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Research Article

FEASIBILITY OF VERMICOMPOSTING CORAL VINE (*ANTIGONON LEPTOPUS*) EMPLOYING THREE EPIGEIC EARTHWORM SPECIES

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ABSTRACT

The study on the vermicomposting of the plant, coral vine, in two forms fresh and soaked by three-epigeic earthworm species *Eudrilus eugeniae* Kinberg, *Eisenia fetida* Savigny and *Perionyx excavatus* Perrier is reported in this study. The semi-continuous mode of reactor operation was carried out. The performance of the reactor was evaluated by quantifying vermicast output, recording growth, and reproduction over the period of 150-day duration. The reactors operated sustainably with a steady increase of vermicast recovery, earthworm zoomass, and juveniles generated. In all the reactors, vermiconversion rate was marginally higher in reactors with the soaked form of feed than the fresh form of the feed. The maximum vermicast output was recorded in *E. eugeniae* followed by reactors with *E. fetida,* and *P. excavatus*: The change in zoomass also exhibited the same trend. There was no mortality in any of the reactors.

Keywords: Coral vine, Vermicast recovery, Zoomass, *Eisenia fetida,* Reactors.

INTRODUCTION

The common name of *Antigonon leptopus* Hook and Arn is a coral vine. It is a fast-growing, perennial, herbaceous vine, which can climb to 12 m (40 ft.) from tuberous roots and a slightly woody base (Langeland, 2008; Pichardo & Vibrans, 2009). Coral vine has invaded several parts of land in Asia and Africa (Raju *et al*., 2001). Its ability to flourish in all soil types and drought tolerance makes coral vine as a dangerous pest of many cultivated crops in anthropogenic habitats (Burke & DiTommaso, 2011). Coral vine is capable of producing a prolific number of viable buoyant seeds that disperse in the air and help the weed spread. Due to its aggressive growth, coral vine tends to overrun landmasses at the expense of vegetation (Burke & DiTommaso, 2011; Ernst & Ketner, 2007; Langeland, 2008).

The control measures of the coral vine are limited (Ernst & Ketner, 2007). Though a physical or mechanical method of control is methodical in holding the weed infestation in check; it is not helpful for the complete eradication. This is due to the persistent underground tubers and viable seeds, which are capable of sprouting again and resulting in spreading beyond its natural range (Burke & DiTommaso, 2011; Langeland, 2008; Raju *et al*., 2001). Likewise, chemical control is also an effective long-term approach to manage coral vine infestations, but herbicides that involved in managing coral vine might not be economically and environmentally acceptable if large areas require treatment (Burke & DiTommaso, 2011). There is no information found on biological means of controlling coral vine. Therefore, once the coral vine is established, it is hard to eradicate. Attempts have been made to utilize coral vine mostly as a food source and medicinal properties (Busch *et al*., 2003; Chistokhodova *et al*., 2002; Lans, 2006; Mamidipalli *et al*., 2008; Vanisree *et al*., 2008). Nevertheless, the utilizable quantities are small for these purposes, and even it is a region-specific utilization.

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A broad survey of the state-art-the-review disclosed that there is no study accounted on vermicomposting of coral vine.

Vermitechnology is an appropriate technology for handling of many biodegradable wastes through the activity of earthworms as the biological agent. Vermicompost is known to have a rich source of soil-friendly and plant-friendly microorganisms, hormones, and enzymes (Deka *et al*., 2011). Since earthworms' metabolism relies on carbon to the maximum extent, it sequesters nearly all the carbon from the substrate as an attractive feature in one among the various merits of vermicomposting option (Abbasi *et al*., 2014). The advantage of the use of weed phytomass as feedstock in vermicomposting is due to high productivity, free accessibility, and invasive attributes (Barney & DiTomaso, 2008). However, there is no recognized commercial facility available particularly to processes plant based organic wastes such as foliage, weed biomass, or crop directly in vermicomposting (Tauseef *et al*., 2014). In this paper, we report the efforts made to generate organic fertilizer from the coral vine by employing three earthworm species *E. eugeniae*, *E. fetida*, and *P. excavatus*.

