Comparative assessment of growth potential and vermicomposting efficiency of the Epigeic Earthworm *Eisenia Foetida* over the other species *Eudrilus eugenae* and *Perionyx excavatus*

Running Title: Vermicomposting efficiency of *Eisenia Foetida* earthworm species

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Abstract

Vermicomposting has gained momentum in recent years due to its manifold benefits Earthworms are known to degrade organic matter, but all species are not having the same potential to degrade organic matter. So selecting a suitable earthworm species is the first important step of vermicomposting activity. Therefore, for selecting a better performing species in Pudukkotai district, Tamilnadu. for vermicomposting a thorough study was conducted to explore the efficiency of earthworms. During the present study earthworm species such as 1 *Eisenia Foetida* 2:*Eudrilus eugenae* 3: *Perionyx excavatus* were selected and inoculated to see their efficiency in reduction of organic waste materials. Vermicomposting of 90 days resulted both in large population size as well as higher decomposition of waste material. On the basis of C/N ratio and biomass potential it may be concluded that *Eisenia Foetida* will be utilized in vermi-technology as one of the important components of organic farming and sustainable agriculture in Pudukkottai district of Tamilnadu.

***Keywords*: biomass potential, Coccun, *Eisenia Foetida*, Earthworms, Vermicompost,**

1. Introduction

Earthworms belonging to Phylum Annelida, Class Chaetopoda, and Order Oligochaeta occupy a unique position in animal kingdom. Low level of soil fertility is one of the main constraints in boosting up agricultural production in India. The energy crisis in the country has resulted in a steep increase in the price of fertilizers which in turn hits the small and marginal farmers. Under such situation, recycling of organic waste is the only alternative for providing a renewable supplementary source of nutrients for crop plant in the countryside. In India crop residues, tree wastes, animal wastes, urban and rural wastes, agro industries by-products etc are the major manurial resources and can be converted into bio fertilizers if treated scientifically. Otherwise, these wastes pose environmental problems like foul smell, occupying large spaces, production of disease causing microbes and disease carrying vectors. Biological material like earthworm is a boon to minimize the pollution caused by mismanagement of these organic wastes by enhancing the process of degradation of complex substance Into usable form by plants and microbes It is essential to use appropriate species of earthworms in waste management. Importance of vermiculture dates back when Darwin [1] for the first time realized the role of earthworm in agriculture and called them as 'ploughman of the earth'. These vermiresources have vast and diversified potentials for waste recycled bio-fertilizer production, land reclamation, environmental detoxification and food sources. These bio- fertilizers can replace chemical fertilizer to considerable extent and create a better environment for the growth of plants. Vermi- technology has gained momentum in recent years due to its manifold benefits. It is an eco-friendly and cost effective technology using earthworms as bioreactors for converting organic materials into valuable compost. According to Sangwan *et al.* [2] the cost of crop production may be reduced significantly if vermicompost are integrated in nutrient management in agricultural field. Research on vermicomposting by using various wastes has been successfully going on throughout the world [3-16]. There are number of earthworm species present in the soil and among them indigenous species are better adapted to local area from the begning but exotic becomes acclimatized after many generations of repeated growing. So choosing a suitable earthworm species for that particular area is the first important step of any vermicomposting activity.

2. Materials and Methods

The vermicomposting experiment was conducted from August (2017) to August (2018) in rural area of Pudukkottai district, Tamilnadu, India. Goat dung was obtained from different animal farms of pudukkottai area and was air dried before use.

2.1 Collection of earthworms

Earthworms were collected from vermiculture farm at Sivagiri, karur District of Tamilnadu, India which due to cropping pattern comes under paddy- sugarcane belt region. The collected worms were washed with water, preserved in 4-10% formalin depending upon their size and were identified by Dr. Arockia Jhon paul, Assistant Professor, Department of Zoology, Arumugam pillai and Seethai ammal college, Thiruppathur, Sivagangai district , Tamilnadu, India. Earthworms were categorized according to their feeding habits before culturing in the laboratory

