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Research Article

Comparison of Performance of Intra and Interspecific Earthworm Species in Vermicomposting Coral Vine (*Antigonon leptopus*)

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ABSTRACT

Three epigeic earthworm species *Eudrilus eugeniae, Eisenia fetida,* and *Perionyx excavatus* were utilized to understand the intra and interspecific competition for food and space by comparing the process efficiency of vermicomposting coral vine. Coral vine was subjected to vermicomposting directly without any supplementation of animal manure or any pre-processing. Over a period of 150-day pulse-fed operation, all the reactors fed with coral vine were sustainably vermicomposted with the increase in earthworm zoomass, and offspring generated. The most efficient production of vermicompost was achieved by *E. eugeniae* followed by other two species. There was no significant difference, statistically, in the reactor performance when two or three of the species were used together. Overall, it is affirmed that the interspecific population of earthworms has no perceptible advantage over intraspecific population in the vermicomposting of coral vine.

Keywords: Intra and Interspecific population; coral vine; *Eudrilus eugeniae; Eisenia fetida*; Waste utilization

INTRODUCTION

Antigonon leptopus (coral vine) is a perennial plant, cultivated as an ornamental plant for its beautiful flowers. However, which, when ignored, can grow rapidly over other plants, scattering and invading beyond its area of introduction. The Global Compendium of Weeds has added/declared coral vine as a dangerous troublesome weeds, and it has been observed to be one of most fast-growing weed in tropical and insular ecosystems [1-4].The control measures of the coral vine are limited [5].Though physical, chemical, and hybrid means of controlling are effective in maintaining the weed invasion check, it is not helpful for the sustainable eradication due to its environmental and economic constraints. Attempts have been made to utilize coral vine, mostly as a food source and medicinal properties [6-11]. Nevertheless, the utilizable portion and quantities for these purposes are limited, and even those options are region-specific. A broad survey of the state-art-the-review disclosed that there is no study reported on vermicomposting of coral vine.

Different species of earthworm naturally exist in an acre of land, each occupying/representing various niche as their habitat with different substrates as their feed [12]. Most vermicomposting experiments have used epigeic earthworm species of *E. fetida, E. eugeniae, and P. excavatus* because they possess higher vermicomposting potential, adaptability to various organic wastes and various environmental conditions than other earthworm species. Therefore, epigeic species as they share ecologically same niche and food preferences, it is possible that mixing of epigeic earthworm species in the vermicomposting process may achieve a greater stabilization than the reactor with single species alone. Also, their interaction in waste decomposing systems may have their impacts in waste minimizing efficiencies [12-14]. However, since the association diversity of earthworm species differs with habitat, climate, soil type vegetation, and food supply, the laboratory-based experimental results may not be extrapolated to the field population of earthworm [15-17].

In the earlier reports, single and multiple species were compared concerning vermistabilization process, physical, chemical and biological characterizations, microbial activities, substrate induced respiration, and dehydrogenase activity. By these findings, some authors have concluded multi-species earthworm can decompose organic matter more efficiently than the single-species earthworms [18-20]. However, some other authors have inferred multi-species earthworm did not exhibit any influence

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on single species earthworm in the vermicomposting process [12,18]. A broad survey of the state-of-the-art disclosed that there was no report that exists on the standard protocol on how to calculate the rate of vermiconversion of the feed getting converted to vermicast in a particular period [21].The literature on Vermicomposting of different phytomass into vermicast employing single species of earthworms abound with reports; however, there were no reports on vermicomposting of coral vine with various species of earthworms following an extensive survey.

The aim of the present work is to compare the three different epigeic earthworm species of *E. eugeniae, E. fetida,* and P. excavatus in vermicomposting coral vine in reactors with single species or combinations of two or three species.