MATERIALS AND METHODS

The epigeic species, *E. eugeniae*, has been used in Europe, and North America for vermicomposting of animal manure due to its appetite, high growth rate, and higher frequency of reproduction (Gajalakshmi *et al*., 2001). *E. fetida* is another epigeic species, which is peregrine and ubiquitous also, which can stand an extensive range of temperature and moisture (Domínguez, 2004). The third epigeic species of earthworm considered by us, *P. excavatus* is endemic in India (Ismail, 1997). However, it is prevalent in various other areas all around the world. The use of these earthworm species in other countries has also grown, but its commercial application so far has been confined to the vermicomposting of animal manure (Ismail, 1997; Kumar, 1994; Manna *et al*., 1997). Despite that these earthworm species are being utilized in laboratory studies to vermicompost plant phytomass like *Cymbopogon winterianus*, *Parthenium hysterophorus* by blending with animal manure (Deka *et al*., 2011; Vig *et al*., 2011; Yadav & Garg, 2011). These earthworm species have also been successfully utilized to vermicompost phytomass like *Eichhornia crassipes, Azadirachta indica, Mangifera indica*, and *Ipomoea carnea*, without any supplementation of animal manure (Gajalakshmi & Abbasi, 2004; Gajalakshmi *et al*., 2002, 2005; Gaur & Singh, 1995; Makhija *et al*., 2011).

Methodology

Vermireactors of diameter 35.5 cm, depth 8.5 cm, and volume 7.9 litres were employed. A 3mm thick and moistened jute cloth served as vermibed. Leaves of coral vine were procured manually from places close to the author's laboratory. They were water-washed to free them from adhering dirt. Each reactor was charged with 1.25 kg dry weight equivalent of coral vine. Twelve vermireactors of six sets were operated: In one set of reactors, the plant was used without any pre-treatment (the fresh form of feed) while, in another set of reactors, it was pre-soaked (soaked form of feed) for six hours before being charged. Each reactor was started after the introduction of 20 (16/ kg of feed) healthy adult earthworms of chosen species until the sixth run. At the seventh run, the number of earthworms was increased up to 50 (40/ kg of feed) to accelerate vermicast output. The earthworms were picked up randomly from the cultures maintained with cow dung. All vermireactors were kept at temperatures 30 ± 3 °C and their moisture content as maintained at 65 ± 5% (Gajalakshmi *et al*., 2005; Ganesh *et al*., 2009). Moistened jute cloth and nylon mesh were used to cover the vermireactor to ensure appropriate moisture, humidity, and protection from predators. Once in 15 days, the performance of vermireactor was evaluated based on the quantity of the vermicompost generated, zoomass gain and fecundity as detailed elsewhere. One-way ANOVA was used to find the difference between the performances of the reactors.

