2 and T4 vermicompost applied rose plants showed more height and produced more flowers than C, T1 and T3 due to the presence of more macro nutrients (N,P and K) in the waste coffee and tea grounds. During the vermicomposting the OC, C:N, C:P ratio, pH and EC is reduced. It is suitable for plant growth and more flower production. The results are supported by many researchers. Arancon et al. (2006) reported that the increased strawberry plant growth by application of vermicompost was mainly due to the presence of more microbial population in it. Maria Remedios Morales-Corts et al. (2018) reported that garden waste compost and tea vermicompost was promoted the tomato plant and also increased the shoots, root dry weight, chlorophyll content and stem diameter compared to untreated plants. They were also observed that the compost and vermicompost tea was act as organic fungicides. It had suppressive effect on *R.Solani* and *F. Oxysporum*. Sakthivel Vellaikannu et al. (2017) was reported that high content of N, P, K, Ca, Mg, Fe, Zn, Cu and Ec and low level of OC and pH was observed in vermicompost of tea leaves waste mixed with cowdung (30th day) than control. Reduction in pH towards neutrality should be important in retaining nitrogen and seems to promote the nutrients availability to plant (Brady, 1988). Shinde et al. (1992) reported that EC values reduced or remain unchanged and ranged between 0.21-0.46 ds/m in the vermicompost. During the composting of tea waste contain more essential nutrients for plant. They are chloride, sulphate, total phosphorus, available phosphorus, organic matter, calcium and magnesium more in compost than soil. This compost rapidly enhanced the plant growth and their yield (Minakshi and Smita, 2016).

The organic matter and organic carbon in the soil and vermicompost act as a buffer for many deficiencies in soil, form the main source of energy for both soil organisms and plants and useful to maintain soil physic-chemical properties. The C/N and C/P ratio is of importance since plant cannot assimilate mineral nitrogen and phosphorus unless the ratio is in between 20:1 and 15:1 or lower (Edwards and Bohlen, 1996). The significant reduction of OM, OC, C/N and C/P ratio in vermicompost of sugarcane and cowdung substrate (Ramalingam, 2001). The reduction in carbon and lowering of C/N ratio in the worm worked compost could be achieved on the one hand by the respiratory activity of earthworms and microorganisms (Edwards and Bohlen, 1996) and on the other hand increase of nitrogen by microbial mineralization of organic matter (Syres et al*.,* 1979) combined with the addition of worm's nitrogenous wastes through excretion (Curry et al*.,* 1995).

Most species of epigeic earthworms are relatively tolerant to pH, but when given a choice in the pH gradient, they moved towards the more acid material, with a pH preference of 5.0. However, earthworms will avoid acid material of pH less than 4.5, and prolonged exposure to such material could have lethal effects (Edwards and Bohlen 1996). It is widely believed that waste coffee grounds are acidic but as the study clearly displayed consistent pH values around neutral (7.0) were recorded throughout the experiment. Microbes driving compost stabilization operate best in the range of pHs between 6.5 and 8.0 (Vallini et al., 2002) and as waste coffee grounds are neutral it represents a valuable feedstock which can sustain microbes for compost stabilization.

The ratio of carbon to nitrogen (C: N ratio) in organic matter added to soil is of importance, because net mineralization of the organic matter does not occur unless the C: N ratio is of the order of 20:1 or lower. Earthworms can have major influences on nutrient cycling processes in many ecosystems. By turning over large amounts of organic matter, they can increase the rates of mineralization of organic matter, converting organic forms of nutrients into inorganic forms that can be taken up by plants (Edwards Bohlen, 1996). In recent years, vermicomposting has emerged as a simple, easily adaptable and effective biotechnology for recycling a wide range of organic wastes for agricultural production. The technology is advantageous over thermophilic compost because it contains a considerable amount of organic acids, such as plant growth promoting hormones and humic acids. It also has high water holding capacity, low C:N ratio and low phytotoxicity (Pant and Wang, 2014).

