International Journal of Trend in Scientific Research and Development (IJTSRD)
International Open Access Journal
ISSN No: 2456 - 6470 | www.ijtsrd.com | Volume - 2 | Issue – 3

# Biodegradation of different organic solid waste by using epigeic earthworms

**Siva. T, P. Serfoji**
PG and Research Department of Zoology, Government Arts College (Autonomous), Kumbakonam, Tamil Nadu, India

## ABSTRACT

The main aim of this study for the reuse of organic wastes by vermicomposting method. A vermicomposting method is a recognised environmentally safe technology for waste reuse. It has a sustainable solid waste management. The explosive growth of human population and technological advances has produced enormous quantities of solid wastes, the management of which has become a problem of global concern. Earthworms, by their peculiar food, feeding and burrowing habits are considered as the most efficient converters of wastes. India, being an agricultural country produces huge quantities of agricultural wastes, which can be converted into vermicompost, a nutrient rich bio fertilizer and soil conditioner. In the present study, an attempt has been made to explore the possibility of using earthworms for converting three different leaf litters – Vegetable wastes, and plant leaf litters into vermicompost. Three epigeic earthworms- well established as efficient bio convertors, *P. excavatus, E. fetida* and *E. eugeniae*- were used in this study.

***Keywords:*** *Vermicompost, Epigeic Earthworms, Leaves litters, Biofertilizer, Sustainable*

## INTRODUCTION

The biological degradation and stabilization of organic wastes by earthworms and its associated microorganisms is termed as vermicomposting (Senapathi, 1996). The role of earthworms right from the time it was in organic solid waste management has been well established since first highlighted by Darwin, (1881) and the technology has been improvised to process the waste to produce an efficient bio-product vermicompost (Kale *et al.,* 1982; Ismail, 1993; Ansari and Ismail, (2001; Gajalakshmi and Abbasi, (2004). Epigeic earthworms like *Eisenia foetida, Eudrilus eugeniae, Lumbricus rubelles* and are used for vermicomposting but local species like *Perionyx excavatus* has proved efficient composting earthworms in tropical or subtropical (Kale,1998; Ansari and Ismail,(2001;Chaudhri *et al.,* (2001). During vermicompost process, when organic matter passes through the gut of earthworms, it undergoes physical, chemical and biochemical changes by the combined effect of earthworms and microbial activities. Vermicomposting, the microbial composting of organic wastes through earthworm activity could be an adequate technology for its transformation.

Earthworm burrows enhance aeration and porosity of soil and improve its water holding capacity (Julka and Palwar, 2005). Thus, vermicompost is an extremely homogenous, fertile material suitable for plant growth and influences vegetation growth like root, and root lengths and biomass in a better way than chemical fertilizers (Kale and Bano, 1980). Earthworms have in-house supply of enzymes such as protease, amylase, cellulose, and chitinase, which degrade complex bio molecule into simple compounds utilizable by the symbiotic gut micro flora. The earthworms speed up the composting process and transform wastes into nutrient rich castings with the help of these enzymes. Castings are good fertilizer additive for agricultural crops (Kumar, 2004). The enzymes secreted by the earthworms alone and or in association with gut micro flora are responsible for decomposition complex organic materials and humification of soil organic matter (Dharmalingam, 2005). It is therefore easy to speculate that vermicasts are rich in enzymes, which accelerated the mineralization rate and converted the wastes into organic fertilizer with higher nutritional value (Lakshmi praba *et al.,* 2004).

## MATERIAL AND METHODS

### Collection and pre decomposition of municipal solid wastes and cow dung

The biodegradable organic solid wastes were collected from Karikulam municipal solid wastes dumping site, at Kumbakonam. The wastes were chopped into small pieces and allowed to partial decomposition for 20 days. Then the waste was mixed with Cow dung in 3:1 ratio.

### Epigeic earthworms used for culture studies

The epigeic earthworms, *Eisenia foetida, Eudrillus eugeniae, Perionyx excavatus* were collected from Periyar Maniyammai University Thanjavur, Tamilnadu. The species were cultured at college laboratory, P.G & Research Department of Zoology, Government arts college (Autonomous), Kumbakonam, premises for six month.

