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Bioconversion of Pineapple Waste into Vermicompost by Employing *Eisenia fetida, Eudrilus Eugeniae* and *Perionyx excavatus*

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Abstract—*Vermicomposting of Pineapple waste can be one of the best method for utilization of pineapple peels generated in large amount during its season. The research work deals with production of organic rich compost called Vermicompost from pineapple peels by utilizing three different species of earthworms namely the Indian blue earthworms, Perionyx excavatus (Perrier,1872), the African night crawler, Eudrilus eugeniae (Kinberg,1867) and the Tiger worm, Eisenia fetida (Savigny,1826). Collected samples were washed with water, air dried, mixed with cowdung slurry in ratio 3:1 and precomposted for three weeks. 500gm of powdered egg shell were sprinkled in the substrate and mixed with phumdi in the ratio 1:1. Five kilogram of substrate were taken into plastic pots of diameter 14cm and dept 12cm . A total of four sets of pots each set comprising three replicates were taken, of which three sets were used for vermicomposting keeping aside the fourth set for composting. The experiment was carried out for 60 days .The harvesting of vermicompost and compost were carried out at the end of experiment as per Pattnaik and Reddy (2010). The homogenized sub-samples of each substrate material and their respective compost and vermicompost samples (100gm dry weight) were collected undestructively at the end from each replicate pots and compound samples were made which were processed for analysis of nitrogen(N), phosphorus(P), potassium(K), Iron(Fe), Copper(Cu), Zinc(Zn) and Manganese(Mn). Initially, the temperature of the substrates was high and then decreased gradually as the composting process progressed. Temperature ranges from 23 ^0C to 25.4 ^0C .The pH ranges from 5.9 to 6.9.The moisture content ranges from 56 to 61.The growth parameters of the three earthworm species is high. The number of juveniles and adults collected was found highest in P. excavatus than that of E. eugeniae and E. fetida. The result indicates that all the three species of earthworms grow well and can produced organic rich vermicompost.*

Keywords*: Vermicompost, Pineapple waste, Phumdi, Eudrilus eugeniae, Eisenia fetida and Perionyx excavatus.*

1. INTRODUCTION

Today the whole world goes for organic farming. People are aware of the health hazards caused by artificial fertilizer, pesticides, insecticides, etc. Biofertilizer is the only solution to the above problems and vermicompost is one of the best organic fertilizer. In the present agricultural scenario, vermiculture and vermicomposting plays very important role in organic farming for sustainable agriculture production.

Vermiculture means scientific method of breeding and raising earthworms in controlled conditions. It aims at creating improved conditions artificially so that earthworms multiply in shortest possible time and space. Vermicomposting is the process which earthworms convert organic wastes into fertile compost which is termed as vermicompost. During the process, the nutrients locked up in the organic waste are transformed into simple and absorbable forms such as nitrate or ammonium nitrogen, exchangeable phosphorous, soluble potassium , calcium and magnesium in worm's gut (Lee,1985; Atiyeh et.al 2002) with significant reduction in the C/N ratio (Bansal and Kapoor,2000; Kaushik and Garg,2003). It is an ecofriendly technique of treating solid waste.

In Manipur, pineapple is grown widely. It is produced in surplus in the market during the month of July-August. Pineapple is the largest fruits produced in Manipur. About 2.40 crores of pineapple fruits are produced in the state. The average weight of a single pineapple is said to be 1.5 kg. The pH of pineapple ranges from 3.2 to 5.6.

The present study aims to bring proper management of solid waste (pineapple waste) by utilizing the three popular species of earthworms i.e. the Indian blue (*Perionyx excavatus*), the African night crawler *(Eudrilus eugeniae)* and the Tiger worm *(Eisenia fetida).*

2. STUDY SITES

The study area covers selectively the market area of Imphal, Bishnupur and food processing unit of Meira food private limited Kakching. Imphal is the capital city of Manipur. It extends over an area of 29.57 sq.km. Geographically, it is situated at 24^{o}48.8'N and 93^{o}57'E.

3. METHODOLOGY

Collection of Earthworm Species used:

The species *Eudrilus eugeniae* was sourced from Institute of Bioresources & Sustainable Development, Takyelpat, Imphal. The Species *Eisenia fetida* sourced from the Directorate of Environment, Porompat, Imphal. The species *Perionyx excavatus* was collected from the local cowshed area of Nambol, Bishnupur District.

Collection of waste:

The sample weighing about 125 kg was collected from the place where pineapples are loaded and peeled by workers to make various items of food and some selective areas of the market.