Moreover this, the results of the study also showed that a greater number of bacterial populations was observed in vermicompost of T2 and T4 followed by C, T1 and T3. It is due to earthworm gut harbours specific symbiotic microflora. Microorganisms are essential part of biodiversity and play a significant role in structuring and functioning of the ecosystem on the environment. During vermicomposting process, the organic matter passes through the worm's gut undergoes physical, chemical, and biochemical changes by the combined effect of earthworms and microbial activities. Hendrikson (1990) recorded high bacterial population in the earthworm cast. Emperor and Kumar (2015) observed that more bacterial, fungal and actinomycetes population and activity in Vermicompost of maximum concentrations of tea waste with cow dung and kitchen waste mixture by using *Eudrilus eugeniae* and *Eisenia fetida*. The present results showed that 3:1ratio of soil and coffee ground waste and 3:1 ratio of soil and tea ground waste is suitable media for bacterial growth in the gut of the *L. mauritii.*

5. CONCLUSION

1:1 ratio of soil substrate mixed with coffee whereas tea ground wastes were suitable feed for the earthworms. So, it increased *L. mauritii's* biomass, hatchlings production, OC, N, P, K nutrients, bacterial population while decreased the C:N and C:P ratio, pH and EC. The application of vermicompost was highly stimulated height and flowering potential of rose plants. In other words, vermicomposting is a best tool to reduce over dumping of coffee and tea ground wastes in open site as well as protect our environment from pollution.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

ACKNOWLEDGEMENTS

The authors are thankful to the Head of the Department of Zoology, Annamalai University, Annamalai Nagar, 608 002, Tamil Nadu, India for providing the necessary facilities to carry out this work.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

Aira, M., Monroy, F., Dominguez, J., & Mato, S. (2000). How earthworm density affects microbial biomass and activity in pig manure. *European Journal of Soil Biology*, 38, 7–10.

Allen, G. N. (1953). *Experiments in soil bacteriology*. Burgess Publ. Co.

Anonymous, A. (1977). *Difo manual of dehydrated culture media and reagents for microbiological and clinical laboratories*. Detroit, Michigan.

Arancon, N. Q., Edwards, C. A., & Bierman, P. (2006). Influences of vermicomposts on field strawberries. Part 2. Effects on soil microbiological and chemical properties. *Bioresource Technology*, 97, 831–840.

Barreto, S. M., Lopez, M. V., & Levin, L. (2008). Effect of culture parameters on the production of the edible mushroom *Grifola frondosa* (maitake) in tropical weathers. *World Biotechnology*, 24, 1361–1366.

Brady, N. C. (1988). *The nature and properties of soil*. Eurasic Publishing House (P) LTD.

Curry, J. P., Byrne, D., & Boyle, K. E. (1995). The earthworm population in winter's cereal field and its effects on soil and nitrogen turnover. *Biology and Fertility of Soils*, 19, 166–172.

Edwards, C. A., & Bohlen, P. J. (1996). *Biology and ecology of earthworms*. Chapman and Hall.

Edwards, C. A., & Burrows, I. (1988). The potential of earthworm composts as plant growth media. In C. A. Neuhauser (Ed.), *Earthworms in environmental and waste management* (pp. 211–220). SPB Academic Publishing.

Emperor, G. N., & Kuma, K. (2015). Microbial population and activity on vermicompost of *Eudrilus eugeniae* and *Eisenia fetida* in different concentrations of tea waste with cow dung and kitchen waste mixture. *International Journal of Current Microbiology and Applied Sciences*, 4(10), 497–506.

Flake, F. M., & Hartenstein, R. (1984). Growth of the earthworm *E. fetida* on microorganisms

and cellulose. *Soil Biology and Biochemistry*, 16, 491–495.

Grappelli, A., Galli, E., & Tomati, U. (1987). Earthworm casting effect on *Agaricus bisporus* fructification. *Agrochimica*, 21, 457–462.

Gurav, M., & Sinalkar, S. (2016). Preparation of organic compost using waste tea powder. *National Conference on Biodiversity: Status and Challenges in Conservation – FAVEO*, 2013, Thakur A.C.S. College, New Panvel, Maharashtra, India.

Hendriksen, N. B. (1990). Leaf litter selection by detrivore and geophagous earthworms. *Biology and Fertility of Soils*, 10, 17–21.

ISI Bulletin. (1982). Manak Bahavan, Bhadur Shah Zafar Marg, New Delhi.

Khucharoenphaisan, K., & Sinma, K. (2018). Effect of agricultural waste on vermicompost production and earthworm biomass. *Journal of Environmental Science and Technology*, ISSN 1994-7887.

