International Journal of Advanced Research in Biological Sciences
ISSN: 2348-8069
www.ijarbs.com

Research Article

Influence of organic solid wastes in vermicultural properties of the epigeic earthworm, *Eisenia fetida*

J. Arockia John Paul[a*], B. Karunai Selvi[b], B. Rajesh[c] and M. Biruntha[d]

[a]Department of Zoology, Arumugam Pillai Seethai Ammal College, Tiruppattur - 630 211. Tamil Nadu, India.
[b]Department of Botany, V.V. Vanniaperumal College for Women, Virudhunagar - 626 001, Tamil Nadu, India.
[c]Sivashakthi Bioplanttec Ltd, Rudrapur, Uttarakhand, India.
[d]Mother Theresa College of Education, Mettusalai, Illuppur, Pudukkottai- 622 102, Tamil Nadu, India.
*Corresponding author: *jajpaul@gmail.com*

Abstract

Locally available biodegradable organic wastes, which possess high quality of organic matter and essential nutrients, were identified and used for vermiculture studies. The growth and reproduction efficiency of an exotic earthworm i.e., *Eisenia fetida* was assessed in various biodegradable organic wastes like municipal solid waste (MSW), mushroom spent substrate (MSS), vegetable market waste (VMW) and biodigested slurry (BDS). Growth rate of the earthworm was gradually increased from the first week to till the termination of the experiment and was attained maximum in MSW amended with cowdung. The appearance of clitellum was observed on the 62nd day in all the substrates except BDS i.e., 60th day. Based on the results it is suggested that *E.fetida* is found suitable for vermiculture in all the organic wastes and BDS supports the maximum growth and reproduction of *E.fetida*.

Keywords: Biodigested slurry, *Eisenia fetida*, reproduction, hatchlings

Introduction

Vermiculture is the production of stock earthworms. It can be described as the scientific method of breeding and rearing earthworms in controlled conditions, it aims at creating favorable conditions, artificially for the multiplication and the growth of earthworms (Bhole, 1992). Earthworms can improve pasture quality. In order to encourage earthworm populations it is important to determine optimal levels of their food resources. The manure from mammalian herbivores is a highly nutritious food source for many species of earthworms (Lee, 1985). Earthworms are segmented elongated tubular apodus, hermaphordite creature that crawl on surface. However there is cross-fertilization i.e. two individuals copulate each other and their head remain on opposite directions. After copulation egg and sperm fertilize in the clitellum and after sometime, the clitellum is shed out from the body on a suitable substrate, which is known as cocoon.

The most effective use of earthworms in organic waste management requires a detailed understanding of the biology of all potentially useful species (Edwards and Bohlen, 1996). Different aspects of the biology of other species have been studied evaluating the suitability for vermicomposting. Environmental conditions and earthworm population density are known to affect earthworm growth and reproduction. Although moisture requirements and moisture preferences of earthworms are considered to the physicochemical properties of different organic wastes indicate that these preferences can vary among substrates.

Various agricultural wastes like post-harvest stubbles, sugar cane trash, coir waste and paper pulp, and faecal matter of cow, sheep, horse, and biogas sludge of poultry droppings have been tried as food source for worms. Their high biomass production may attain an increase of 40 to 90 times in a period of 3 to 6 months with adequate space and food (Viljoen and Reinecke, 1989 and Reinecke and Hallatt, 1989). An endemic earthworm species *P.ceylanensis* has been identified and utilized for municipal solid waste management (Paul *et al.*, 2011) which possesses enough potentiality for its use in vermicomposting in our country. Hence, the present study is carried out to find the influence of common organic wastes on the vermicultural aspects of Chinese tiger worm *E.fetida*.

Materials and Methods

A study of growth and reproduction was carried out with an exotic epigeic worm *E.fetida,* was obtained from the Department of Biology, Gandhigram Rural University, Gandhigram. The earthworms were mass multiplied using cow dung as the medium.

The growth and reproduction studies were carried out in various organic wastes such as municipal solid waste (MSW), mushroom spent straw (MSS), vegetable market waste (VMW) and biodigested slurry (BDS). The organic substrates were selected based on the survey of their availability in huge quantities. All the organic waste substrates were chopped into small pieces and allowed for shade dry. These organic substrates and urine free cowdung was finely powdered separately. To study the effect of various organic substrates on the growth and reproduction of earthworms, 1:3 ratio of each organic wastes and cowdung powder (sieved powder with particle size of 1000-500 µm) were mixed. Moisture content of dampened medium was 70 to 80 %.