RESULTS AND DISCUSSION

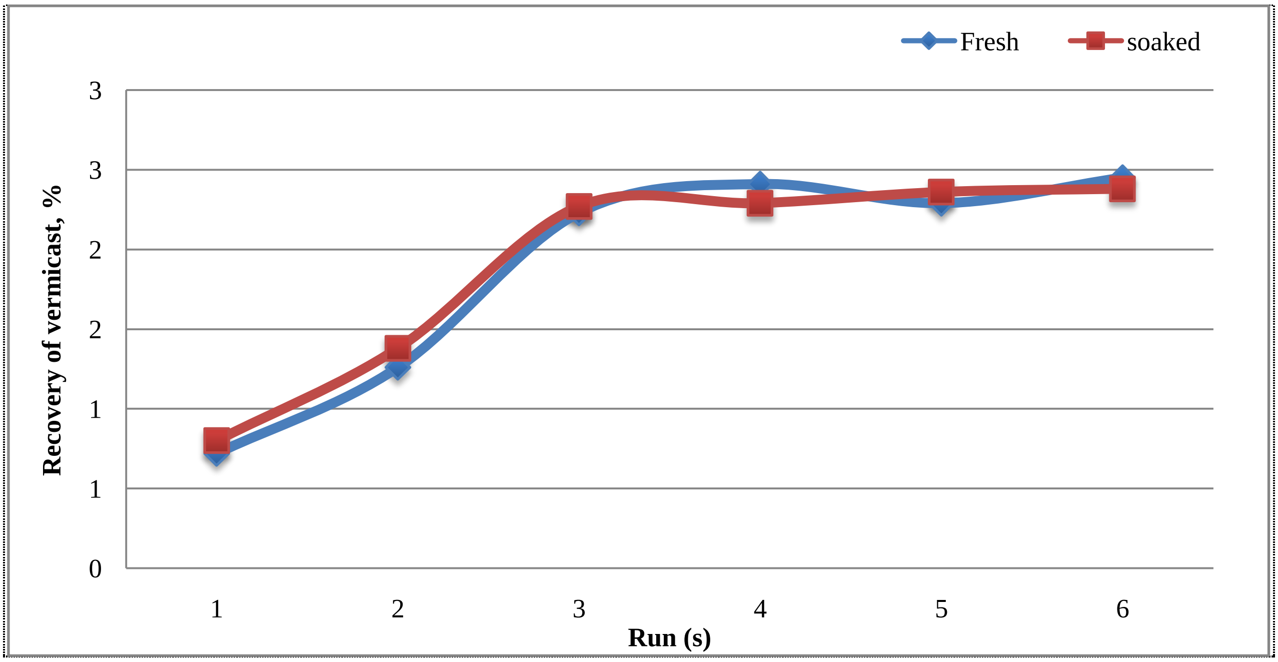
Vermicast recovery in reactors with *E. fetida, E. eugeniae,* and *P. excavatus* in fresh and soaked forms of the feed, as a function of time, is demonstrated in Figures 1 and 2. For the first two runs, the vermicast output was low, which was perhaps due to the introduction of earthworms in coral vine reactors, took some time to change over feed since it got cultured on cow dung as the main feed earlier. The vermicast output increased in the third run, further; the consecutive runs gave a steady recovery. The vermicast output is summarized in Tables 1 and 2. Regarding the efficiency of vermiconversion of the coral vine, in all cases, soaked form of the coral vine was processed slightly higher than the fresh form of the feed. The soaked form of the feed was pulpier than the fresh form of the feed, and this might be the reason for the earthworms to ingest swiftly. The steady and consistent vermicast produced from coral vine was *E. eugeniae* followed by *E. fetida* and *P. excavatus*. One-way ANOVA was carried to analyze the statistical difference between the vermicast output generated from reactors with different earthworm species, and the forms of the feed. Statistically, no significant difference was observed between fresh and soaked forms of the feed - $F (1, 118) = 0.178$, $P=.674$, and among different earthworm species-$F (2, 117) = 1.564$, $P = 0.214$ in vermicast production.

Table 1. Average vermicast production (g), in reactors charged with fresh or soaked forms of coral vine in reactors with earthworm number 16/kg of the feed.

