June 2009 *Volume 4 Issue 5*

Trade Science Inc.

Environmental Science

An Indian Journal

Current Research Papers

ESAIJ, 4(5), 2009 [237-241]

Canteen kitchen waste management through vermicomposting employing *Eisenia foetida* and *Perionyx excavatus* species of earthworm

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Received: 8th May, 2009 ; Accepted: 13th May, 2009

ABSTRACT

A comparative Study was conducted, to test potential of two earthworm species (*E. foetida* and *P.excavatus*) for vermicomposting of canteen kitchen waste management generated on university campus. Vermicomposting of canteen kitchen waste showed better results compared to ordinary composting. Nitrogen and phosphorous contents showed increased trend after 60 days of vermicomposting, whereas potassium content was slightly decreased in the test pits of *P.excavatus* and increased *in E.foetida* as compared with initial material. A decreased in organic carbon content in the waste material was observed to be decreased as compared to initial waste. The efficiency of both earthworm species was observed to be comparable without any statistically significant difference. The results showed both species could be used for management of canteen kitchen waste as compared to ordinary compost method.

KEYWORDS

Eisenia foetida;
Perionyx excavatus;
Vermicomposting;
Canteen kitchen waste.

INTRODUCTION

Solid waste management is one of the biggest environmental challenges that the modern world is facing, mainly due to increase in population, urbanisation and changing habits and attitudes. A methodical approach to handle this waste is to treat, reprocess and recycle organic waste on site to produce useful products. Solid waste arising from human activity has become one of the major environmental issues causing extensive pollution problem and threat to human health. In India, every year 30.3 million tonne of municipal waste is generated. This is equal to about 350g of daily waste per person on average[8]. The average collection efficiency for the municipal solid waste (MSW) in Indian cities is at the maximum 72 %. And almost 70% of the cities do not have adequate waste transportation capacities[13].

Household kitchen waste is one of the major sources of municipal solid waste. In India, domestic waste is mostly of organic nature and contributes 70 to 80% of urban solid wastes. Each household of four individuals generates 0.5-0.75-kg kitchen waste per day[5]. The organic Kitchen waste produced from restaurants and canteens form a major component of putrefying organic waste that end up in landfill sites or is disposed off on roadsides and in waterways. The main health problems are encountered with the kitchen waste.

Traditionally, even though on insignificant scale, thermophilic composting is commonly adopted for treatment of organic wastes or for production of organic fertilizers or manure. A related technique, called vermicomposting (using earthworm to breakdown the

organic wastes) is becoming popular[9]. Composting using worms gives the better end product (vermicastings) than composting due to the enzymatic and microbial activity that occur during the process[1]. Earthworms decompose various types of organic wate materials and convert them into vermicompost[2,6,7,12]. Many studies show that vermicomposting can achieve safe pathogen levels which may be facilitated by the microbial and enzymatic activity with an added advantage of converting the important plant nutrients into a more soluble state, helping in plant utilisation.

Shivaji University campus has three Boys hostels, two ladies hostels, one Vidyarthi Bhavan, one general canteen and two snack pots on the university campus of 800 acres. A total of over four thousand individuals eat daily in these facilities provided by hostels mess and canteen. The leftover generated in the canteen and mess was thrown in the waste bin or dumped without any treatment on campus. This leads to foul smell, rodents and stray dogs problem on campus. Thus canteen and hostel mess leftover waste disposal was a serious health and growing nascence problem. There was the prime need to manage the biodegradable waste generated in canteen to solve the pollution problem. It was therefore proposed to attempt to solve the problem in home by applying vermitechnology in cost effective and eco-friendly manner as demonstration pilot project.

MATERIAL AND METHODS

(a) Vermi-treatment process

A unit with three pits all having same dimensions were constructed (Plate I). Each pit had a dimension of about 90cm in length and 120 cm in breadth. In the first pit, canteen workers dumped the waste, which is sometimes not properly segregated. Plastic, packing materials were segregated from the first pit and then it was kept for partial decomposition for 30days period. The waste dumped in this pit was only the biodegradable. Second and third pits were used for the vermi-treatment process, in which two different earthworm species were used.