### Vermiculture experimental study

Cement tanks (0.90x0.90 m size) and vermicomposting pits were used (0.75 x 0.75 x 0.75 m size) for vermiculture. 100 kg of (dry weight) of the substrate (both plant leaf litters and vegetable wastes) placed in each of the three tanks and vermin bins were inoculated with three species of earthworms with varying number (*E. foetida-154; E. eugeniae-118;and P. exacavatus-124*), but with similar cumulative body weight, since the limit on populations of all earthworm species, in organic wastes, seems to be related to earthworm biomass per unit of waste rather than to overall numbers (Dominguez *et al.,*2001). Moisture content of the substrate was adjusted to 70 to 80%. Three replicates were maintained for each species. The worms were not supplied additional food and the cultures were maintained for 62 days under maximum average temperature 30.5+0.29*c in ventilated area. Care was taken avoid light, rainfall, and natural enemies. The live weight (with full gut content) of the mature worms were measured weekly by hand sorting of the culture media and their juvenile numbers were counted after 62 days.

Vermicompost was harvested after $62^{nd}$ day from the start of bio dung composting. Vermicompost after harvested that sieved through 3mm sieve. It was subjected to chemical analysis (pH, Ec, organic carbon, nitrogen, phosphorus and potassium) to asses it nutrient status (Jackson 1973; Chopra and Kanwar, 1978). The chemical analysis of the initial substrate ( pH, N, P, K and ash ) were carried out following standard methods ( Jackson, 1973 ).

## RESULTS

The physic chemical parameters of the initial, control, harvested vermicomposting prepared from organic solid wastes were analysed (Table 1, 2). The maximum temperature of the vermibed and vermibin was 26°C in the first day at the end of the experiment ($62^{nd}$ day) the control sample was recorded to have 25°C, 23°C, 24°C and 24°C were observed in the case of *P. exacavatus, E. eugeniae* and*E. foetida* worked vermibeds and vermin -bins, respectively. A decreased trend of temperature observed maybe due to the regular watering and periodic turning of the vermibeds.

Worms are sensitive to change in pH. They prefer neutral condition. The pH of the initial substrate was 7 which increased to 7.3 to the control and 7.8, 7.7, and 7.6 in *P. excavatus, E. eugeniae* and *E. foetida* vermicompost beds, respectively. The addition of cow dung as a feed for the earthworms may be responsible for the slight increase in the pH of the harvested product.

Electrical conductivity, the indicator of the concentration of soluble salts were found to be 0.64-0.74 initial sample and 1.74 in m.mhose/cm in control *P. excavatus, E.eugeniae and E.foetida* composts showed an increased electrical conductivity of the order of 11.70, 10.24 and 9.82m.mhos/cm respectively. The increased electrical conductivity may be due to the presence of exchangeable calcium, magnesium and potassium in casts of the worms. The nitrogen content was significantly higher in *P. excavatus, E. eugeniae, E. foetida* incorporated composts (1.94, 1.82, 1.26%) respectively, and compared to the control (0.92%) and initial (0.69%) samples.

The phosphorus level was found to be increased in *P. excavatus* and *E. foetida* treated wastes (2.47, 2.14 and 2.05 %) respectively in comparison with the initial (0.20) and control (1.24%) samples. Similarly the values of potassium in harvested compost obtain through the action *P. excavatus, E. foetida,* and *E. eugeniae* was found to be more of the order of 2.70, 2.35, and 2.13% respectively, when compared with the control (1.28%) and initial organic waste (0.48%) under the investigations.

Micro nutrients, Zn, Cu, Mn and Fe were also found to be increased in *P. excavatus* (278.0; 27.40 0.475.0 and 7563ppm, *E. eugeniae* 218.0, 324.5 and 5885.0 ppm) treated waste respectively in composition with the initial (18.5 and 19.02, 8.5 and 112.5 and 98.4 and 26.46.0 and 2465.0%) and the control (172.2,18.5, 224.5 and 4250.0%) samples. In *E. foetida* treated wastes, the micronutrient content was not found to be increased.

The volatile solids were gradually decreases during the process, which indicates the degradation of the material is completed. The total solids are rough indicators for the reduction for matter. The total solids should decrease when material degrades initiating the proper humification, which depends upon organic characteristics of feed substrate.