The containers used for the study measured 12 cm dia x 9 cm height and were fitted with perforated lids. Initially 50 gram of the medium was kept in each container. As suggested by Hallatt *et al.* (1990), the work was started with many replications and, afterwards, restricted to minimum numbers (three replications) in order to get accurate results for statistical authentication. For the growth study, the hatchlings were gathered from small containers in which cocoons had been placed to hatch. The biomass of each hatchling was measured. Fifteen numbers of *E.fetida* hatchlings were introduced to the experimental containers separately with different substrates, which were kept in a rearing chamber at a temperature of 25±2ºC with relative humidity of 80 percent. After 15 days, fresh medium was added to every container. This was repeated every ten days till the termination of the experiment. While adding the fresh medium some of the older substrates were removed and weighed. This was done to maintain the original volume of the medium in each container.

Reproduction of earthworms

Batches of three replicates were separately kept for hatchlings in different organic substrates for *E.fetida,* for studying the reproduction parameters. After the formation of clitellum the substrates were searched for cocoons for every five days and the number of cocoons produced was recorded for each experimental setup till the termination of the study.

Incubation of cocoons

The cocoons recovered from the vermibeds produced by *E.fetida* were separately kept in small containers with their respective composts. From the total cocoons recovered, a batch of 50 cocoons was randomly selected. The cocoons were individually kept in small plastic containers of 2.5 cm dia x 2.5 cm height carrying one gram of respective composts and observed for the emergence of hatchlings. The number of hatchlings that emerged from each cocoon and the total number of cocoons that hatched were also recorded separately. The biomass of the hatchlings was also recorded by digital analor balance. The percentage of hatching success was calculated as follows:

$$\text{Percentage of hatching success} = \frac{\text{Number of cocoons hatched}}{\text{Number of cocoons incubated}} \times 100$$

Food preference study

The food preference of *E.fetida* was determined based on the percentage of utilized substrates removed from the different vermibeds.

$$\text{Percentage of food utilization} = \frac{A - B}{A} \times 100$$

Where,
A = Total weigh of organic substrate in the vermibed;
B = Weight of utilized material

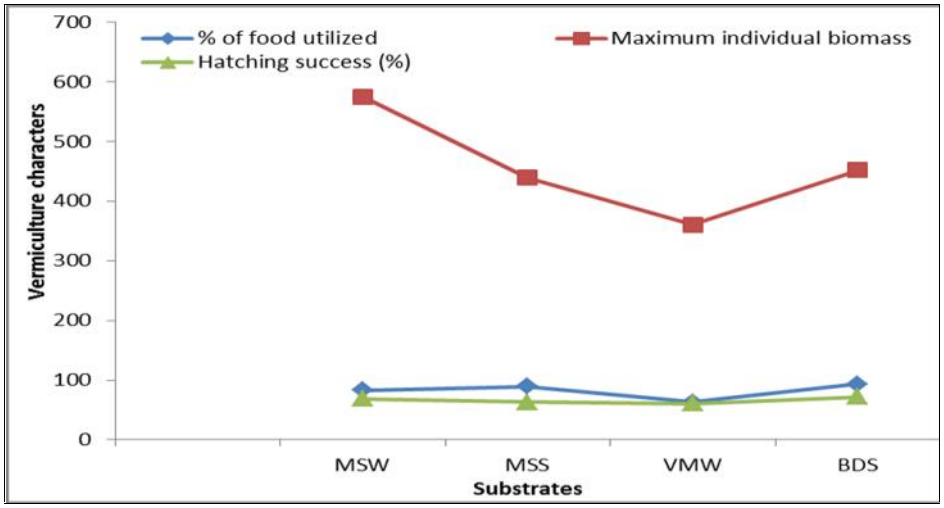
Physico-chemical analysis

The physico-chemical composition of the vermibed substrate were analyzed for the selected parameters such as temperature, moisture, pH and electrical conductivity (EC) (Jackson, 1973), organic carbon and organic matter content (Walkley and Black, 1947), total nitrogen, phosphorous and potassium (Tandon, 1993). The ratio of the percentage of carbon to that of nitrogen (i.e. C/N ratio) was calculated by dividing the percentage of carbon estimated for the sample with the percentage of the nitrogen estimated for the same sample.

