Utilization of Municipal Solid Wastes (MSW) as vermiculture substrate for adult epigeic earthworms and assessment based on their growth and reproduction

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ABSTRACT

Municipal Solid Waste is an unwanted material left from different sources. The problem is mainly due to urbanization, industrialization, poor urban planning and lack of adequate resources which contribute to the huge amount of solid waste generation. This problem has resulted in serious environmental, social and economic complications in the developing countries like India. The current agricultural practices involve extensive use of synthetic fertilizers and pesticides. In this context, the persistence of pesticides and their residues in the soil and water affecting the agroecosystem is a serious concern. Attempts focusing on the use of biological pesticides, fertilizers and biocontrol agents are receiving worldwide attention. The soil pollution due to the solid waste dumps, heavy metals, toxic chemicals, petroleum, diesel and crude oil is of great concern. The present study involves the application of vermitechnology in solving the problems of solid waste management and to assess the suitability of municipal solid waste cow dung (MSW) as vermiculture substrate for three different epigeic earthworms viz., *Eisenia foetida, Eudrilus eugeniae* and *Perionyx excavatus*.

Key words: Vermitechnology, *Eisenia foetida*, *Eudrilus eugeniae*, *Perionyx excavatus*, Municipal solid waste (MSW)

I. INTRODUCTION

Earthworms have over 600 million years of experience as ecosystem engineers. Vermiculture scientists all over the world know about the role of earthworms as waste managers, as soil managers and fertility improves for long time. But some comparatively new discoveries about their role in wastewater treatment, contaminated soil remediation, have brought a revolution in the vermiculture studies (Sinha, 2009). 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 rubellus* 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; Chaudri *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, 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 vermicast 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).

II. MATERIALS AND METHODS

2.1. Collection and pre-decomposition of municipal solid wastes with cow dung

The Municipal Solid Wastes (MSW) was collected from dumping site at Kumbakonam. The wastes were chopped into small pieces and allowed to partial decomposition for 30 days (Figure 1). Then the wastes were mixed with Cow dung in 3:1 ratio.

2.2. Epigeic earthworms used for culture studies

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

Figure (1) VERMICULTURE UNIT

Figure (2) EARTHWORM'S COCOON AND YOUNG ONES

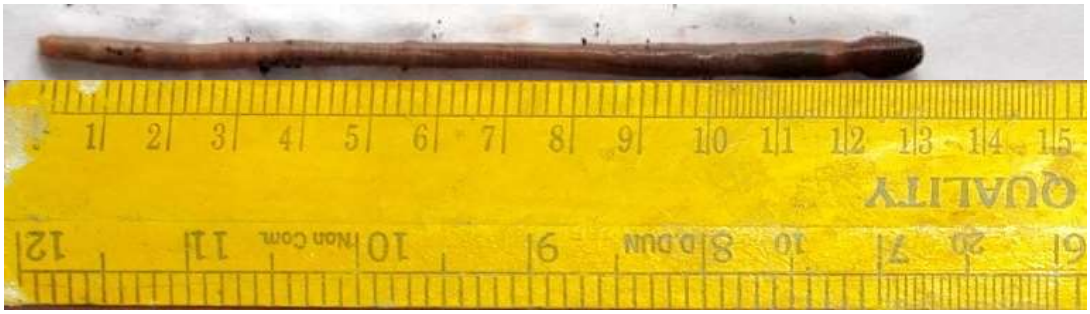

Figure (3) MATURED EARTHWORM

III. RESULTS AND DISCUSSION

This study was investigated the suitability of municipal solid wastes and cow dung as vermiculture substrate for epigeic earthworms viz., *P. excavatus, E. eugeniae* and *E. foetida* on the basis of their survivability, rate of body weight increase (growth) and reproduction. Changes in the body weight of *P. exacavatus, E. eugeniae* and *E. foetida* in municipal solid wastes and cow dung diet are given in table 1. *E. fetida* has less activity when compared to other two species that showed casting activity in the municipal solid wastes and cow dung through the study period. Both *P. exacavatus, E. Eugenia* showed weight gain of 0.816 g and 0.176 g within 30 days. Weight gain by *E. foetida* was very low (0.036 g) compared to other two species. In *P. exacavatus***,** *E. eugeniae* and *E. foetida*, the rate of body weight increase was 28.8, 26.2 and 5.04 mg worm-1 day-1 respectively (Table 1.)

In this study, had its highest biomass on the 7th day; its body weight increase was significant with respect to its initial weight. *E. foetida* had its lowest biomass on the 7th day its body weight also; increase was significant with respect to its initial weight. In contrast, both and *E. eugeniae* having wide range of choice on food materials had significant increase in their body weight up to 35th day and after that, their body weight started to decline sharply over a period of next 27 days.

Mortality of earthworms were very high (50%) in *E. foetida*, when being compared with that (17%) in both *E. eugeniae* and *P. exacavatus* Mortality of earthworms was noticed on the 28th day in the cultures of *E. eugeniae*, *P. excavatus* and *E. foetida***.** the fast growth rate, high mean body weight and survivability of *Perionyx excavatus* in (MSW) and cow dung as vermiculture substrate for *Perionyx* and also could give a clear advantage over the vermicompost species as a potential protein producer.