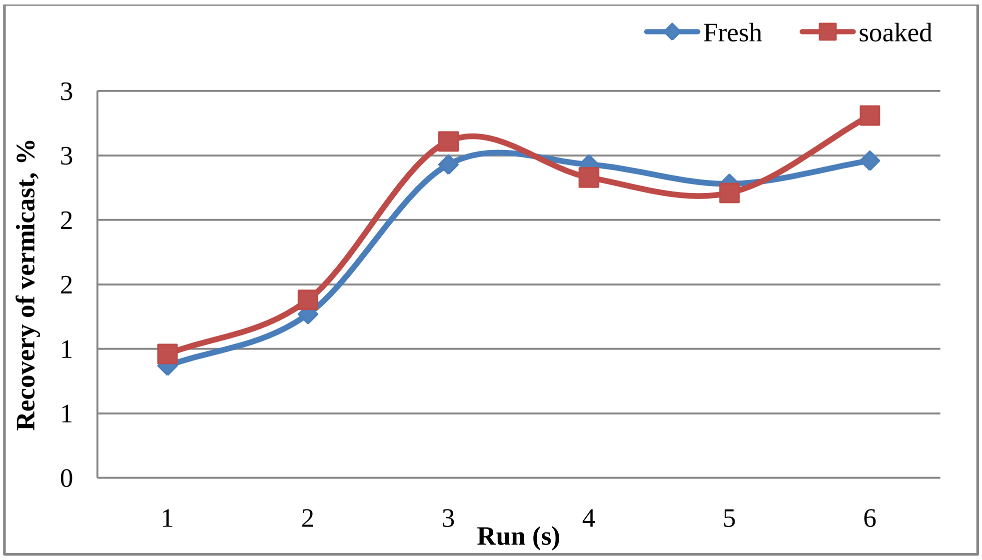
Days	Vermicast production, g (±SD)					
	E. fetida		*E. eugeniae*		*P. excavatus*	
	Fresh	Soaked	Fresh	Soaked	Fresh	Soaked
15	9.5±0.7	10.2±1.7	11.4±0.8	11.9±2.3	5.6±0.4	7.3±2.3
30	16.5±1.1	22.2±1.7	16.6±1	20.4±0.7	11.8±0.4	13.1±0.4
45	28.1±0.4	29±0.2	31.5±1.6	28.9	26.1±0.1	25.9±0.2
60	29.4±1.1	27.8±0.2	29.8±0.9	29.3±2.2	26±1.1	26.9±0.8
75	29.1±0.6	26.2±1.5	28.1±0.6	30.1±2.1	25.1±2.5	28.3±0.8
90	30.2±0.6	29.2±2.2	32.9±3.1	32.2±0.6	28.3±1.1	27.1±1.1

Table 2. Average vermicast production (g), in reactors charged with fresh or soaked forms of coral vine in reactors with earthworm number 40/kg of the feed.

Days	Vermicast production, g (±SD)					
	E. fetida		*E. eugeniae*		*P. excavatus*	
	Fresh	Soaked	Fresh	Soaked	Fresh	Soaked
105	55.9±0.2	53.1±1.3	58.7±1.3	59.9±1.4	50.2±0.8	50.3±2
120	56.4±1.4	59.5±2.7	59.5±2.7	64.3±4.2	47.3±6.2	51±2.8
135	54.7±1.5	66.1±2.7	63±0.2	61.6±0.9	50.4±0.1	53.6±1.4
150	62.2±2	59.3±2.8	58.8±5.4	63.6±2.2	47.6±5.1	53.9±2.2



(a)



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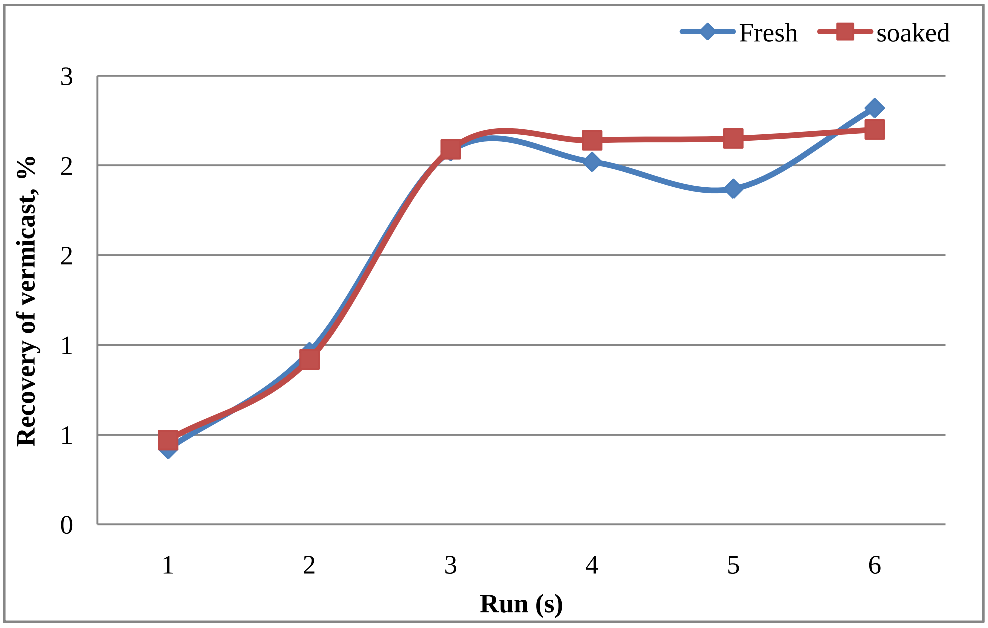