**Table 1. Initial characteristics of the organic solid wastes**

| **Parameters** | **Vegetable wastes** | **Plant leaf litter wastes** | | |
|---|---|---|---|---|
| | | ***Mongifera indica*** | ***Pongamia glabra*** | ***Paliyalthia longifolia*** |
| Temperature | 26 | 26 | 26 | 26 |
| pH | 6.8 | 7.2 | 7.2 | 7.3 |
| Ec (mhos/cm) | 0.74 | 0.72 | 0.68 | 0.72 |
| Nitrogen % | 0.69 | 0.76 | 0.78 | 0.68 |
| Phosphorus % | 0.20 | 0.60 | 0.68 | 0.65 |
| Pottasium % | 0.48 | 0.48 | 0.94 | 0.92 |
| Organiccarbon % | 29.5 | 32.05 | 26.05 | 28.04 |
| Calcium (ppm) | 1.04 | 1.05 | 1.02 | 1.05 |
| Zinc (ppm) | 28.0 | 18.5 | 19.02 | 17.05 |
| Iron (ppm | 3145.0 | 2646.0 | 2465.0 | 2347.0 |
| Manganese (ppm) | 148.5 | 112.5 | 98.04 | 99.2 |
| Copper (ppm) | 10.4 | 8.5 | 7.2 | 6.4 |

Values on dry weight basis, average values of five samples.
Units-ppm- parts per million,
**Ec – Electrical conductivity is measure of the relative salinity of soil or the amount of soluble salts it contains.
*** Kjeldahl nitrogen – is a measure of the total percentage of nitrogen in the sample including that in the organic matter.

**Table 2. Physico - Chemical parameters of the vermicompost**
**(Plant leaf litters and vegetable Waste) produced by P.excavatus, *E. eugeniae, E. foetida***

| **62nd day of vermicompost** | | | | |
|---|---|---|---|---|
| **Parameter** | **Control** | ***P.excavatus*** | ***E.eugeniae*** | ***E.fotida*** |
| Temperature | 25 | 23 | 24 | 24 |
| Ph | 7.4 | 7.8 | 7.6 | 7.6 |
| Ec (mhos/cm) | 9.24 | 11.70 | 10.24 | 9.82 |
| Nitrogen % | 0.92 | 1.94 | 1.82 | 1.26 |
| Phosphorus % | 1.24 | 2.47 | 2.14 | 2.05 |
| Pottasium % | 1.28 | 2.70 | 3.35 | 2.13 |
| Calcium % | 2.24 | 4.40 | 4.12 | 3.82 |
| Magnesium % | 0.15 | 0.46 | 0.32 | 0.30 |
| Zinc (ppm) | 12.5 | 0.28 | 24.5 | 22.2 |
| Iron (ppm) | 4250.0 | 7563.0 | 5885.0 | 5425.0 |

| | | | | |
|---|---|---|---|---|
| Manganese (ppm) | 224.5 | 475.0 | 324.5 | 285.5 |
| Copper (ppm) | 18.5 | 27.0 | 21.4 | 19.5 |
| Boron (ppm) | 24.2 | 34.0 | 28.5 | 18.4 |

Values on dry weight basis, average values of five samples.
*Units-ppm- parts- per million,
** Ec – Electrical conductivity is measure of the relative salinity of soil or the amount of soluble salts it contains.
*** Kjeldahl nitrogen – is a measure of the total percentage of nitrogen in the sample including that in the organic matter.

## DISCUSSION

The amount of urban waste in India is increasing constantly and it needs to be disposed off in landfills or via incineration. However, public acceptance and the cost of these waste disposal methods and the main problems for the authorities. Fruit and vegetable waste constitutes about 70,000 tonnes per annum, which represents the significant amount of municipal solid wastes (Dominguez *et al.,* 1997; Edwards and Bohlen, 1996). In terrestrial ecosystems, litter is the main component of detritus, which enters the decomposition subsystem and broken down by an array of decomposing organism. The litter decomposition is an important functional process of terrestrial ecosystem governing the cycling of nutrients ( Karmegam and Daniel, 1999; Chaudry *et al.,* 2001; Umamaheswari *et al.,* 2004). The litter quality is one among the several variables that regulate the decomposition process. This shows that the material is pure organic and contains the nutrients required for growth of plants. The compost can use as a soil conditioner. The present study was aimed at converting the available plant leaf litters wastes and vegetable wastes into nutrient rich composts through the introduction of this epigeic earthworms' viz., *Perionyx excavates, Eudrilus eugeniae* and *Eisenia foetida*.