Rate of reproduction in waste diet for both *P. excavatus* **(**1.4 young's worm^{-1} week^{-1} and E. eugeniae (1.3 young worms^{-1} week^{-1}) was significantly higher ($P < 0.05$) than that in *E. foetida* (0.3 young worms^{-1} week^{-1}) over a period of 62 days (Table 1). The present investigation, it appeared that suitability of municipal solid wastes and cow dung as vermiculture substrate for the species studied in the descending order was *P. excavatus> E. eugeniae > E. foetida.*

Table.1 UTILIZATION OF MUNICIPAL SOLID WASTES AND COW DUNG DIET ON THE GROWTH, MORTALITY AND REPRODUCTION OF *P. EXACAVATUS, E. EUGENIAE* AND *E. FOETIDA*

Growth, mortality and reproduction Parameters	*P. exacavatus*	*E. eugeniae*	*E. foetida*
Number of adults used in the culture	16	18	8
Mean body weight (g)	1.75 ± 0.03	1.35±0.04	0.56±0.02
Feeding and casting activity	High	High	Less
Highest individual weight (g)	2.57±0.02	1.38 ±0.03	0.74±0.02
Weight gain (g)	0.816±0.04	0.176±0.04	0.36±0.02
No. of days to attain maximum Body weight.	28	28	7
Rate of body weight increase (mg. worm^{-1} day^{-1})	28.8±2.2	6.2±1.2	5.04±1.2
Weight loss (mg. worm^{-1} day^{-1})	-13.0	-12.0	-18.0
No. of young ones produced in culture after (62 days)	78.0±1.4	43.0±0.16	54±1.6
Rate of reproduction (young worm^{-1} week^{-1})	1.4±0.4	1.3±0.2	0.3±0.06
Mortality of adults	17%	17%	50%

Earthworms continue to grow throughout their lives with enlargement of their body segments following emergence from the cocoons but the rate of growth decline following sexual maturity (Edwards and Bohlen, 1996). It is well known that the quality and amount of food available influence not only the size of earthworm population but also the species present and their rate of earthworms (Elvira *et al.,* 1996; Dominguez *et al.,* 1997, 2000) but the information is very scanty on the effect of diet on adult earthworms during vermicomposting process. The present study was undertaken to investigate the suitability of municipal solid wastes and cow dung as vermiculture substrate for epigeic earthworms' viz., *E. Eugeniae* and *E. foetida* based on their survivability, rate of body weight increase (growth) and reproduction.

Changes in the body weight of, *E. eugeniae and E. foetida* in the municipal solid wastes diet were determined. *E. foetida* has less activity compared to other two species that showed casting activity in the leaf litter wastes and vegetable wastes throughout the study period. Both and *E. eugeniae* showed weight gain of 0.816 g. and 0.176 g. within 30 days. Weight gain of *E. foetida* was very low (0.036 g) compared to other two species. In *Perionyx, Eudrilus* and *Eisenia*, the rate of body weight increase was 28.8, 26.2 and 5.04 mg worm^{-1} day^{-1} respectively.

Data on the growth rate of three vermicomposting species are close to the values reported by Reinceck and Hallett (1989). In the *P. excavatus* (23.5 mg worm^{-1} day^{-1}), Neuhauser *et al.,* (1989) *in E. foetida* (7 mg worm^{-1} day^{-1}) and Vilijoen and Reineck (1989) in *E. eugeniae* (34 mg worm^{-1} day^{-1}) in group culture in mammalian dung where the investigators used juveniles in their growth experiments on worms. In this study, *P. excavatus* had its highest biomass on the 7th day; its body weight increase was significant with respect to its initial weight**.** *E. foetida* had its lowest biomass on the 7th day; its body weight increase was significant with respect to its initial weight. Probably municipal solid wastes had a negative effective on the feeding activity of *E. foetida* and *P. excavatus* thus inhibited their growth in the medium. In contrast, both *E. eugeniae* and having wide range of choice on food materials had significant increase in their body weight up to 35th day and after that, their body weight started to decline sharply over a period of next 27 days.

Mortality of adults was very high (50%) in *E. foetida* when being compared with that (17%) in both *E. eugeniae* and *P. excavatus*. Mortality of the worms was noticed in the 28th day in the cultures of *E. foetida, P. excavatus* and *E. eugeniae*. The fast growth rate, high mean body mass and survivability of *Perionyx* in municipal solid wastes as vermiculture substrate for *Perionyx* and also could give a clear advantage over the vermicompost species as a potential protein producer. Rate of reproduction in leaf litters waste and vegetable waste diet for both (1.4 Young's worm^{-1} week^{-1}) and E. eugeniae (1.4 young worm^{-1} week^{-1}) was significantly higher ($p < 0.05$) than that in *E. foetida* (0.2 young worms^{-1} week^{-1}) over a period of 62 days. Neuhauser *et al.,* (1988) from their studies on growth and reproduction of vermicomposting species, *Perionyx, Eisenia* and *Eudrilus* reported that optimum temperature for their growth and survival was

25°c and *P. excavatus* produced 13 young worms-^{1} week-^{1}, *E. foetida* 19 young worms^{-1} week^{-1}, this study data are not comparable with that of Neuhauser *et al.,* (1988) because of this study was carried out in a comparatively higher temperature 30 $\pm$ 0.29°C and also do not know the time of juvenile peak of *Perionyx*, *Eudrilus* and *Eisenia* in municipal solid wastes diet due to lack of regular observations on their reproduction. The growth and reproduction may differ considerably due to these variables.

The investigation, it appeared that suitability of municipal solid waste as substrate for the species studied in the descending order was *Perionyx excavatus* > *E. eugeniae* > *E. foetida*. Kale and Krishnamurthy (1981) advocated the possible occurrence of volatile potentiators or modifiers in the leaves that might be responsible for differential feeding preference by the worms. Hendrickson (1990) suggested that C: N ratio and particularly polyphenol concentrations are the most important factors in determining municipal solid wastes palatability of detrivorous earthworms. It is responsible to assume that some phenolic compounds and particularly toxic phenyl hydrazine present in these municipal solid wastes material affected the feeding activity that along with other factors resulted differential survivability, growth and reproduction of the earthworms studied.

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