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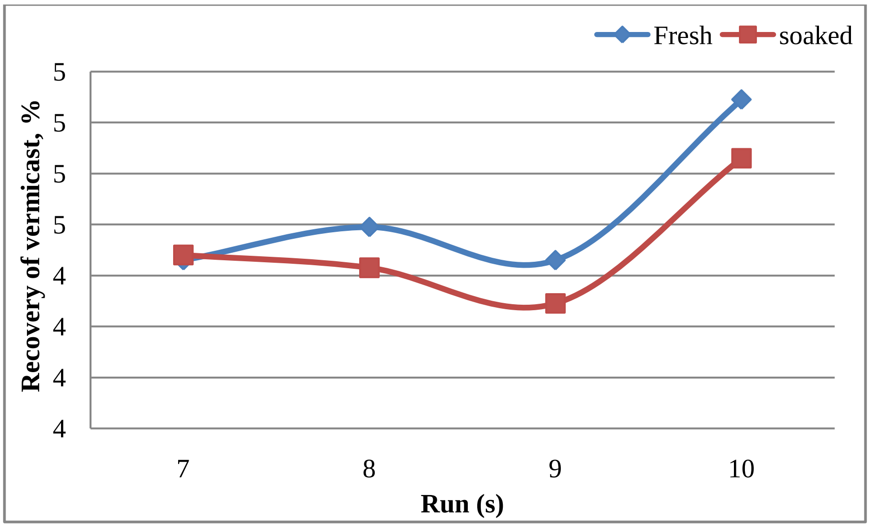
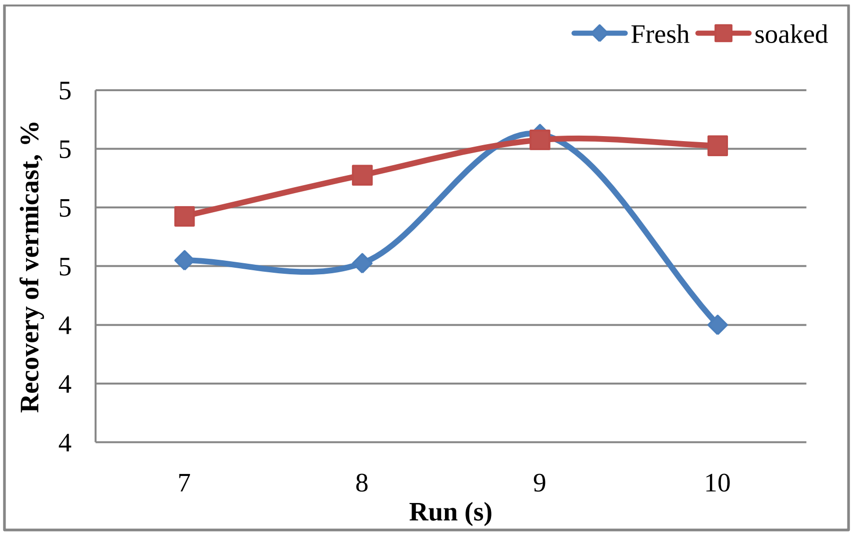
Figure 1. Vermicast as percentage of feed mass, in reactors with (a) *E. fetida*, (b) E. *eugeniae*, and (c) *P. excavatus* charged with fresh and soaked forms of coral vine in reactors with earthworm number 16/kg of the feed.