Kondamudi, N., Mohapatra, S. K., & Misra, M. (2008). Spent coffee grounds as a versatile source of green energy. *Journal of Agricultural and Food Chemistry*, 56, 11757–11760.

Krishnamoorthy, R. V., & Vajrabhiah, S. N. (1986). Biological activity of earthworm casts: An assessment of plant growth promoter levels in casts. *Proceedings of the Indian Academy of Sciences (Animal Science)*, 95, 341–351.

Liu, K., & Price, G. (2011). Evaluation of three composting systems for the management of spent coffee grounds. *Bioresource Technology*, 102(17), 7966–7974.

Morales-Corts, M. R., Perez-Sanchez, R., & Gomez-Sanchez, M. A. (2018). Efficiency of garden waste compost teas on tomato growth and its suppressiveness against soil-borne pathogens. *Scientia Agricola*, 75(5), 400–409.

Neuhauser, E. F., Kaplan, D. L., Malecki, M. R., & Hartenstein, R. (1980). Materials supportive of weight gain by the earthworm *Eisenia fetida* in waste conversion systems. *Agricultural Wastes*, 1(2), 43–60.

Orozco, S. H., Cegarra, J., Trujillo, L. M., & Roig, A. (1996). Vermicomposting of coffee pulp using the earthworm *Eisenia fetida*: Effects on C and N contents and the availability of nutrients. *Biology and Fertility of Soils*, 22, 162–166.

Pant, A., & Wang, K. (2014). Recycle organic waste through vermicomposting.
Available:http://www.ctahr.hawaii.edu/uhmg/news/V10-Pant-Wang-benefits-vermicompost.pdf
Last accessed 8 June 2015.

Patriquin, D. G., Barnes, D., & Abboud, A. (1995). Diseases, pests, and soil fertility. In H. F. Cook & C. Lee (Eds.), *Soil management for sustainable agriculture* (pp. 161–174). Wye College Press.

Ramalingam, R. (2001). Vermicomposting of crop residue sugarcane trash using an Indian epigeic earthworm, *Perionyx excavates*. *Journal of Experimental Zoology India*, 4(2), 267–272.

Sakthivel, V., Malathi, C., Jayashri, S., & Saralabai, V. C. (2017). Physico-chemical analysis of vermicompost produced from tea leaves waste mixed with cowdung using *Eudrilus eugeniae*. *European Journal of Biotechnology and Bioscience*, 5(6), 35–36.

Senapathi, B. K. (1993). Vermitechnology in India. In N. S. Subba Rao, C. Balagobalan, & S. V. Ramakrishna (Eds.), *New trends in biotechnology* (pp. 347–358). Oxford & IBH.

Shinde, P. H., Naik, R. L., Nazivkar, R. B., Kadam, S. K., & Khaire, V. M. (1992). Evaluation of vermicompost. *Proceedings of the National Seminar on Organic Farming*, TNAU, Coimbatore, 54–55.

Syers, J. K., Sharpley, A. N., & Keeney, D. R. (1979). Cycling of nitrogen by surface casting earthworms in pasture ecosystems. *Soil Biology and Biochemistry*, 11, 181–185.

Tandon, H. L. S. (1993). *Methods of analysis of soils, plants, waters, and fertilizers*. Fertilizer Development and Consultation Organisation.

Tomati, U., Grappelli, A., & Galli, E. (1987). The presence of growth regulators in earthworm-worked wastes. In A. M. Bonvicini Paglioi & P. Omodeo (Eds.), *On Earthworms: Proceedings of the International Symposium on Earthworms* (pp. 423–435). Unione Zoologica Italiana.

Tomati, U., Grappelli, A., & Galli, E. (1988). The hormone-like effect of earthworm casts on plant growth. *Biology and Fertility of Soils*, 5, 288–294.

Vallini, G., Gregorio, S., Pera, A., & Cunha Queda, A. (2002). Exploitation of composting management for either reclamation of organic wastes or solid-phase treatment of contaminated environmental matrices. *Environmental Reviews*, 10(4), 195–207.

Peer-review history:
The peer review history for this paper can be accessed here:
https://prh.mbimph.com/review-history/4349