METHODOLOGY

The effective volume of vermireactors was seven liters (diameter 30 cm, depth 9.7 cm). Vermibed was a 3 mm thick double layered moistened jute cloth. The coral vine plant was gathered physically from Auroville and adjacent regions: The collected plant was then shredded and water-washed to ensure the materials were free of any adhered particles. Each reactor, run in duplicate, was charged with 750 g dry weight equivalent of coral vine. Each reactor was commenced after the introduction of 90 healthy adult individuals of chosen species. Three epigeic species of earthworm were grouped to have seven combinations of the reactor in the equivalent number of earthworm species. The reactors were either alone with E. fetida or E. eugeniae or P. excavatus or with two species together and or with three species together. The earthworms were picked up randomly from the cultures maintained with cow dung. All vermireactors were maintained at temperatures 30 ± 3 °C and their moisture content as maintained at 65 ± 5% [22,23]. Moistened jute cloth and nylon mesh were used to cover the vermireactor to ensure appropriate moisture, humidity, and protection from predators. Each 15 days once, the performance of vermireactor was evaluated by separating the vermicompost and weighing it, as has been detailed elsewhere in the thesis. One-way ANOVA was used to find the difference between the performance of the reactors.

RESULTS AND DISCUSSION

The average vermicast output of the reactors for each run over five months is presented in Table 1. It may be seen that in three cases (9h run, with E. fetida reactor, and fifth run, with E. eugeniae, P. excavatus combination reactor, and fifth run, with E. fetida, P. excavatus combination reactor) the duplicates agreed to within ± 3.5 mg. The trend of vermicast recovery in a given time followed a consistent pattern in the case of all the 14 reactors (Figure 1). There was a slow but steady rise in vermiconversion from the beginning until two runs. After that, a plateau was reached and was maintained for over four months. This indicates that the earthworms, which had been reared on cow dung before they were transferred to the experimental reactors, took some time to adapt to the coral vine feed and, after the initial lag phase, have achieved a consistent rate of vermicast output. This indicates that the identical plateau has occurred in reactors where earthworm population was maintained with the initial number. (Table 2) reveals that the overall average vermicast recovery in reactors with single, and multi-species have an increasingly higher fraction of the coral vine is not having statistically significant difference from each other. The vermicast output, per earthworm, per day, as represent the steady-state conversion achieved from 45th day onwards. In reactors with single species, the vermicast output was 86.2 mg, 97.9 mg, and 72.9 mg from the reactors with E. fetida, E. eugeniae, and P. excavatus respectively. However, this indicates only a marginal difference with multi-species reactors. This is also confirmed by the one-way ANOVA results, which showed that the difference between single, and multi-species reactors ($F(6, 133) = 1.190$, $p = 0.316$) was not statistically significant. Overall, the steady and consistent vermicast output was achieved in reactors with *E. eugeniae* followed by *(E. fetida + E. eugeniae), E. fetida, (E. fetida + E. eugeniae + P. excavatus),(E. eugeniae + P. excavatus), (E. fetida + P. excavatus), and P. excavatus* (Figure 1).

Table 1: Vermicast as % of feed mass, in reactors with intra and interspecific earthworm species of *E. fetida, E. eugeniae, and P. excavatus* charged with coral vine as feed.

Days	Vermicast output %, (±SD)						
	E. fetida	*E. eugeniae*	*P. excavatus*	*E. fetida and E. eugeniae*	*E. eugeniae and P. excavatus*	*E. fetida and P. excavatus*	*E. fetida E. eugeniae and P. excavatus*
15	2.7 ± 0.2	3.1 ± 1.1	1.2	2.6 ± 0.2	2.5 ± 0.5	2.3 ± 0.4	2.9 ± 0.4
30	6.4 ± 0.6	5.3 ± 0.2	4.1 ± 0.3	6.0 ± 0.5	6.0 ± 0.7	4.6 ± 0.6	5.6 ± 0.7
45	12.9 ± 0.7	15.6 ± 0.3	12.8 ± 0.5	13.5 ± 1.4	13.5 ± 0.3	13.9 ± 0.4	12.8 ± 0.9
60	13.9 ± 1.4	15.8 ± 1.6	12.8 ± 1.8	17.2 ± 2.5	14.4 ± 1.3	15.5 ± 1.5	13.9 ± 0.3
75	17.8 ± 0.9	18.4 ± 1.4	12.8 ± 0.9	15.7 ± 2.6	13.6 ± 3.1	15.9 ± 3.5	17.7± 0.6