The change in zoomass, as a function of time, is presented in Table 3. Except *P. excavatus*, other species increased in zoomass from the first run itself. Further, in the successive runs, the zoomass of all three epigeic species gradually increased until the sixth run. On the seventh run, due to the further add-on of 30 new individuals of earthworm along with existing 20 individuals the drastic zoomass reduction was recorded, which reflected in per day per worm vermicast output (Table 2). However, it proceeded to increase in the consecutive runs and to fluctuate until the end of the experimental period (Table 3). The vermicast recovery is set to go on increasing till the earthworms attained the peak of vermiconversion . Thenceforth, the fluctuation in vermicast output was observed, as the number of earthworms that were used in the reactors had demonstrated potency in their active age (Table 1). As indicated in Table 3, *E. fetida* gained more zoomass than the other two species. The increase of zoomass in *E. fetida* was 131.3%, and 148.1%; in the case of *P. excavatus*, it was 128.1%, and 127.3% increase, and 125.6%, 118.9% increase in *E. eugeniae* with fresh and soaked forms of the feed respectively. The cocoon formation would take a large amount of the energy of earthworm. If the cocoon formation is not held, the energy will be spent on tissue formation (Chaudhari and Bhattacharjee 2002).



(a)



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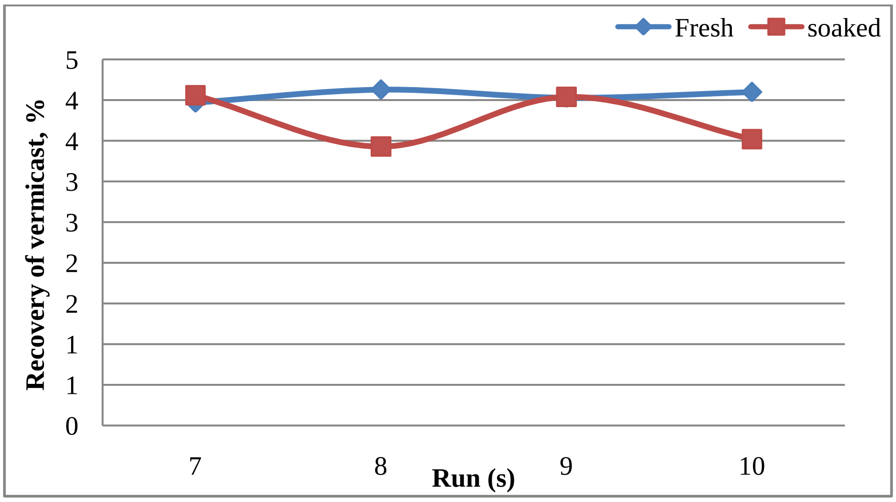

(c)

Figure 2. Vermicast as percentage of feed mass, in reactors with (a) *E. fetida*, (b) *E. eugeniae*, and (c) *P. excavatus* charged with fresh and soaked forms of coral vine in reactors with earthworm number 40/kg of the feed.

Table 3. Average zoomass gain (per earthworm) recorded in reactors charged with fresh or soaked forms of coral vine as feed.

Days	Zoomass (mg)					
	E. fetida		*E. eugeniae*		*P. excavatus*	
	Fresh	Soaked	Fresh	Soaked	Fresh	Soaked
Initial	299.5	258.0	1052.0	1099.5	304.3	299.3
15	309.3	260.3	1071.5	1104.8	303.3	299.0
30	329.0	266.8	1149.5	1161.0	322.8	314.8
45	357.8	287.3	1248.3	1246.0	340.3	339.0
60	385.3	313.3	1310.3	1330.5	359.5	367.0
75	400.5	328.3	1373.8	1366.5	374.5	382.8
90	411.8	342.8	1408.5	1413.0	395.0	396.0
105	333.9	321.5	1153.4	1131.4	321.0	315.8
120	360.3	348.6	1221.8	1184.0	344.3	340.2
135	380.6	371.1	1276.7	1257.5	370.7	362.0
150	393.3	382.1	1320.8	1307.8	389.7	380.9
Total zoomass gain	93.8	124.1	268.8	208.3	85.5	81.7

Reproduction was observed from all reactors (Figure 3). The trend for the juvenile production from various reactors is as follows, *E. eugeniae* > *E. fetida* > *P. excavatus* and *E. eugeniae* > *P. excavatus* >*E. fetida* in fresh and soaked forms of the feed respectively. The cocoon formation followed the trend *P. excavatus* > *E. eugeniae* > *E. fetida* in both fresh and soaked forms of the feed. The results (Figure 3) indicate that, the number of juveniles generated by *E. fetida*, *E. eugeniae*, and *P. excavatus* was 49, 59, 40 and 46, 61, 53; in case of cocoons, it was 79, 82.5, 113.5 and 70, 72, 94.5 in fresh and soaked forms of the feed respectively.