The physic-chemical parameters of the initial control and harvested vermicomposts prepared from vegetable waste and plant leaf litters waste were analysed. The maximum temperature of the vermin-bed and vermin –bin was 26$^o$C in the first day. At the end of the experiment (62$^{nd}$ day),the control sample was recorded to have 25$^o$C and 23$^o$C, 24$^o$C and 24$^o$C was observed in the case of *Perionyx, E. eugeniae and E. foetida* worked vermibeds and vermibins respectively. A decreased trend of temperature observed may be due to the regular watering and periodic turning of the vermibeds. Chaudry *et al.,* (2001), Umamaheswari *et al.,* (2004) Hemalatha and Meenambal (2006) also recorded similar results, which strongly support the present work. Worms are sensitive to change in pH. They prefer neutral condition. The pH of the initial substrate was 7.3, which increased to 7.4 to the control and 7.8, 7.7 and 7.6 in *P. excavatus*, *E. eugeniae* and *E. foeida* vermicompost beds, respectively. The addition of cow dung as a feed for the earthworms may be responsible the slight increase in the pH of the harvested product (Chaudhuri *et al.,* 2001; Hemalatha and Meenambal, 2006; Bansal and Kapoor, 2000).

Electrical conductivity, the indicator of the concentration of soluble salts was found to be 0.68-0.74 in m.mhose /cm in the initial sample and 9.24 in m.mhose/cm in the control. *P. excavates*, *E. eugeniae* and *E. foetida* composts showed an increased electrical conductivity of the order of 11.70, 10.24 and 9.82 m. Mhos/cm respectively. The increased electrical conductivity may be due to the presence of exchangeable calcium, magnesium and potassium n casts of the worms (Chaudri *et al.,* 2001; Umamaheswari *et al.,* (2004). A marked reduction in the bulk density was noted in *P. excavates* compost (0.53), *E. eugeniae* compost (0.48) and *E. foetida* compost (0.46) when taken compared to the control (0.66) and the initial substrate (0.46). N. P. K are encapsulated in the humus and stored, until beckoned by plants thus producing high energy with long-term beneficial growth, if humification process is proper. It is considered to very important to force crop production (Hemalatha and Meenambal, 2006).

The nitrogen content was significantly higher in *P. excavatus, E. eugeniae and E. foetida* incorporated composts (1.96, 1.84 and 1.25 %) respectively, compared to the initial (0.98%) and control (0.69 %) samples. The increasing trend of nitrogen in the vermibeds and vermibins was also observed earlier (Bouche *et al.,* 1997; Curry *et al.,* 1995; Ramalingam, 1992; Balamurugan *et al.,* 1999; Bansal and Kapoor, 2000; Umamaheswari *et al.,* 2004; Arokia john Paul *et al.,* 2005; Hemalatha and Meenambal, 2006). The increase of nitrogen in the present study may be due to the addition of muco-proteins secreted from the body wall of the earthworms Ozawa *et al.,* (2005).

The phosphorus level was found to be increased in *P. excavates, E. eugeniae and E. foetida* treated wastes (2.24, 2.14 and 2.05 %) respectively in comparison with the initial (0.20 %) and control (1.24 %) samples. Similarly the value of the potassium in the harvested compost obtained through the action of *P. excavates, E. eugeniae and E. foetida* was found to be more of the order of 2.70, 2.35 and 2.15 % respectively when compared with the control (1.28 %) and the initial organic waste (0.48%) under investigation. Graft (1971); Nijhawan and kanwarn (1952), Ramalingam (1997) and Hemalatha and Meenambal (2006) recorded similar trends of results which strongly support the present work.

Total solids are rough indicators for the reduction for matter. The total solids decrease when material degrades indicating the proper humification, which depends upon organic characteristics of feed substrate. Macro and micro (Zn, Cu, Mn and Fe) were significantly higher in vermicast is attained the required quality of manure.

## CONCLUSION

From the investigation, it may be concluded that *Perionyx excavates* could be adjudged as the best suited worm for converting the leaf litters and vegetable waste into bio composts in terms of nutrient and physical structure. From this investigation, it appeared that suitability of plant leaf litters viz., Mango, pongamia, Polyalthia and vegetable wastes as vermiculture substrate for the species studied in descending order was *P. excavates > E.eugeniae > E. foetida*.