2.2 Preparation of vermibeds

Three different vermiculture sets were maintained by using three different earthworm species:1 *Eisenia Foetida* 2:*Eudrilus eugenae* 3: *Perionyx excavatus* . Efficiency of these species were evaluated by vermicomposting in circular plastic containers (28 cm diameter and 30 cm depth) using a mixture of organic wastes viz., goat-dung , kitchen waste and crop residue in equal proportion by weight. Kitchen waste and crop residues in the culture used were dried and chopped. The selected waste was then mixed in equal proportion. The main characteristics of vermibed was as follows pH, 8.2 ± 0.3; TOC, 24.48(%); TKN, 0.62(%); C/N ratio, 40.72; TP, 0.26 (%); K, 0.58(%)]. Experiment was conducted in triplicate for each species. Before introducing earthworm species culturing containers were given the base of 2cm pebble layer followed by 100gm of soil and 100gm of partially decomposed goat dung. Ten adult worm of each species were separately released above this layer. After that each container was filled with 1.5kg organic waste, and covered with moist jute bag. Each culture containers were kept inside vermiculture house (shaded place) at a temperature 27±3°C for 60 days well protected from predators and ants. Water was sprinkled on alternate days to maintain appropriate moisture content.

Parameters observed

After 60days vermicompost was prepared and total earthworms were counted. Efficiency of each species was determined based on waste mixture characteristics before and after vermicomposting, the parameters are pH, electric conductivity, organic carbon (OC), total kjeldhal nitrogen (TKN), organic matter, available phosphorous (P), exchangeable potassium (K) and C/N ratio using methods [17- 20]. Percent decomposition was also calculated as described by[21].and biomass potential, clitellum development and cocoon production were also taken into consideration for the assessment

2.3 Statistical analysis

One way ANOVA was done to determine any significant difference among the parameters analyzed in vermicomposting. Duncan multiple ranged test was performed as a post hoc analysis to compare the data. All the reported data are the mean of five replicates. All statements reported in this study are at the $P < 0.05$ levels.

3. Results and Discussion

Table 2 shows the various parameters studied during the vermiculture of three species belonging to different ecological categories. All the species showed different potential for the reduction of organic materials used**. pH**: After 90 days of vermiculture the end products from all treatments showed fall in pH value from its initial value. The pH was within the range of 6.7±0.03 – 7.4±0.07 which is within the optimal range for plant growth. There was decrease in pH from the initial alkaline condition towards slightly acidic. This may be due to mineralization of nitrogen and phosphorus into nitrates / nitrites and orthophosphates [22]. The pH values for each species varied significantly ($P< 0.05$). **EC**: All the three species revealed gradual increase in EC from initial value 1.6mS/cm to a range of 1.82 ± 0.05 – 1.72±0.08mS/cm in all the three species studied. This increase may be due to loss of weight of organic matter and release of different mineral salts in available forms [23]. There was no significant variation ($P< 0.05$) in EC for all the three species. **OC**: The reduction in organic carbon of the source was revealed in all the three species. The combustion of carboneous substance was enhanced by all the three species resulting in reduction of organic carbon 2.15, 1.81 and 1.4 times in final compost. Difference in organic carbon and organic matter in all the three species was observed which might be due to significant difference in decomposition percentage of the waste mixture and population build- up trend of the different species. in *E. foetida*, the maximum carbon reduction(2.15times) was obtained, followed by *Eudrilus eugenae* (1.81 times)and *Perionyx excavatus* (1.4 times). The difference in OC content at the end of experiment was significant ($P< 0.05$) for all the three species. The reduction in organic carbon was possibly achieved by respiratory activity of earthworms and microorganisms [23, 15].

TKN and C/N ratio: Total N content resulted highest amount in species 1 (2.11 fold increase in N and 4.96 times decrease in C/N ratio) whereas lowest was recorded in case of species3 (1.2 fold increase in N and 2.28 times decrease in C/N ratio) . The decrease in C/N ratio might be related to increase in earthworm population which led to higher rate of substrate utilization and rapid decrease in organic carbon. The release of CO_2 from carbon part in the process of respiration, mucus and nitrogen excrements, increase in the nitrogen level and decline in the C/N ratios [24-25]. C/N ratio is an important criteria of a good manure that can be easily assimilated by plants and should lie between 10 and 20 [26]. In our studies, the C/N ratios were found to be less than 20 Significant variation ($P< 0.05$) was seen in all the three. Populations build up being slower; C/N ratio remained at higher level in species 2 and 3. All these species are having different ecological categories and their size also limits their activity for decomposition. According to the classification given by Bouche [27] and Julka [28] epigeic species are litter dwellers and mainly feed on organic rich matter. They are very active and reproduce fastly. Present result supports the earlier observations. Whereas, endogeic species mainly form burrows, feed on soil and organic matter and are slow decomposers as compared to epigeic species.

