



Vermicompost Production using Wild Collected Different Earthworm Species from Madurai District, Tamil Nadu, India and their Qualitative and Quantitative Evaluations

Karthigeyan M^a, Mani P^b and Alagesan P^{c, *}

^aDepartment of Zoology, Arumugam Pillai Seethai Ammal College, Tiruppattur- 630211, Tamil Nadu, India.

^bDepartment of Biotechnology, Annai College of Arts and Science, Kumbakonam- 612503, Tamil Nadu, India.

^cPG & Research Department of Zoology, Yadava College, Madurai- 625014, Tamil Nadu, India.

Received: 8 Oct 2018/ Accepted: 6 Nov 2018/ Published online: 01Jan 2019

Corresponding Author Email: master.maniji@gmail.com

Abstract

Earthworms are the potential sources of compost production; they are called vermicompost which are the promising sources for best agriculture practice. For best understanding the local wild earthworm species for the vermicompost production, this study was carried out. There were four different species of earthworm was collected from five different location of Madurai district, Tamil Nadu, India and they were identified as *Drawida sp.*, *Perionyx excavatus* and *Lampito mauritii* and *Drawida japonica*. All of the earthworm species were individual tested for the production of vermicompost using a 14kg mixed biomass waste as the bioconversion substrate and a commercial available earthworm species of *Perionyx excavatus* was used for comparison. Among the wild isolated earthworm from this study, *Perionyx excavatus* showed the highest vermicompost production with 13 Kg and 1 Kg as unused biomass with 690g of final earthworm weight, significantly, this was higher than the commercial type earthworm, *Perionyx excavatus* which produced 10.3 Kg vermicompost and 3.7 Kg as unused biomass with 607g earthworm final weight. Moreover, the vermicompost produced from wild collected *P. excavatus* evidenced appreciable nitrogen, phosphorus, potassium and organic carbon than the other earthworm species of both wild and commercial types. From these observations, this study suggesting the use of wild type earthworm species, *Perionyx excavatus* for more

appreciable bioconversion of mixed waste biomass to the valuable vermicompost production.

Keywords

Earthworm species; Vermicompost; Nutritional analysis; *Perionyx excavatius*; Madurai district.

1. INTRODUCTION

Environmental degradation is a major threat confronting the world, and the rampant use of chemical fertilizers contributes largely to the deterioration of the environment through depletion of fossil fuels, generation of carbon dioxide (CO₂) and contamination of water resources. It leads to loss of soil fertility due to imbalanced use of fertilizers that has adversely impacted agricultural productivity and causes soil degradation. Now there is a growing realization that the adoption of ecological and sustainable farming practices can only reverse the declining trend in the global productivity and environment protection (1, 2). Vermicomposting is a simple biotechnological process of composting, in which certain species of earthworms are used to enhance the process of waste conversion and produce a better end product. Vermicomposting differs from composting in several ways (3). It is a mesophilic process, utilizing microorganisms and earthworms that are active at 10–32°C (not ambient temperature but temperature within the pile of moist organic material). The process is faster than composting; because the material passes through the earthworm gut, a significant but not yet fully understood transformation takes place, whereby the resulting earthworm castings (worm manure) are rich in microbial activity and plant growth regulators, and fortified with pest repellence attributes as well! In short, earthworms, through a type of biological alchemy, are capable of transforming garbage into 'gold' (4).

In this study, four different wild type earthworm species were isolated from local areas Madurai district, Tamil Nadu, India and were used for the vermicompost production. All the species were involved individually in vermicompost making using a mixed waste biomass as the bioconversion substrate and the efficiency of the wild type earthworm producing vermicompost was qualitatively and quantitatively compared with each other and with a commercial available known species of earthworm, *Perionyx excavatius*.

2. MATERIALS AND METHODS**2.1. Collection of Earthworm species**

Different soil samples were collected for the isolation and study of earthworm in and around Madurai district, Tamil Nadu, India. Top soil samples were collected at a depth of 0–20 cm using soil auger from five different areas viz., cultivating land of Vadipatti, non cultivating land of Thirumangalam, grass land of Usilampatti, garden soil from Alagar kovil and Sewage soil from Melur during the month of September, 2017. Earthworms were collected from the possible different sites of all the above mentioned different five locations. To avoid the dry season when soil is hard to excavate and earthworms are more difficult to find, sampling took place wet season of September, 2017. Soil pits (20 × 20 × 20 cm) were dug using a spade and earthworms were hand-sorted in the field. The collected earthworms were then stored in plastic containers with perforated lids along with soil. They were maintained in these boxes by sprinkling water every day until further use. Moreover, the collected species of earthworms were identified with the help of systematic keys followed by Edward and Lofty (5) and Julka (6).