## REFERENCES


1. **Ansari., A.A., and S.A. Ismail (2001a).** Vermitechnology in organic solid waste management, *J. soil Biol Ed*., 21(1-2) ; 21-24.
2. **Bansal., S, and K.K. Kapoor (2000).** Vermicomposting of residues and cattle dung *with Eiseniaefoetida, Biores.* Technol., 73; 21-24.
3. **Balamurugan., V, Gobi M. and G.Vijayalakshmi (1999)** Comparative studies on degradation of press mud using cellulolytic, fungi and exotic species of earthworms with a note on its gut micro flora, *Asian J. Microbial Biotech. Environ. Sci.*, 1 (3): 131-134.
4. **Chaudheri., P.S, Pal, T.K. Gautham bhattacharjee and S.K. Dev (2001)** Suitablity of rubber leaf Litters (Heveabrasilensis, Var Prim 600) as vermiculture Substrate for epigeic earthworms,and Eiseniafoetida, *J.soil Biol. Ecol.*, 21(1-2):36-40.
5. **Chopra, S.L and J.S Kanwar (1978)** Analytical Agricultural chemistry *Kalyani publishers*, Delhi, pp.334.
6. **Curry J.P, D. Byrne and K.E. Boyle (1995)**. The earthworm population inwinter cereal field and its effects on soil and nitrogen turnover. *Biol. Fertil. Soils,* 19:166-172.
7. **Edwards C.A. and P.J. Bohlen (1996)**. Biology and ecology of earthworms, 3rd Ed. *Chapman and Hall*, London.
8. **Darwin. C. (1881)** The formation of vegetables mould through the action of worms, with observations on their habitats, *Murray*, London, pp.326.
9. **Dominguez J. Edwards C.A and j. Ashby (2001)**. The biology and population dynamics of *Eudrillus eugeniae* (kin berg) (Oligochaeta) in cattle waste solids, *Pedobiologia*, 45
10. **Graff O. (1971)** Stiksoff, Phosphor and Kalium inder wiesenwer such flache – des soling projects *Ann. Zool. Econ*. 4:503-512.
11. **Gajalakshmi S. and Abbasi, S.A.2004**. Neem leaves as a source of fertilizers-cum pesticide vermicomposting. *Bioresou, Technol.*, 291-296
12. **Hemalatha B. and T. Meenambal (2006)**. Vermicomposting of different organic wastes with paper mill sludge. Asian J. microbial. *Biotech Environ. Sci*., 18 (3); 661-665.
13. **Ismail, S.A., (1993)** key note papers and intended abstracts congress on traditional sciences and technologies of *India IIT Bombay*, no10: 27-30.
14. **Jackson, M.L., (1973**) Soil chemical analysis, prentice hall India Pvt. Ltd., New-Delhi., pp 239-241.
15. **Julka and Palivwal (2005)**. In proceedings; vermitechnology transfer to N.S.S-programme Officers, Jeyaraj. R and Indira, Jeyaraj (eds), *Rohini Press*, Coimbatore, Tamil Nadu India, pp. 5-21.
16. **Daniel. T and Karmegam N. (1999).** Bioconversion of selected leaf litters using an African earthworm, *Eudrilus eugeniae. Ecol. Environ. Conserve.* 5(3): 271-275.

17. **Kale, R.D., and M.R. Bano (1996)** *In proc. Natl. semi*. On organic waste-utilization, pp. 151-160.
18. **Kale, R.D 1998)** Earth worm Cinderella of Organic farming, *Prism Book Pvt. Ltd*., Banglore., India, P.88.
19. **Ramalingam, R. (1997)** Studies on the life cycle growth and population dynamics of *Lampito mauritii* (Kinberg) and *Eudrilus eugeniae* (Kinberg) (Annelida – Oligochaeta) cultured in different organic wastes and analysis of nutrients and microbes of vermicompost. Ph.D.l Thesis, Annamalai University, Annamalai Nagar, India.
20. **Umamaheswari, S., Balamurugan, V. and G.S. Vijayalakshmi (2004)**. Degradation of leaf litter wastes by earthworms, *J. Ecobiol*, 1 (2)153-155