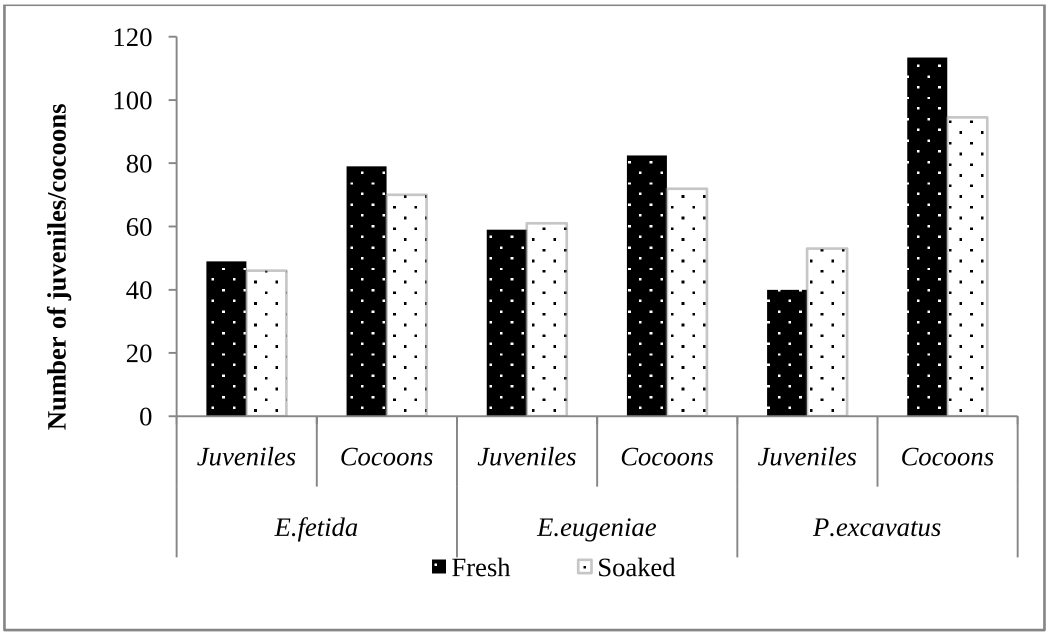

Figure 3. Number of juveniles and cocoons recorded in reactors with *E. fetida, E. eugeniae,* and *P. excavatus,* charged with fresh and soaked forms of coral vine as feed.

Direct vermicomposting was achieved in both fresh and soaked forms of feed, without supplementation of animal manure. Previously, (Gajalakshmi *et al*., 2002), and (Makhija *et al*., 2011), reported on vermicomposting *Eichhornia crassipes* in a fresh form of feed-inclusive of different other forms of feed, and *Ipomoea carnea* in a soaked form of the feed respectively. These studies revealed the steady increase of vermicast output, zoomass gain, and reproduction in epigeic species of earthworm. Moreover, *E. eugeniae* was found to be the favourite species of earthworm by vermicast production (Manna *et al*., 1997), as that of the finding of the present study.

CONCLUSION

Experiments were carried out to determine the vermicomposting potential of three epigeic species earthworms *E. eugeniae*, *E. fetida*, and *P. excavatus* fed with fresh and soaked forms of the coral vine, over a five-month span. The results show that, vermicomposting of coral vine demonstrated that with respect to the mass of vermicast generated in 15 days of the time of given feed rate, in all reactors, soaked form of feed was vermiconverted a bit quicker than the fresh form of the feed. The earthworm species that steadily generated more vermicast was *E. eugeniae* followed by *E. fetida*, and *P. excavatus;* the same trend was exhibited in the case of change in earthworm zoomass. In all reactors, animals grew, produced offspring, and survived in the test feed.

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