2.2. Vermicomposting

All the individual earthworm species isolated in this study were individually tested for the efficiency of making small scale vermicomposting and were compared with commercially available earthworm, *Perionyx excavatius* which was purchased from Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India.

2.2.1. Procedure

Using a plastic tank with the size of 0.6 m width x 1.4 m length x 0.6 m height was used for vermicomposting. Numerous holes were made each with a distance of at least 2cm length. Kitchen wastes like unused vegetable, fruits, leaves and cow dung were used as mixed biomass for vermicompost making which were first sun dried for a week and chopped them to the required smaller size using the knife and scissors. For cow dung decomposition a slurry preparation was made for quick pre-treatment. At the bottom, 2 inch of sandy soil was added followed by the addition of dry chopped

kitchen waste and decomposed cow dung was added one by one with a mixing rate. Totally about 14 kg of total biomass (4 kg dried vegetables + 2 kg fruit + 4 kg dried leaves + 4 kg decomposed cow dung) was used which were watered carefully and waited till enough water drained off. About 300g of earthworm was added at the end. For every species of earthworm under study, the above preparation was made. The composts were covered with gunny bags and water was sprinkled on regular basis to maintain the moisture content of the compost. Further, the tank was covered with thatch roof to prevent the entry of ants, lizards, mouse, etc. and to protect the compost from rainwater and direct sunshine. After 30 days, the tank was verified for the quantity available of vermicompost which were sieve separated from for non digestible waste biomass and both were weighed for comparison. All the collected vermicompost samples were analysed for nitrogen, potassium phosphorus and organic carbon as per the given procedure mentioned below.

2.3. Quantitative nutritional examination of vermicompost

2.3.1. Available Nitrogen

Available nitrogen was determined using alkaline potassium permanganate method (7). The procedure involves distilling the soil with alkaline potassium permanganate solution and determining the ammonia liberated by titrating against sulphuric acid (0.02N).

2.3.2. Available Phosphorus

The Olsen's method (8) was used for the determination of available-P in soil. In this method soil was extracted with 0.5 M NaHCO_3 (pH 8.5). Five ml of extract was taken and colour was developed by ascorbic acid solution. After 10 minutes, the intensity of blue colour was measured on spectrophotometer at 720 nm.

2.3.3. Available Potassium

Five grams soil was extracted with 1N neutral (pH 7.0) ammonium acetate solution by shaking for 30 minutes potassium content in the extract was determined flamephotometrically (9).

2.3.4. Organic carbon

The organic carbon content of the soil samples were determined by the method of Walkey and Black (10). 1 g finely ground soil sample was passed through 0.5 mm sieve without loss was taken into 500 ml conical flask, to which 10 ml of 1 N potassium dichromate and 20 ml conc. H_2SO_4 were added with measuring cylinder. The contents were shaken for a minute and allowed to stand for 30 min. Then 200 ml distilled water, 10 ml orthophosphoric acid and 1 ml diphenylamine indicator were added. The solution was titrated against 0.5 N ferrous ammonium sulfate till the colour flashes from blue-violet to green. The blank titration was carried at the beginning without soil. The results were calculated by the following formulas:

$$\text{Organic carbon \%} = \frac{N \times (V_1 - V_2) \times 0.39 \times \text{mcf}}{S}$$

Where: N = Normality of ferrous ammonium sulfate (FAS)

V1 = Volume of 0.5 N

FAS required to neutralize 10 ml of 1 N $\text{K}_2\text{Cr}_2\text{O}_7$ i.e. blank reading (ml).

V2 = Volume of 0.5 N

FAS needed for titration of soil sample (ml)

S = Weight of air-dry sample (g)

0.39 = $0.003 \times 100\% \times 1.31$ (0.003 is the milliequivalent weight of carbon in g). It is assumed that only 77% of the organic matter is oxidized and a fraction of $100/77 = 1.31$

3. RESULTS AND DISCUSSION

There were four different species of earthworm was found from the above mentioned five selected locations (Fig 1-4). They were identified as *Drawida* sp., *Perionyx excavatus* and *Lampito mauritii* and *Drawida japonica*. Moreover, *Drawida* sp. constituted the maximum of collected species,

counted of 33.33% of the overall identified morphologically distinct species followed by *Perionyx excavatus* and *Lampito mauritii* constituted of each 25% of the total earthworm species and least values was observed with *Drawida japonica* constituted only 16.67% of the overall population.


