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Vermicomposting of banana peduncle, a market yard waste

Pratheepa, M.,* Mettilda, S. and **Vinoliya, J.**
Dept. of Zoology, Holy Cross College, Nagercoil.
Corresponding author: metti.silvester@gmail.com

ABSTRACT

Solid waste management is a key issue that is to be addressed globally owing to its ecological problem and vermicomposting is an ideal measure to recycle organic waste in an eco-friendly approach. The compost thus obtained may be rich in nutrients that would enhance the growth of plants. The present study aims to convert banana peduncle, an important market yard waste along with three different excreta such as cow, goat and poultry into vermicompost using Eudrilus eugeniae, an epigeic earthworm. Number of worms recovered, the quantity of macro nutrients (N, P and K), pH and electrical conductivity of the vermicompost were analyzed. Results revealed that N, P, K value was more or less same in the vermicomposts suggesting an increase in nutrient value of organic matter. Growth performance of earthworm strongly supports the usage of the above mentioned excreta and banana peduncle as good feeding materials in vermicomposting practice. The study suggests that vermicomposting is a good method for recycling of disposed livestock excreta and market yard waste in generating wealth from wastes.

Key words: banana peduncle, *Eudrilus eugeniae*, market yard waste, vermicompost.

1. Introduction

Agriculture provides plenty of organic waste, consisting of crop straw, husk, sugarcane trash, groundnut shell, animal remnants etc., amounting to nearly 320 million tons annually [1]. Animal excretes are considered as an important resource that fertilize, supplement organic matters, and improve soil conditions, but are a source of environment pollution too. Vermicomposting is the best biotechnology to reduce the load on the treatment and disposal of biodegradable agro waste. Various organic wastes tested as feed material for different species of earthworms includes sewage sludge [2], crop residues [3], cow slurry [4], vine fruit industry sludge, rice stubbles, leaves [5], different animal wastes [6] and vegetable waste [7].

Organic excreta can be fragmented rapidly by earthworms which results in stable and nontoxic substances having a potentially high economic value and can be used as a soil conditioner for the growth of plants. This product is designated as worm worked sample. Physically, the substance is finely fragmented peat like material which has a good structure, porosity, aeration and moisture holding capacity and provides suitable nutrients to the plants [8]. Vermicomposting differs from composting in several ways [9]. Nutrients in worm worked sample are often much higher than traditional garden compost, reduces the population of soil pathogenic microbes and also has an important role in nitrogen fixation [8]. The worm castings or faecal materials are often referred to as 'black gold' produced by the worms is a rich source of a variety of essential plant nutrients like N, P, K in available form and also in the availability of plant growth promoting substance like hormones, vitamins, amino acids and other micronutrients. Vermitechnology is a small scale low technology approach and uses locally available labour and raw materials [10].

Besides vermicomposting, earthworms have other multiple uses. Earthworms contain 70 - 80% high quality lysine rich protein on a dry weight basis. They have very low

carbohydrates and lipids [11]. Linoleic, linolenic and arachidonic acids required for the growth and reproduction of animals are the points to be considered for their use as component of animal feed [12]. Dried and powdered earthworms are used in animal feed industries in countries like Philippines. Tribes in Australia and New Zealand use earthworms as their food. According to an estimate earthworm protein is considered equivalent to fish protein. Many of South East Asian institutions in China are concentrating on isolation of enzymes and other proteins from tissues of earthworms. A number of medicines produced from earthworms by unani system of medicine are used to cure piles, arthritis, stones of gall bladder etc. In a study, coelomic fluid of *Eudrilus eugeniae* called vermin wash was substituted for trace elements and vitamins to prepare basal medium for induction of callus in tissue culture studies [13].

Availability of a large number of earthworm species in India, utilization of earthworms in vermitechnology might help in the management of organic solid excretes thereby producing solid increasing biomass of worms and collection of worked sample for agricultural application. It is the need of the hour to study the potential of an epigeic earthworm, *Eudrilus eugeniae* to compost different excreta (cow, poultry, and goat) and other wastes into value added product and its influence on reproduction and growth. This study has been done for reducing the pollution problems due to animal waste and market waste by converting it into compost by using earthworms very successfully, economically and usefully. This investigation also aims to estimate the biochemical composition of earthworm which could be used as feed for poultry and aquatic organisms.