Results and Discussion

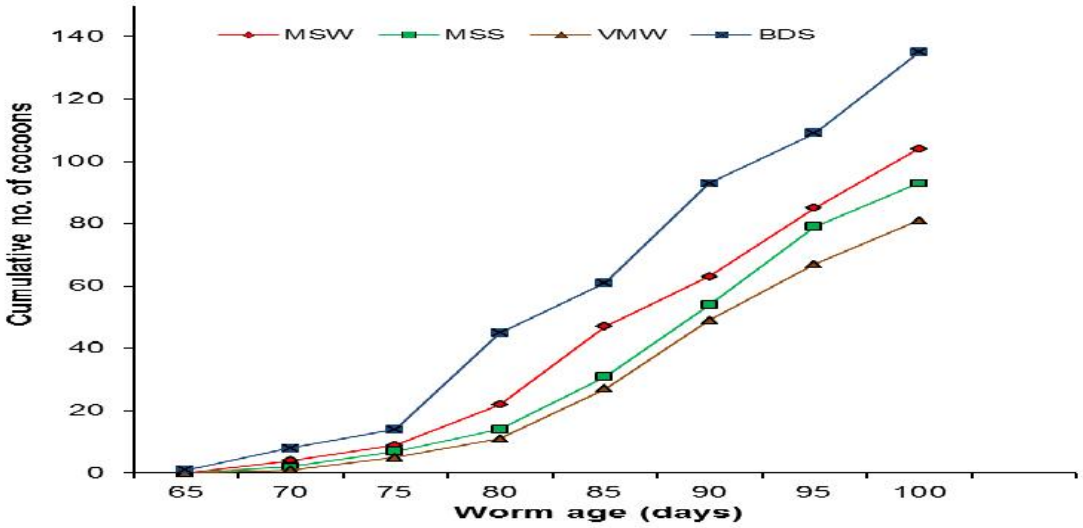
After the termination of experiment the food utilized by the earthworms were calculated to find out the food preference are shown in Fig. 1. Percentage of food utilized was high in the trough containing BDS. Maximum individual biomass achieved by *E.fetida* in various organic wastes is shown in Fig.1. Maximum biomass was observed in MSW i.e., 575.38±42.60 mg. Loehr *et al.* (1984) used sewage sludge as food source and reported that *P.excavatus* reached its maximum biomass after approximately 100 days. Their observation falls in line with these results. The hatchling success of 50 cocoons in various organic substrates is shown in Fig. 1. Cocoons of *E.fetida* that were produced in BDS, MSW, MSS and VMW had a hatching success of 71.80, 68.51, 63.45 and 60.71% respectively. Kale *et al.* (1982) and Loehr *et al.* (1984) obtained 67 and 50 % respectively. Reinecke *et al.* (1992) observed the hatching success of 72 % in cattle dung at 25ºC for *P.excavatus.* Karmegam (2002) achieved 90 % of hatching success in cowdung for *P.ceylanensis.*

Fig. 1. Food preference study, maximum individual biomass achieved and hatching success of 50 cocoons of *E.fetida* in various organic wastes



The cumulative cocoon production of *E.fetida* cultured in various organic substrates until the age of 100 days is shown in Fig. 2. *E.fetida* started producing cocoons at the age of 65 days in BDS and at the age of 70 days in MSW, MSS and VMW. The cumulative cocoon production was increased with the increase in the age for all the four substrates. Maximum number of 135 cocoons was observed at the termination of the experiment in BDS. Biruntha *et al.* (2013) observed maximum of 183 cocoons of *Perionyx excavates* in pressmud. The cocoon production was also affected by the food source. VMW support the least growth and reproduction of the earthworm species. This may be due to the presence of high cellulose and lignin content in the VMW.

Fig. 2. The cumulative cocoon production of *E.fetida* in various organic substrates until the age of 100 days



The percentages of cocoons of *E.fetida* releasing specific numbers of hatchlings after incubation at 25ºC in various organic substrates are shown in Table 3. At 25ºC, 20 to 28 % of cocoons produced one hatchling, 17 to 25 % produced two hatchlings, 13 to 21 % of cocoons produced three hatchlings, 2 to 4 % of cocoons produced four hatchlings and 1 to 4 % of cocoons produced five hatchlings in different organic wastes.

Table 3. The percentage of cocoons of *E.fetida* releasing specific numbers of hatchlings after incubation at 25ºC

Substrate	Number of hatchlings cocoon^{-1}				
	1	**2**	**3**	**4**	**5**
MSW	22	25	18	2	2
MSS	26	19	16	2	1
VMW	28	17	13	2	1
BDS	20	23	21	4	4

Physico-chemical parameters of the various organic substrates used for vermiculture are given in Table 4. The temperature and moisture content of the substrate was ranged from 23.33ºC (VMW) to 26.33ºC (MSW) and 35.41% (MSS) to 49.20% (BDS). C/N ratio of the substrate was very high in VMW and very less in BDS. These physico-chemical parameters of the substrate influence the growth and reproduction of the earthworms (Edwards *et al.*, 1998).