90	17.6 ± 2.6	18.0 ± 2.2	10.8 ± 0.4	16.7 ± 2.2	15.5 ± 1	14.5 ± 0.7	15.5 ± 1
105	14.6 ± 1.9	17.6±1.7	14.5 ± 1.9	15.4 ± 1.3	13.2 ± 0.4	15.1 ± 1.4	14.8 ± 0.9
120	14.9 ± 2.1	17.5	14.4±1.4	18.2 ± 1	16.3 ± 1.3	13.0 ± 0.3	11.6 ± 0.4
135	17.4 ± 3.5	18.3 ± 0.6	12.8 ± 1.4	13.5 ± 0.8	15.6 ± 1.2	13.8 ± 2.2	15.2 ± 0.4
150	14.9 ± 1	19.8	14.0 ± 0.8	16.3 ± 0.8	14.9 ± 1.5	14.5 ± 2.1	17.6 ± 1.3

Table 2: Average vermicast output (mg, d-1, worm-1), in reactors with intra and interspecific earthworm species of *E. fetida, E. eugeniae, and P. excavatus* charged coral vine as feed.

Days	**Vermicast output, mg day -1, worm-1**						
	E. fetida	*E. eugeniae*	*P. excavatus*	*E. fetida and E. eugeniae*	*E. eugeniae and P. excavatus*	*E. fetida and P. excavatus*	*E. fetida E. eugeniae and P. excavatus*
15	15	17.4	6.8	14.7	13.9	12.9	15.9
30	35.3	29.6	22.8	33.6	33.3	25.5	31.3
45	71.8	86.7	71.2	74.9	74.8	77.1	71.2
60	77.3	87.8	71.2	95.5	79.7	85.9	77
75	98.8	102.3	71.4	87	75.7	88.4	98.2
90	98	99.7	59.7	92.6	86.4	80.4	86.3
105	81.3	98	80.7	85.4	73.3	84.1	82.1
120	83	96.9	80.1	100.9	90.4	72.5	64.6
135	96.4	101.8	71.1	75	86.5	76.8	84.4
150	82.7	110.1	77.6	90.5	82.5	80.3	97.9
Average *	86.2 ± 10.3	97.9 ± 7.7	72.9 ± 6.8	87.7 ± 9.3	81.2 ± 6.3	80.7 ± 5.3	82.7 ± 11.8

Note: * Vermicast output average with standard deviation is based on the steady state conversion from 45th day onwards.

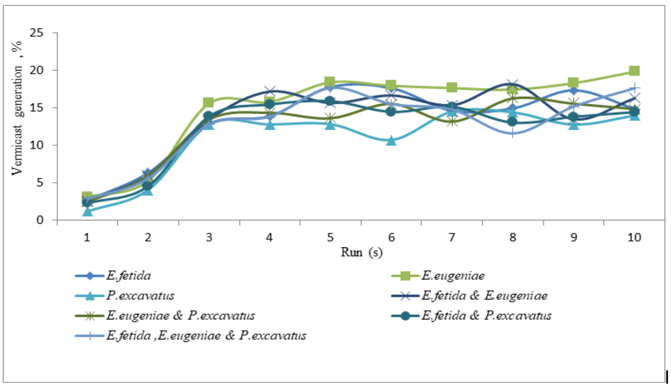

Figure 1: Pattern of vermicast generation as a function of time in coral vine-fed rvermieactors with intra and inter specific earthworm species.