2. Materials and Methods

2.1. Collection of Earthworm, animal excreta and banana peduncle: Earthworm ***Eudrilus eugeniae***, commonly referred as African night crawler, a large epigeic species used in this vermicomposting study were collected from Vivekananda Kendra, Kanyakumari. The fresh excreta of three different animals like cow, goat and poultry (hen) droppings were collected from the animal husbandry. The excreta were dried and powered. The banana peduncles were collected from Monday market, Kanyakumari District, Tamil Nadu. The collected peduncles were chopped into small pieces, dried and crushed.

2.2. Experimental Design: Vermicomposting was done at Holy Cross College, Nagercoil. Plastic bins of (length 26 cm and width 35cm) were used to carry out vermicomposting. The bedding materials viz., small pieces of stones and coconut fibers were piled at the bottom of four plastic containers viz., Vermibin I, II, III & IV. Each container was then filled with banana peduncle (0.5 kg) and animal excreta (1.5 Kg) in different proportions. The first container was filled with cow dung and banana peduncle in the ratio of 3 : 1; the second container with cow dung, goat manure and banana peduncle in 1 : 2 : 1 ratio; the third container with cow dung, poultry manure and banana peduncle in 1 : 2 : 1 ratio; the fourth container with cow dung, goat manure, poultry waste and banana peduncle in 1 : 1 : 1 : 1 ratio. The dry materials were moistened so that the overall moisture level is of 40 – 50% and this set up was maintained as such by sprinkling water for 15 days for partial decomposition. After 15 days 85 earthworms were released into the container. While releasing the earthworms, care was taken to ensure sufficient moisture in the feed approximately 30 – 40% by sprinkling water. After seven weeks of composting, a portion of feed with loose granular casts (brown to black in colour) was harvested from the vermibins.

2.3. Analysis: The harvested vermicompost was dried and the quality was assessed by physico-chemical characterization (pH, electrical conductivity, total nitrogen, phosphorus and potassium) in the Soil Testing Laboratory, Vetturnimadam, Nagercoil. To understand the effect of different feeding materials on earthworms, the biological parameters (number and size, length) and the biochemical parameters (protein [14], carbohydrate [15] and lipid [16]) of the recovered earthworm were assessed.

3. Results

The pH value of the vermicompost was between 8.2 and 8.4, indicating alkaline nature of the vermicompost. The highest electrical conductivity 2.5 dS/ dm was observed in vermibin III and minimum in vermibin I and II (Table - 1). The nitrogen value of sample I, III and IV was same. The amount of nitrogen in vermicompost II was very low. Phosphorous and potassium level was same in all the samples (Table - 1). Maximum number of worms (120) was recovered from vermibin IV and minimum (90) from vermibin III. Greater number of earthworms below 6 cm length was recovered from vermibin IV (Table – 2). Biochemical constituents of earthworm showed maximum protein, carbohydrate and lipid from the sample of vermibin I (Table - 3).

Table - 1: Physico-chemical characters of the vermicompost.

Vermibin	Physical characters		Macro nutrients		
	pH	Electrical conductivity (dS / dm)	Nitrogen Kg/ acre	Phosphorous Kg/ acre	Potassium Kg/ acre
I	8.2	2.1	115	100	500
II	8.3	2.1	80	100	500
III	8.4	2.5	115	100	500
IV	8.2	2.2	115	100	500

Table - 2: Earthworms recovered after Vermicomposting organic materials.

Vermibin	Number of Earthworms recovered	
	Total population	Number of young ones (below 6 cm)
I	118	27
II	114	20
III	90	17
IV	120	33

Table - 3: Protein, carbohydrate and lipid content of earthworms fed by different waste in different proportion.