Pre-Composting:

The collected pineapple waste was washed and air dried separately spreading over a polythene sheet for 48 hours and then mixed with cow dung slurry in ratio 3:1and 500 gm of powdered egg shell were sprinkled in 25gm of sample and mixed with phumdi in the ratio 1:1. Then it is precomposted for three weeks before putting into vermicomposting and composting process. Pre-composting is the pre processed and pretreated practice of raw waste. The waste materials, in the pre-composting process were decomposed aerobically by the active role of bacteria. When the temperature of the pre-composted substrate was brought down to 25°C, adult earthworms with well-defined clitella belonging to the three species namely, *E. eugeniae*, *E. fetida*, and *P. excavatus* were introduced on the pre-composted material filled in each set of earthen pots (Pattnaik and Reddy, 2010).

Experimental Design:

In each pot five kg of the substrate were taken for vermicomposting and composting. A total of four sets of earthen pots each set comprising three replicates was taken for each waste, of which three sets were used for vermicomposting with each set using one species of earthworm and the fourth set was used for normal composting that is, without using any earthworm. Three species of earthworms, each of fifty adult individuals, were introduced on the top of the pre-composted substrate in each of the three sets of pots keeping aside the fourth set for composting without earthworms. Small holes were drilled at the bottom of each pot which was filled with small stones up to a height of 5 cm for air circulation and good drainage. The processes of vermicomposting and composting were carried out for a period of 60 days. The temperature and moisture content were maintained by sprinkling adequate quantity of water at frequent intervals. The harvesting of vermicompost and compost, and total earthworm biomass, individual body weight, total numbers of juveniles, adults, and cocoons were carried out, at the end of the experiment (Pattnaik and Reddy, 2010).

Physico –Chemical Analysis

The homogenized sub-samples of each substrate material and their respective compost and vermicompost samples (100 g dry weight) were collected undestructively at 60 days from each replicate pot and compound samples were made, which were processed for analyses of major nutrients—total nitrogen (N), phosphorus (P), potassium (K), and micro nutrients like Iron (Fe), Copper (Cu), Zinc (Zn) and Manganese (Mn).

Nitrogen (N): Determination of N content by Micro – Kjheldahl method (Jackson, 1973).

Phosphorus (P): Determination of P content by UV Calorimeter (Anderson and Ingram, 1993).

Potassium (K): Determination of K content by Flame, photometer (Simard, 1993).

Trace elements: Iron(Fe), Copper(Cu), Zinc(Zn) and Manganese(Mn) by Atomic Absorption Spectrophotometer (AAS) method (AOAC, 1984).

Analysis of physical parameters:

(1) Weight: Weighted by using digital electronic balance.

(2) Temperature & pH: Temperature and pH was recorded on 0 day (substrate) and 60 days for each replicate pots using Mercury thermometer and digital pH meter.

(3) Moisture content:

Procedure:

(a) 10 gm of the sample was taken in a crucible.

(b) The crucible was kept at 105°C for 16 hrs.

(c) The crucible was then cooled in desiccators and the % of moisture content was calculated using the following method.

Calculations: % moisture content=d/10×100, where, d = loss of weight after heating (Bhatt and Limaye, 2012).

4. RESULTS AND DISCUSSION

Table 1: Physical Characteristic

Parameters	0 days	60 days			
	Substrate	Compost (without worm)	Vermicompost		
			Eudrilus eugineae	Eisenia foetida	Perionyx excavatus
Weight (kg)	5±0	3.3±0.05	2.2±0.05	2.3±0.07	2.3±0.07
Temperature (°C)	25.4±0.7	23.4±0.6	23±0.7	23±0.9	23.1±0.8
pH	5.8±0.8	6.5±0.8	7.2±0.3	7.3±0.8	6.9±0.8
Moisture contents (%)	56±2.4	58.2±0.6	61±0.7	60.8±0.5	60±0.7

Source: Research Finding

The physical characteristic recorded during the period of the study is presented in **Table 1**.

Temperature: The temperature ranges from 23±0.7 ºC to 25.4±0.7ºC. As compared to the substrate, the temperature lowers gradually at the end of the experiment when the vermicompost was formed. At the beginning of the experiment, the temperature of the substrate was high and then decreased gradually as the composting process progressed. Due to intensive microbial activity on the organic matter the heat was released by oxidative action resulting rise in temperature during the first mesophilic phase of composting process. Due to thermophilic phase temperature rose up and then followed by cooling phase at the time of compost maturation. So, temperature decreases with the progress of composting process. It may also be due to regular sprinkling of water.

pH: The pH of the substrate and their respective compost and vermicompost ranges from 5.8±0.8 to 7±0.8.This shows the ph increases gradually from substrate to compost to vermicompost. The value of the vermicompost is very near neutral because of the secretion of NH_4^+ ions that reduced the pool of H^+ ions(Haimi and Hahta,1987) and the activity of calciferous glands in earthworms containing carbonic anhydrase that catalyzes fixation of CO_2 as $CaCO_3$, thereby preventing the fall in pH (Kale et. al.1982). The increased trend of pH in the compost and vermicompost is in consistence with the findings of Tripathi and Bhardwaj, 2004.