Note: (-) *E.fetida*, (-)*E.eugeniae*, (-) *P.excavatus*, (-) E.fetida & *E.eugeniae*, (-) *E.fetida & P.excavatus*, (-) *E.eugeniae & P.excavatus*, (-) *E.fetida, E.eugeniae, P.excavatus.*

The earthworm zoomass increased over time in all the reactors. In the first run, there was no zoomass gain recorded in all reactors but in fact, there was a decrease in weight. Further in the successive runs, the zoomass increased linearly with time and grew in all the reactors during the 5-month operation (Figure 2). As Table 3 revealed, the reactor with E. fetida, and E. fetida + E. eugeniae recorded the maximum zoomass increase of 41 %. The zoomass gain followed the trend, *E. fetida* = *E. fetida* + *E.eugeniae* > *E. fetida* + *E. eugeniae* + *P. excavatus* > *E. eugeniae* = *E. fetida* + *P. excavatus* > *E. eugeniae* + *P. excavatus* > *P.excavatus* (Figure 2). Following this observation, there was noclear trend to connect the increase in zoomass and the rate of vermiconversion. However, the reactors with the combination of *E. fetida* + *E. eugeniae* earthworm species was found to be stable performers in both vermiconversion rate and zoomass gain.

Table 3: Change in zoomass (per worm), in reactors with intra and interspecific earthworm species of . fetida, . eugeniae, and P. excavatus charged with coral vine as feed.

Days	Zoomass gain, mg day -1, worm-1						
	E. fetida	*E. eugeniae*	*P. excavatus*	*E. fetida and E. eugeniae*	*E. eugeniae and P. excavatus*	*E. fetida and P. excavatus*	*E. fetida E. eugeniae and P. excavatus*
Initial	235.4	731.3	245.6	459.5	471.9	232.7	355.2
15	224.8	708.6	233.6	442.7	454.2	220.6	339.7
30	230.5	713.2	237.6	457.8	458.6	223.6	353.7
45	244.9	733.7	246.8	490.7	480.9	238.4	379.3
60	259.5	768.4	261.4	524.6	500.6	255.4	400.2
75	282.2	814.1	275.4	553.9	527.2	271.2	417.7
90	296.3	869.2	290.6	572.6	559.8	288.7	438.1
105	306.2	904.7	303.7	596.4	575.5	300.2	460.8
120	323.6	943.8	312.9	629.9	607.1	309.4	474.6
135	328.7	980.3	320.9	644.4	626.2	315.8	484.1
150	332.9	1001.8	324.6	648.9	640.2	319.7	494.9
Total zoomass gain (per worm)	97.4	270.4	79	189.4	168.3	87	139.7

All earthworm species reproduced successfully in the reactors (Figure 3). There was no discernable trend observed in both juveniles and cocoon formation vis-a-vis any earthworm species. The juvenile production in various reactors followed the trend *E. fetida + E. eugeniae + P. excavatus > P. excavatus > E. fetida + E. eugeniae = E. eugeniae + P. excavatus > E. eugeniae > E. fetida+ P. excavatus > E. fetida.* For cocoon formation, the trend followed was *P. excavatus >E. eugeniae = E. fetida + P. excavatus*

> E. eugeniae + P. excavatus > E. fetida + E. eugeniae + P. excavatus> E. fetida > E. fetida + E. eugeniae (Figure 3). The performance of P. excavatus, as per experimental data, was shown to be the least producer of vermicast and less in zoomass gain except in the case of reproduction, it was highly productive when the species is present alone in the reactor or any one of the combinations (Figure 3). Moreover, E. eugeniae was the best performer in both situations, whether it is present alone or in one of the combination.

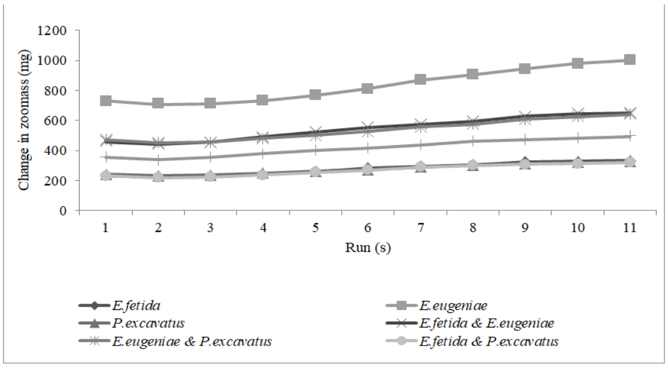

Figure 2: Change in zoomass (per worm) in coral vine-fed vermireactors with intra and inter specific earthworm species.