Vermibin	Protein (mg/ ml)		Carbohydrate (mg/ ml)		Lipid (mg/ ml)	
	Wet earthworm	Dried earthworm	Wet earthworm	Dried earthworm	Wet earthworm	Dried earthworm
I	8.01 ± 0.18	6.69 ± 0.33	3.51 ± 0.58	2.23 ± 0.37	1 ± 0.2	0.73 ± 0.152
II	6.7 ± 0.36	4.60 ± 0.35	2.71 ± 0.35	2.01 ± 0.47	0.8 ± 0.152	0.66 ± 0.251
III	5.70 ± 0.11	4.51 ± 0.29	1.58 ± 0.11	1.26 ± 0.11	0.5 ± 0.1	0.4 ± 0.1
IV	7.0 ± 0.47	5.14 ± 0.43	1.99 ± 0.11	1.32 ± 0.40	0.7 ± 0.11	0.5 ± 0.1

4. Discussion

Vermicomposting is the process by which red wiggler worms called earthworms are used to aid in the decomposition of organic matter. The organic degradable refuge of plant and animal origin provides a good source of nutrients to improve soil productivity. In the present investigation, an attempt was carried out to study the proper utilization of an agriculture waste from the market yard, banana peduncle through vermicomposting using different animal excreta (cow, goat and poultry). The growth and reproductive performance of *E. eugeniae* in selected excreta showed increased biomass and number of young ones. Loh *et al*,[17] reported that the young one production per worm in goat manure was higher than in poultry manure. The hatchability of young ones was not much affected by manure treatment.

Worm worked sample was analysed for electrical conductivity, pH, N, P, K. Earthworms are very sensitive to hydrogen ion concentration: it limits their distribution and influences the numbers of those worms that go into diapause. The alkaline pH of vermicompost may be attributed by the secretion of ammonium ions that reduce the pool of hydrogen ions [18] and the activity of calciferous glands in earthworms containing carbonic anhydrase that catalyses the fixation of carbon dioxide as calcium carbonate, thereby preventing the fall in pH [19]. The increased trend of pH in vermicompost is in consistence with the findings of Mary Mettilda Bai *et al.* [7] and the increase could be due to the presence of alkaline compounds in the banana peduncle (characterised by the pungent smell). This pH increase is beneficial in agriculture where this can be used to reduce the acidic character of soils in farms.

Electrical conductivity is the measurement of total amount of soluble salts present in the sample. The electrical conductivity of all vermicompost showed more or less same value. It indicates that the feeding activity of *Eudrilus eugeniae* along with microorganisms present in their body and in the organic matter has increased the process of mineralization and also improved the availability of the nutrients for plant growth.

The N, P, K values showed remarkable increase in all vermibins. The enrichment of earthworm casts with available nutrients has been observed by Lee [20]. Nitrogen is mainly excreted as ammonium in the urine released by the worm; it is thus mixed with the soil and found in the casts [20]. Increase in nitrogen content could be attributed to enhanced microbial activity in the gut of earthworm and cause the transformation of soluble nitrogen into microbial protein, thereby preventing the nitrogen loss. Protein content of earthworm's tissues is high and yields nitrite on decomposition. Higher amount of phosphorus and potassium content might be due to the high amount of these in compounds especially potassium in banana peduncle [21] and due to the mineralization of organically bound phosphate and potassium into available phosphorus and potassium after passing through intestine of the earthworm. Further, presence of phosphate solubilizing bacteria in the gut is likely to solubilize good amount of phosphorus from insoluble form in any organic material into quality experimental sample as potential phosphate biofertilizer [22].

Biochemical parameters such as protein, carbohydrate and lipid in the body of earthworm were analyzed. The carbohydrate content of the body is lesser than the protein content. Lipid content is lower than the carbohydrate level. High level of protein present in earthworm represents its high nutritional value which provides a substantial nutrition to the animals consuming them [23].

This study suggests the use of banana peduncle, a market yard waste which could be recycled into wealthy manure through vermicomposting along with livestock excreta. Thus this attempt supports vermitechnology to generate fertilizer, reduce solid waste and protein feed for animal husbandry.

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