Moisture: The moisture content ranges from 58.2±0.6% to 61±0.7%. According to Liang *et al.*, 2003, the moisture content of 60-70% was proved to be having maximal microbial activity, while 50% moisture content was the minimal requirement for rapid rise in microbial activity. During the study it was observed that vermicompost samples showed higher moisture content then the compost and the substrate, which may be due to their high absorption capacity and of the assimilation rate by microbial population indicating the higher rate of degradation of waste by earthworms.

Table 2: Individual length and live weight, total biomass gain, total number of cocoons, juveniles and adult numbers were studied

Earthworm growth parameters	E. eugineae	E. foetida	P. excavatus
Individual length (cm)			
Initial	13±0.2	8.2±0.25	9.1±0
Final	13.4±0.1	10.86±0.3	10.2±0.1
Individual weight (g)			
Initial	3.2±0.2	0.56±0.1	0.33±0.02
Final	5.2±0.1	1.4±0.1	1.02±0.05
Total biomass (g)			
Initial	160±0.02	28±0.01	16.5±0.02
Final	1520±0.04	461±0.02	280±0.01
Average worm no. per cocoon	2.7±0.05	3.5±0.02	1.1±0.03
Average cocoon no.at the end	75±0.02	72±0.01	189±0.05
Average Juvenile no. at the end	100±0.02	126±0.02	162±0.05
Average adult no. at the end	312±0.02	323±0.02	371±0.03

Source: Research Finding

The above **Table.2** shows the main individual length and live weight, total biomass gain, total number of cocoons, juveniles and adult numbers were studied. The growth parameters of the three earthworms species cultured in pineapple waste showed that *Eudrilus eugeniae* showed highest length than that of *Eisenia fetida* and *Perionyx excavatus*. Maximum increase in weight was recorded in *E.eugeniae* followed by *E. fetida* and P. *excavatus.* The total length, weight and biomass of the three earthworm species were increased at the end of the experiment. It may be due to the quality of the substrate or could be related to fluctuating environmental conditions. The total biomass gain recorded was maximum in *E.eugeniae*. The number of worms produced per cocoon was higher in *E. fetida* while the number of cocoons collected at the end of the experiment was more in *P.excavatus*. The number of juveniles collected at the end of the experiment was found highest in *P.excavatus*. Interestingly the average adult number of *P.excavatus* was found highest. The higher numbers of cocoons, juveniles and adults collected from the vermicompost processed by *P.excavatus,* was probably because of its indigenous nature being adaptable to the abiotic environmental conditions extremely well compared to other exotic species (S. Pattnaik and Reddy,2009). The overall increase in the above parameters in pineapple waste could be related to the nutrients present in it.

Physico-chemical analysis of substrate, compost and Vermicompost:

Table 3: Analysis of elements in substrate, compost and vermicompost

Nutrients	0 days	60days			
	Substrate	Compost	Vermicompost		
			E. eugeniae	E. fetida	P. excavatus
N (%)	1.3	1.7	1.7	1.6	2
P (%)	0.035	0.02	0.065	0.067	0.069
K (%)	0.1	0.2	0.25	0.3	0.28
Total Fe (%)	0.18	0.21	0.22	0.22	0.22
Total Mn (%)	0.04	0.09	0.15	0.18	0.14
Total Cu (%)	0.006	0.006	0.009	0.007	0.008
Total Zn (%)	0.05	0.05	0.07	0.06	0.07

Source: Research Finding

From the above Table 3 it is being observed that the vermicompost of *P.excavatus* has the highest Nitrogen

content of 2% and the least 1.3% in the substrate. The vermicompost of *P. excavatus* has the highest Phosphorus content of 0.069% and the least 0.02% in compost. The vermicompost of *E. fetida* has the highest Potassium content of 0.3%. The vermicomposts of all the three species of earthworms has a total Iron content of 0.22%. The vermicompost of *E. fetida* has the highest Manganese content of 0.18% and Substrate has the least of 0.04%. The highest Copper content is found in the vermicompost of *E. eugeniae* with a 0.009% and the least of 0.006% in Substrate and Compost. The highest Zinc content of 0.07% is found in the vermicomposts of *E. eugeniae* and *P. excavatus* and the least content of 0.05% is found in Compost and substrate.

5. CONCLUSION

It is concluded that among the three species, the indigenous species, *Perionyx excavatus* shows better growth and reproduction performance compared to the other two exotic species. *P. excavatus* was more efficient in bio-conversion of pineapple waste into nutrient rich vermicompost compared to *E. fetida* and *E. eugeniae*. Vermicompost produced by all the three species showed higher contents of nutrients compared to that of the sole compost as well as the substrates. Thus, Pineapple waste can also be converted into vermicompost which have more contents of nutrients.

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