TP and K: Vermicomposting accelerates the mineralization of metabolites and subsequently enriches the end product with more available form of soil nutrients. As data indicate TP and K content was highest in *E. foetida* followed by *Eudrilus eugenae* and *Perionyx excavatus*. The differences in both the contents obtained from different treatments were not significant (P< 0.05). Hatanaka *et.al* [29] stated that the ratio of organic matter and ash content were important factor to monitor whether composting process was completed or not, and this ratio should be approximately 2. Our data revealed that in case of *P. excavatus* ,ratio between organic matter: ash content is 2.3 conferred incomplete composting by this species, whereas in remaining treatments the value was below 2 suggesting completion of composting process.

Biomass potential: However, in our experiments, the biomass gain was observed to be highest in *Eisenia Foetida* followed by *Eudrilus eugena* and by *Perionyx excavatus*

biomass gain by *Eisenia Foetida* species was about 1.3 times higher than *Perionyx excavatus* This difference could be due to the difference in species morphology and food utilization ability.

clitellum development and cocoon production All individuals in all the three species developed clitellum before day 28(4th week0 and was found to be earlier (3rd week)in *Eisenia Foetida* . Cocoon production by earthworms was started by day 30 in *Eisenia Foetida* and the maximum number of cocoons was recorded in this species followed by the other two closely. In the number of cacoon production per worm also it is this Epigeic earth worm dominated the other two

4. Conclusion

On the basis of chemical analysis, and growth parameters, the present observations indicated that *E. foetida* were efficient species in performance over other species in terms of reduction of C/N ratio and increase in nitrogen content of vermibed (decomposition and mineralization)as well as in growth potential Epigeic worms are capable of converting all the organic waste into manure. Our result confirmed that the quality and composition of substrate influenced the efficiency of earthworms for composting process as well as their growth potentials

Table **1:** Chemical composition of vermiculture media before and after vermicomposting by three different species of earth worms :1 *Eisenia Foetida* 2:*Eudrilus eugena* 3: *Perionyx excavatus*

species	pH		EC		OC(g kg $^{-1}$)		TKN(g kg $^{-1}$)		C/N ratio(g kg $^{-1}$)		P(g kg $^{-1}$)		K(g kg $^{-1}$)		OM (g kg $^{-1}$)	Total ash (g kg $^{-1}$)
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	After	After
Eisenia Foetida	8.2	6.7±0.03	1.6	1.82±0.05	48.74	22.66±0	4.6	9.70±0.01	44.3	8.93±0.01	4.1	6.72±0.0	6.1	10.37±0.0	39.49±1	37.10±1
Eudrilus eugenae	8.2	6.9±0.02	1.6	1.76±0.04	48.74	26.92±0	4.6	7.22±0.03	44.3	12.65±0.03	4.1	6.23±0.03	6.1	9.63±0.1	47.76±0	41.53±0
Perionyx excavatus	8.2	7.4±0.07	1.6	1.72±0.08	48.74	34.73±0	4.6	5.52±0.02	44.3	19.42±0.03	4.1	6.06±0.01	6.1	9.27±0.1	63.27±0	27.11±0

Each value is the mean ± SE of five replicates.

Significant variance (P <0.05) two way analysis of variance (ANOVA) was applied in

Table 2: Growth potential and Cocoon production by three different species of earth worms :1 *Eisenia Foetida* 2:*Eudrilus eugena* 3: *Perionyx excavatus*

species	Biomass potential		Clitellum Development started in	total no. of cocoons pro duced after – 12 weeks	no. of cocoons produced / worm	no. of cocoons produced / worm / day
	mean initial weight / earthworm (mg)	Maximum Weight achieved / worm (mg)				
Eisenia Foetida	162±67	1194±145	3rd week	109±13.9	28.6±5.9	0.36±0.05
Eudrilus eugenae	152±40	996±108	4th week	97±10.3	19.4±2.3	0.24±0.03
Perionyx excavatus	160±29	954±94	4th week	89±12.7	16.8±3.1	0.22±0.03

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