Based on the observations of the worm maximum individual biomass, cocoon production, food preference study, hatchling success, number of hatchlings/cocoon and physico-chemical analysis of four different organic substrates, it is suggested that *E.fetida* is found suitable for vermiculture in various organic wastes like MSW, MSS, VMW and BDS and MSW supports the maximum growth and BDS supports the reproduction of *E.fetida*.

Table 4. Physico-chemical parameters of the various organic substrates used for vermiculture

Sl.No	Parameters	MSW	MSS	VMW	BDS
1	Temperature (ºC)	26.33	25.67	23.33	24.00
2	Moisture (%)	46.67	35.41	39.26	49.20
3	pH	7.35	7.50	7.61	7.42
4	Electrical conductivity (dSm^{-1})	2.07	1.63	1.72	1.46
5	Organic carbon (%)	34.83	33.56	46.91	28.15
6	Organic matter content (%)	60.05	57.86	80.87	48.63
7	Nitrogen (%)	0.82	0.75	0.72	1.32
8	Phosphorus (%)	0.48	0.39	0.37	0.65
9	Potassium (%)	0.67	0.43	0.50	0.82
10	C/N ratio	42.48	44.75	65.15	21.33

References

Bhole, R.J. 1992. Natural farming and vermiculture biotechnology. In: Proceedings of National Seminar on Natural Farming. (Eds.: Somani, L.L., Totawat, K.L. and Baser, B.L.). Pp. 143-151.

Biruntha, M., Paul, J. A.J. and Mariappan. P. 2013. Growth and reproduction of *Perionyx excavatus* in different organic wastes. *International Journal of Current Microbiology and Applied Sciences,* 2(2): 28-35.

Edwards, C. A., Dominguez, J. and Neuhauser, E.F. 1998. Growth and reproduction of *Perionyx excavatus* (Perr.) (Megascolecidae) as factors in organic waste management. *Biol. Fertil. Soils*, 27: 155-161.

Edwards, C.A. and Bohlen, P.J. 1996. Biology and Ecology of earthworms. 3rd edition. Chapman and Hall, Londan. Pp.1-426.

Hallatt, L., A.J., Reinecke and Viljoen, S.A. 1990. Life cycle of the oriental compost worm *Perionyx excavatus* (Oligochaeta). *S. Afr. J. Zool.*, 25(1): 41-45.

Jackson, M.L. 1973. *Soil Chemical Analysis*. Prentice Hall of India Pvt. Ltd., New Delhi.

Kale, R.D., Bano, K. and Krishnamoorthy, R.V. 1982. Potentials of *Perionyx excavatus* for utilization of organic wastes. *Pedobiol.*, 23: 419-425.

Karmegam, N. 2002. Studies on earthworms, vermiculture, vermicomposting and utilization of vermicompost for plant growth. Ph.D., Thesis submitted to Gandhigram Rural University, Gandhigram, India.

Lee, K.E. 1985. Earthworms, Their Ecology and Relationship with Land Use. Academic Press, Sydney.

Loehr, R.C., Martin, J.H., Neuhauser, E.F. and Malecki, M.R. 1984. Final project report submitted to the National Science Foundation,118pp. Department of Agricultural Engineering, Cornell University, Ney York.

Paul, J.A.J. Karmegam, N. and Thilagavathy Daniel. 2011. Municipal solid waste (MSW) vermicomposting with an epigeic earthworm, *Perionyx ceylanensis* Mich. Biores. Tech. 102: 6769–6773.

Reinecke, A.J. and Hallatt, L. 1989. Growth and cocoon production of *Perionyx excavatus* (Oligochaeta). *Biol. Fertil. Soil*, 8: 303-306.

Reinecke, A.J., Viljoen, S.A. and Saayman, R.J. 1992. The suitability of *E.eugeniae, Perionyx excavatus* and *E.fetida* (Oligochaeta) for vermicomposting in Southern Africa in terms of their temperature requirements. *Soil Biol. Biochem.,* 24(12): 1295-1307.

Tandon, H.Z. 1993. Methods of analysis of soils, plants, waters and fertilizers. Fertilizer Development and Consultation Organization, New Delhi, India. Pp.148.

Viljoen, S.A. and Reinecke, A.J. 1989. The number, size and growth of hatchlings of the African Nightcrawler, *Eudrilus eugeniae* (Oligochaeta). *Rev. Ecol. Biol. Soil.,* 26: 1-12.

Walkley, A. and Black, I.A. 1947. Oxidizable matter by chromic acid with sulphuric acid heat of dilution. *Soil Sci*., 63:251.