Figure 1: *Drawida sp.*

Figure 2: *Lampito mauritii*

Figure 3: *Perionyx excavates*

Figure 4: *Drawida japonica*

3.2. Vermicompost production

All the earthworm species isolated in this study including a commercially available earthworm species, *Perionyx excavatus* were involved individual for testing the efficiency of vermicompost making. The vermicomposting tank was inspected regularly to avoid the presence of ants, lizards, mouse etc. and watered regularly. After 30 days of vermicomposting, the biomass in the tank was verified for the quantitative presence of vermicompost as well as unused waste biomass (Fig. 2). Among the wild isolated earthworm from this study, *Perionyx excavatus* showed the highest conversion of mixed biomass waste to vermicompost with 13 Kg and 1 Kg as unused biomass which was followed by *Lampito*

mauritii produced 9 Kg vermicompost and 5 Kg as unused biomass, *Drawida japonica* produced 8.5 Kg vermicompost and 5.5 Kg as unused biomass and least value was recorded with *Drawida sp.* produced 8 Kg vermicompost and 6 Kg as unused biomass. Significantly, the commercial species of *Perionyx excavatus* included in this study showed 10.3 Kg vermicompost and 3.7 Kg as unused biomass which was less vermicompost production when compared to the wild earthworm species of *Perionyx excavatus*. To the fact, wild earthworm species of *Perionyx excavatus* produced 1.7 Kg more vermicompost than the commercially available *Perionyx excavatus*.

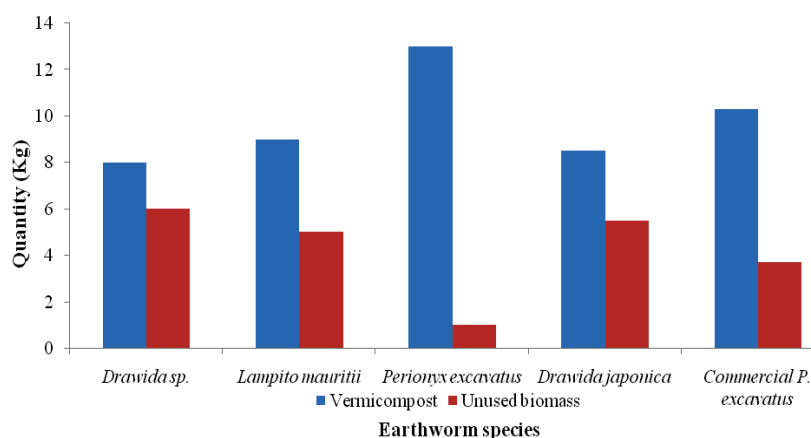


Figure 5: Compost forming abilities of different isolated earthworm species using a mixed waste biomass and comparing the results with a commercially available species of *Perionyx excavatus*

Moreover, the weight of earthworm was evaluated at the end of 30th day (Fig. 6) which was collected from the unused biomass separated using sieve separation. Maximum weight of earthworm was 690g which obtained from vermicompost culture using wild type earthworm, *Perionyx excavatus*, next was 607g resulted from the commercial earthworm species, *Perionyx excavatus*. Further,

Drawida japonica, *Lampito mauritii* and *Drawida sp.* resulted 556g, 552g and 512g of earthworm collected at the end period of vermicomposting. The observations evidence the fast growth of the earthworm species utilized in this study and easy accessibility of the mixed biomass taken for vermicompost making.

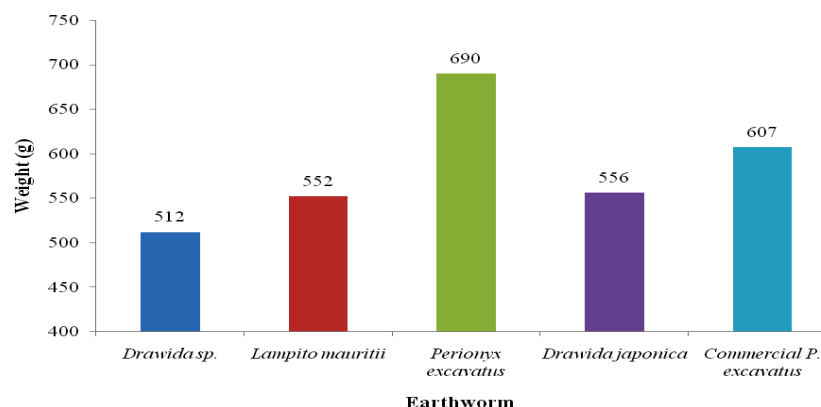


Figure 6: Weight of different earthworm collected during the 30th day or end period of Vermicompost forming