In each pit, the first layer (bottom layer) was made by mixing of grass and dried leaves, which was spread up to 10cm height of pit. Cow dung was spread on this layer up to the 10cm layer. Kitchen waste was spread up to 50cm (i.e. 30cm) and above that a layer of 1cm cow dung was added (Plate). After two to three days the identified earthworm species i.e. *Eisenia foetida* and *Perionyx excavatus* were inoculated, having the same weight adults (clitellum developed). About 1500 individuals of both species were inoculated in two different pits (second and third). While in first pit was kept for regular composting, made as the same layers of bedding material as like vermi-treatment. Regular composting pit was considered as control (without worm). The vermi-treatment process was carried out for 60 days in second and third pit.

(b) Chemical analysis

The chemical analysis of samples before and after vermicompost, was done by using standard methods. Samples were collected on every 10^{th} day and analysed for various parameters. pH, total nitrogen, total phosphorous, and total potassium were determined after every 10^{th} day while organic carbon, total calcium and total magnesium were determined after 60^{th} day of composting .

pH and Organic Carbon, were determined using pH meter and Wallery back method. Where as total Kjeldahl Nitrogen (TKN), total Potassium (TK) and total available Phosphorous (TP) were estimated by Kjeldahl, Flame emission Technique, and Spectrophotometer. All the samples were analysed in triplicate and results were averaged.

(c) Statistical analysis

Student 't' test was applied to data to determine significant differences between various parameters of the two species. Differences were considered significant, where $p < 0.05$.

RESULTS AND DISCUSSION

TABLE 1 shows change in the chemical properties of canteen waste during its 60^{th} day of composting with and without the earthworms. The set without earthworms was considered as control. Species *E.foetida* and *P.excavatus* were used for vermicomposting to check the efficiency of the two earthworms species in vermicomposting.

TABLE 1 : Physico-chemical analysis of composted kitchen waste with and without earthworm at different time intervals; (values are average ± S.D.)

Parameter	Species name	Number of Days						
		Initial	10	20	30	40	50	60
pH	Without worm(C)	9.85±0.05	9.82±0.053	9.30±0.100	8.54 ±0.060	8.24±0.100	8.12±0.020	8.02±0.040
	E.foetida	-	9.72±0.100	9.28±0.027	8.64 ±0.020	8.24±0.191	7.74±0.132	7.34±0.053
	P.excavatus	-	9.64±0.131	9.15±0.095	8.68±0.053	8.10±0.091	7.65±0.030	7.24±0.087
Total nitrogen	Without worm	0.80±0.07	0.88±0.040	0.96±0.020	1.20±0.060	1.60±0.092	1.62±0.020	1.64±0.040
	E.foetida	-	0.94±0.053	1.24±0.087	1.46±0.203	1.68±0.122	1.74±0.035	1.84±0.060
	*P.*excavatus	-	0.98±0.020	1.28±0.080	1.52±0.092	1.64±0.087	1.62±0.044	1.68±0.060
Total phosphorous	Without worm(C)	0.95±0.087	1.10±0.100	1.45±0.118	1.61±0.030	1.78±0.060	1.84±0.020	1.85±0.050
	E.foetida	-	1.20±0.211	1.38±0.171	1.55±0.089	1.81±0.076	1.84±0.026	1.88±0.072
	P.excavatus	-	1.15±0.050	1.30±0.087	9.65±0.030	1.73±0.026	1.79±0.026	1.88±0.072
Total potassium	Without worm(C)	1.54±0.08	1.34 ±0.087	1.22±0.052	1.17±0.030	1.00±0.035	0.97±0.010	0.80±0.085
	E.foetida	-	1.24±0.053	1.48±0.072	1.55±0.121	1.64±0.144	1.60±0.020	1.64±0.151
	P.Excavatus	-	1.52±0.072	1.47±0.052	1.49±0.061	1.38±0.072	1.30±0.026	1.32±0.053

(C- Control)

TABLE 2 : Changes in physicochemical parameters, during kitchen waste composting (after 60th day)(n=2)

Parameters	Initial	After 60 days		
		Without worm (C)	*E.foetida*	*P.excavatus*
pH	9.85±0.050	8.02±0.040	7.34±0.053	7.24±0.087
Organic carbon	37.8±0.721	13.5±0.625	10.8±1.249	12.48±1.952
Total Nitrogen	0.80±0.072	1.64±0.040	1.84±0.060	1.68±0.060
Total Phosphorous	0.95±0.087	1.85±0.050	1.88±0.072	1.88±0.072
Total Potassium	1.54±0.087	0.80±0.085	1.64±0.151	1.32±0.053
Total calcium	4.73±0.090	5.24±0.088	2.80±0.529	2.90±0.200
Total Magnesium	0.55±0.141	0.66±0.131	0.48±0.080	0.44±0.139