Note: (–) *E. fetida*, (–) *E. eugeniae*, (–) P. excavates, (–) *E.fetida & E.eugeniae*, (–) *E.fetida & P.excavatus*, (–) *E.eugeniae & P.excavatus.*

There was no mortality in any of the reactors. All reactors observed to have a good growth of earthworms, and they reproduced well to different degrees. These observationsconfirm that all three epigeic species (E. *fetida*, *E. eugeniae, and P. excavatus*) can be utilized to vermicompost sustainably coral vine in semi-continuously fed reactors with single, and multi-species.

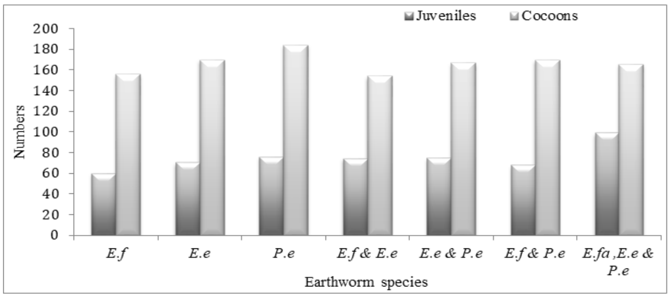

Figure 3: Number of juveniles and cocoons recorded in reactors with intra and interspecific earthworm species of E. fetida, E. eugeniae, and P. excavatus charged with coral vine as feed.

Earlier [12] have reached similar conclusion on the study with multi-species performance as one among the factor that affects the vermistabilization process with municipal sludge using three epigeic species E. eugeniae, E. fetida, and P. excavatus. Also, [24] reported, multispecies did not necessarily increase waste to vermicast. These reports uphold the fact that there were any obvious advantages in the performance of multispecies over single species [25,26].

SUMMARY AND CONCLUSION

The study objective was to compare single and multiple species of earthworm in vermicomposting coral vine as a feed to evaluate the earthworm performance in terms of vermiconversion, zoomass gain, and fecundity. The three-epigeic species that were employed were E. fetida, E. eugeniae, and P. excavatus. The results indicated that the vermiconversion efficiency of feed (as observed from the mass of vermicast generated in 15 days of the time of given feed rate), in every instance in which, P. excavatus was present alone or in one of the combinations seemed to have reduced. The reactors with E. eugeniae enhanced the reactor performance in which the combination of *E. fetida* + *E. eugeniae* was the most successful pair in vermiconversion of the coral vine as feed. The zoomass of all three epigeic species was increased over time. The best growth was achieved in reactors with *E. fetida,* and *E. fetida* + *E. eugeniae* combinations. The total zoomass-gain between single and multi-species reactors did not reflect any perceptible correlation. All earthworm species successfully reproduced in the reactors. The highest cocoon formation was observed in reactors with P. excavatus alone, or in combination with other species. In the case of juvenile production, the trend is not discernable, however; the reactors with *P. excavatus* + *E. eugeniae* combination had the maximum number of juveniles. From the present studies, it could be concluded that both single and multi-species reactors showed a similar performance in terms of vermiconversion, growth, and reproduction. In the case of multi-species reactors, there were no significant advantages observed over the reactors with single species in terms of vermicast production, growth, and reproduction. Moreover, in almost all instances, no significant difference was ($p= 0.316$)observed between single, and multi-species reactor as per One-way ANOVA. This concludes that the performance of multi-species in vermicomposting coral vine is not considerably imperative against the performance of single earthworm species. However, comparing both inter and intraspecific population of earthworms for their performances may be varied under the influence of substrates, temperature, and moisture.

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