3.2. Nutritional analysis of vermicompost

The harvested vermicompost samples were analysed for the total presence of nitrogen, phosphorus, potassium and organic carbon (Fig 7 and table 1). Similar to the above observation, the maximum nutritional values of 2.58% N₂, 2.6% P, 2.7% K and 20.8% organic C was observed in the vermicompost produced by wild earthworm species of *Perionyx excavatus* followed by the commercial earthworm

species of *Perionyx excavatus* showed 2.24% N₂, 2.1% P, 2.2% K and 19.2% organic C. The other wild earthworm species of this study evidenced 1.6% N₂, 1.2% P, 1.3% K and 15.9% organic C in vermicompost produced by *Lampito mauritii*, 1.71% N₂, 1.6% P, 1.1% K and 15.2% organic C in vermicompost produced by *Drawida japonica* and least results of 1.51% N₂, 0.9% P, 0.8% K and 15% organic C in vermicompost produced by *Drawida sp.*

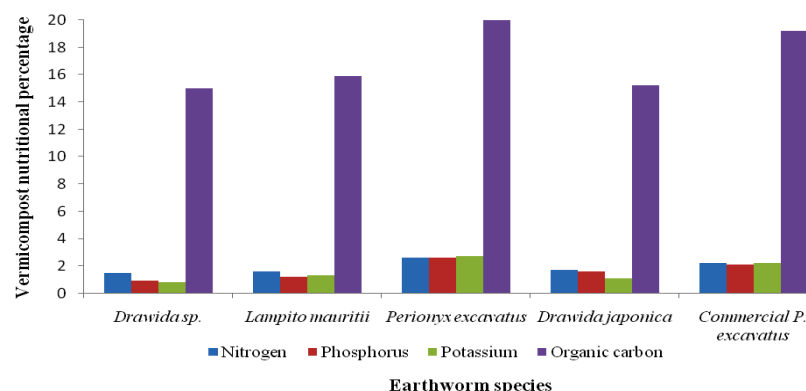


Figure 7: Nutritional percentages of vermicompost produced using different earthworm species isolated in this study in comparison with a commercial species of *Perionyx excavates*

Similarly, an experiment was conducted during 1998–1999, in a deciduous forest located in the semi-arid tropics of central India, to evaluate the suitability of different forest litters as biomass material for the vermicompost production using the tropical epigeic earthworms i.e. *Eisenia*

fetida (Savigny), *Perionyx excavatus* (Perrier) and *Dicogaster bolau* (michaelsen). *Eisenia fetida* showed appreciable production of vermicompost than the other species taken for study with excellent NPK (Nitrogen, phosphorus and potassium) values (11).

Table 1: Percentage nutritional values of vermicompost harvested from different isolated earthworm species of this study in comparison with a commercial earthworm

Earthworm species	Vermicompost nutritional analysis (Percentage)			
	Nitrogen	Phosphorus	Potassium	Organic carbon
<i>Drawida sp.</i>	1.51	0.9	0.8	15
<i>Lampito mauritii</i>	1.6	1.2	1.3	15.9
<i>Perionyx excavatus</i>	2.58	2.6	2.7	20.8
<i>Drawida japonica</i>	1.71	1.6	1.1	15.2
<i>Commercial P. excavatus</i>	2.24	2.1	2.2	19.2

4. CONCLUSION

These overall observations proved that the wild type earthworm species of *Perionyx excavatus* was more efficient in making the high quantities of vermicompost production which has also evidenced more appreciable values of nitrogen, phosphorus, potassium and organic carbon than the rest the wild type earthworm as well as commercial earthworm species. To the fact, the appreciable quantitative and qualitative evaluations of vermicompost from this study also representing the capabilities of digesting mixed biomass waste using the wild type species, *Perionyx excavatus* than the commercial regular type species. Overall, this study suggesting the use of wild type earthworm species, *Perionyx excavatus* for more efficient production of valuable vermicompost.

5. ACKNOWLEDGEMENT

The authors declare that there is no conflict of interest with any researcher or funding agency.

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