(C- Control)

Unpalatable aromatic substances produced both by plant material and micro organisms at early stages of decomposition as recorded earlier[7]. With the advancing progress of decomposition pH of the material decreased slowly, with a lower trend in the experimental set (>7.3) in comparison with control (>8.0) up to 60 days. CO_2 and organic acid produced during microbial metabolism probably decrease the pH during composting[4]. It is likely that the comparatively lower pH (nearly neutral) during vermicomposting process is due to the additional contribution made by earthworm.

In the experimental set of *E.foetida*, carbon level showed statistically significant decrease trend as compared with control ($p<0.05$), while in case of *P.excavatus* organic carbon level was not significantly different ($p>0.05$). Decreasing trend of the carbon content during composting indicated degradation of waste. Carbon level decrease in the control and experimental (with worm) sets as compared with initial values. These results indicated that earthworms accelerated the decomposition process of the organic matter.

Total nitrogen content was significantly increased in the experimental sets of *E. foetida* than in control, while this value did not significantly differ than control (without worm) and in experimental set of *P.excavatus* species. The higher percentage of nitrogen was obtained in the experimental sets of *E.foetida* species 1.84 (±0.060) N% than in control 1.64 (±0.040) N% and *P.excavatus* 1.68 (±0.060) N%. The relatively high level of the nitrogen in vermicomposting compared to composting was contributed by earthworm through excretion of NH_4^+ and secretion of mucus. Nitrogen content in both experimental sets was not significantly different (TABLE 2).

Total phosphorous content of experimental set (with earthworm) also showed higher values than control. The decreasing trend of phosphorous was in *E.foetida* (1.88±0.072) = *P.excavatus* (1.88±0.072) > control (1.85±0.050). While values of the phosphorous compared with two experimental sets was also not significantly different. Ghosh et al.[3] reported higher levels of transformation of phosphorous from organic to inorganic state and thereby into available forms during vermicomposting as compared to ordinary composting. Same observation was recorded in this experimentation as well.

When compared with experimental set and control, total potassium content did not show a significant difference in it. In both experimental sets, total calcium values were significantly different than control. It showed

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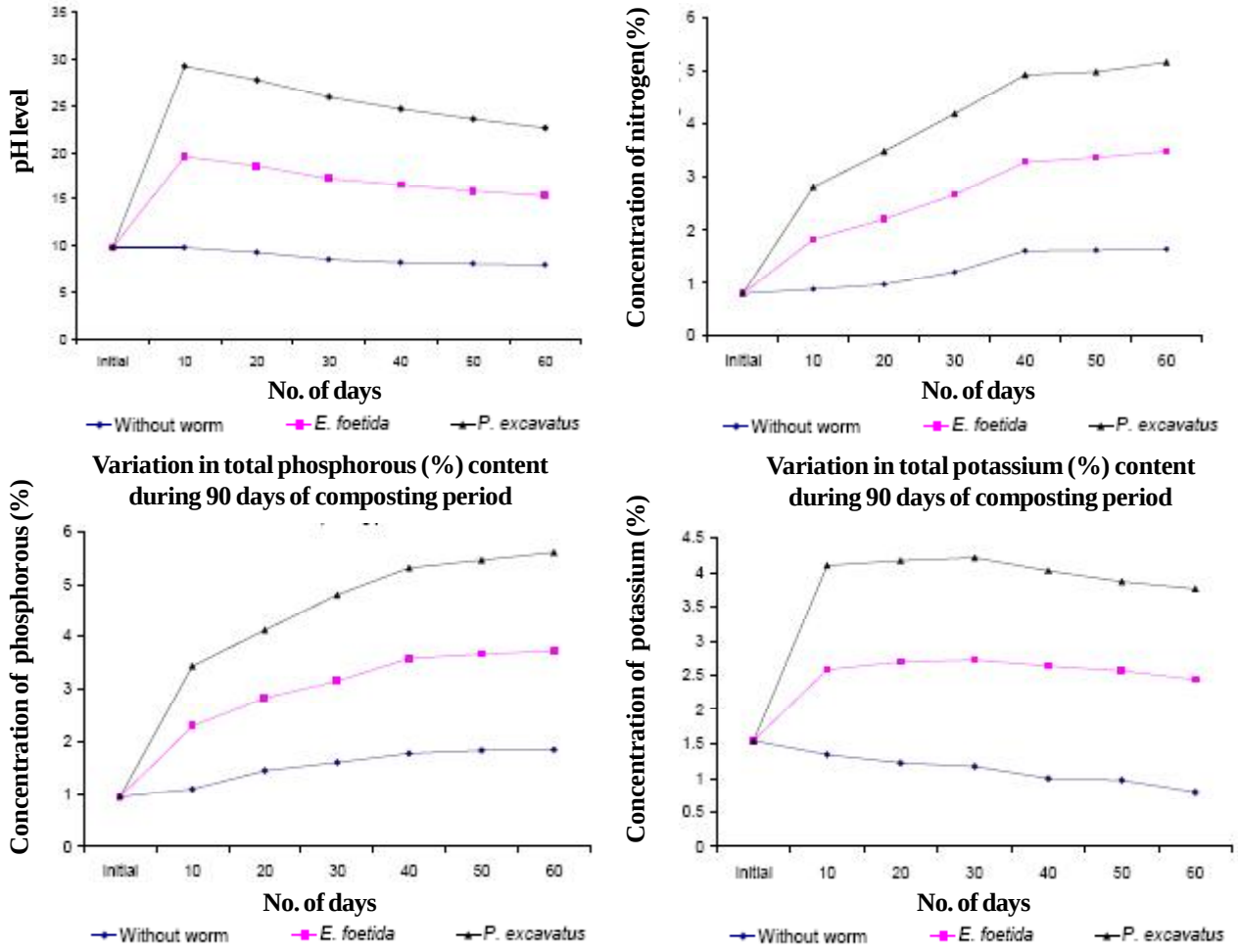

Figure 1

decreased trends than the initial values. Calcium values were not significant different i. e. same in comparison of both experimental sets. Total magnesium values in the experimental sets and control were not significantly different when the same results were observed in comparison of two experimental sets. Total magnesium values in experimental set of *E.foetida* and control were significantly different.

Increased NPK content in the compost was observed by Parthasarathi and Ranganathan[10]. Tripathi and Bharadwaj[14] also observed increased in NPK in the composting material taking cow dung using the species *Eisenia foetida*. In this work increased in NPK during the course of compost has also been observed.

Changes in the biomass of earthworm

During the vermicomposting changes in the earthworm biomass (n=10) were observed. Average initial biomass of the *E.foetida* species was 0.260 (±0.012) gm and *P.excavatus* was 0.269 (±0.014) gm. After 60th days of vermicomposting period, biomass of these species was increased i.e. (*E.foetida* 0.397(±0.077) gm, *P.excavatus* 0.468 (±0.086) gm respectively.

TABLE 3 : Changes in the biomass of two earthworm species after vermicomposting (n=10)

Species	Initial weight (gm)	Final weight (gm)
E.foetida	0.260 ±0.012	*0.397±0.077
P.excavatus	0.269±0.014	*0.468±0.086

***Significantly increased values 't' test p<0.05**

After Vermicomposting the two earthworm species showed statistical increase ($p<0.05$) in biomass when compared with the initial weight of the species. The biomass of the *E.foetida* and *P.excavatus* species were increased by 52.67 % and 73.97 % respectively as compared with initial weight. Comparing both species, biomass was not significantly different ($p>0.05$) that means both the species achieved the similar weight af-

ter 60 days of composting period and their performance in vermicomposting was comparable.

CONCLUSION

During the study, the university canteen kitchen waste was managed as a pilot project on experimental basis. The organic carbon content in the waste material was reduced than its initial concentration after 60 days period of experimentation, which indicates decomposition of waste material. Vermicomposting of canteen kitchen waste showed better results compared to ordinary composting. Nitrogen and phosphorous contents showed increased trend after 60 days of vermicomposting, whereas potassium content was slightly decreased in the test pits of *P.excavatus* and increased *in E.foetida* as compared with initial material. The efficiency of both earthworm species was observed to be comparable without any statistically significant difference.

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