

Eudrilus eugeniae is used in a semi-continuous reactor to vermicompost different types of weed (*Salvinia Molesta*).

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Abstract

(Purpose) Three types of *Salvinia molesta* were fed to various vermireactors during ten months of trials: (a) whole plants, b) shredded plants, and c) dried in sunlight plants (for twenty-four hours). There were two modes of operation for the reactors: batch and semi-continuous. **(Outcomes)** The tests identified two distinct patterns. (i) Compared with batch reactors, semi-continuous vermireactors produced better vermicast yields, earthworm growth, and reproduction; (ii) *Eudrilus eugeniae* preferred sun-dried *salvinia* as their primary feed source.

(Conclusions) The highest vermicast production (60.5%) and highest earthworm zoomass (75.2%) were obtained using sun-dried plants as feed, which was subsequently followed through shredded and whole weed in semi-continuous vermireactor operations. None of the reactors had any fatalities. Therefore, the results of the experiments verify that *S. molesta* and *E. eugeniae* can be vermicomposted sustainably in any of the forms..

Keywords: *Eudrilus eugeniae*; *Salvinia molesta*; Vermicompost; PDCR; Batch

1. Introduction

According to estimates, aquatic weeds are present in roughly half of India's freshwater systems. One of the fastest-growing aquatic weeds in the world, *Salvinia molesta* can double in size in two to twelve days. This can have a disastrous effect on water resources, both in terms of quantity and quality. For example, it can reduce the amount of water that inland water stocks can store by using it for both growth and evapotranspiration. Furthermore, *salvinia* mats obstruct sunlight before it reaches the water and inhibit the natural water current, resulting in stagnation. decaying, encouraging the growth of snails and mosquitoes while inhibiting the growth of fish As a result, the dead weeds and rot become unsightly, and the ecosystem of the sound-aerated water begins to deteriorate, encouraging the growth of disease spreading insects and inhibiting the growth of fish. (Abbasi, 1998; Lancar and Krake, 2002).

The majority of the world's water surfaces are home to aquatic weeds: *S. molesta* and *Eichhornia crassipes*, sometimes known as water hyacinth. One of the most pervasive and annoying weeds in the world, water hyacinth appears to be losing its habitat to *salvinia* in many areas. In fact, *salvinia* has earned a spot as "the world's worst weed" in the official Guinness Book". (Abbasi, 1998, Bioinvaders, 2002).

It is unlikely for a casual observer to believe that *salvinia* can displace water hyacinth. However, *salvinia* has done precisely this in Goa, Kerala, Andhra, Tamil Nadu, and many other places throughout the world. (Abbasi, and Nipaney, 1984; Bioinvaders, 2002; NSW, 2006; Varshney and Babu, 2008).

Humanity has attempted a wide range of strategies in an attempt to defeat aquatic weed species. These consist of mechanical removal, biological control, and various forms of chemical spraying. Although pesticides kill weeds, they harm all plants they come into contact with. They also pose a serious health risk because they are highly costly and pollute the water. Mechanical removal techniques are expensive and ineffectual because they do not completely eradicate the problem because reinfestation happens quickly. Finding an animal that can eat weeds faster than they

can grow has been a major endeavour, as biocontrol is thought to be one of the least expensive and safest methods. (Abbasi, 1998; Bioinvaders, 2002; Lancar and Krake, 2002).

A 1981 article in "Nature" claimed that the Australian lake Monderra salvinia mats were thwarted by the beetle *Cyrtobagous singularis*. But when the beetle has been active elsewhere, it has never proved as successful. The main danger associated with biocontrol was the beetle's explosive self-population in ideal circumstances (Thomas and Room 1984; Abbasi, 1998). There exist several reports regarding the potential application of *Salvinia molesta*. These consist of producing biogas, paper, mulch, ruminant fodder, handicrafts, and paper (Ad Hoc Panel, 1976; Howard and Harley, 1998). The salvinia's most favourable evaluation is negligible in comparison to the harm and financial losses they inflict. These methods, however, never make up for the overall risks associated with this weed.

As a result, we offer research on how well the earthworm *E. eugeniae* produces vermicast from diverse vermireactors that are fed varied kinds of salvinia. After the aquatic weed passes through the earthworm's digestive system, it loses its capacity to reproduce asexually or sexually, as the authors had previously noted (Abbasi et al., 2000). Farmers also highly value vermicast as a soil conditioner. Therefore, vermicomposting seems to be a very advantageous choice for both the long-term use of weed and its disposal. (Gajalakshmi et al., 2002).

2. Materials and Method

Because of its enormous appetite, rapid growth, and capacity for reproduction, the *E. eugeniae*, Kinberg worm is a common vermicomposting worm in North America and Europe.

It was introduced to India with the aim of expediting the process of vermicomposting animal manure and diverse types of biomass.

(Ashok Kumar, 1994; Ismail, 1998).

2.1. Vermireactors

Vermireactors were made of round plastic containers with a volume of 7 l, a diameter of 16 cm, and a depth of 8 cm. A double layer of wet jute cloth served as the vermibed surface, onto which 100g of dry weight salvinia was deposited. Twenty adult, healthy *E. eugeniae* were added into each reactor. Temperature and moisture levels were maintained in the same conditions for each reactor. (Abbasi et al., 2002).

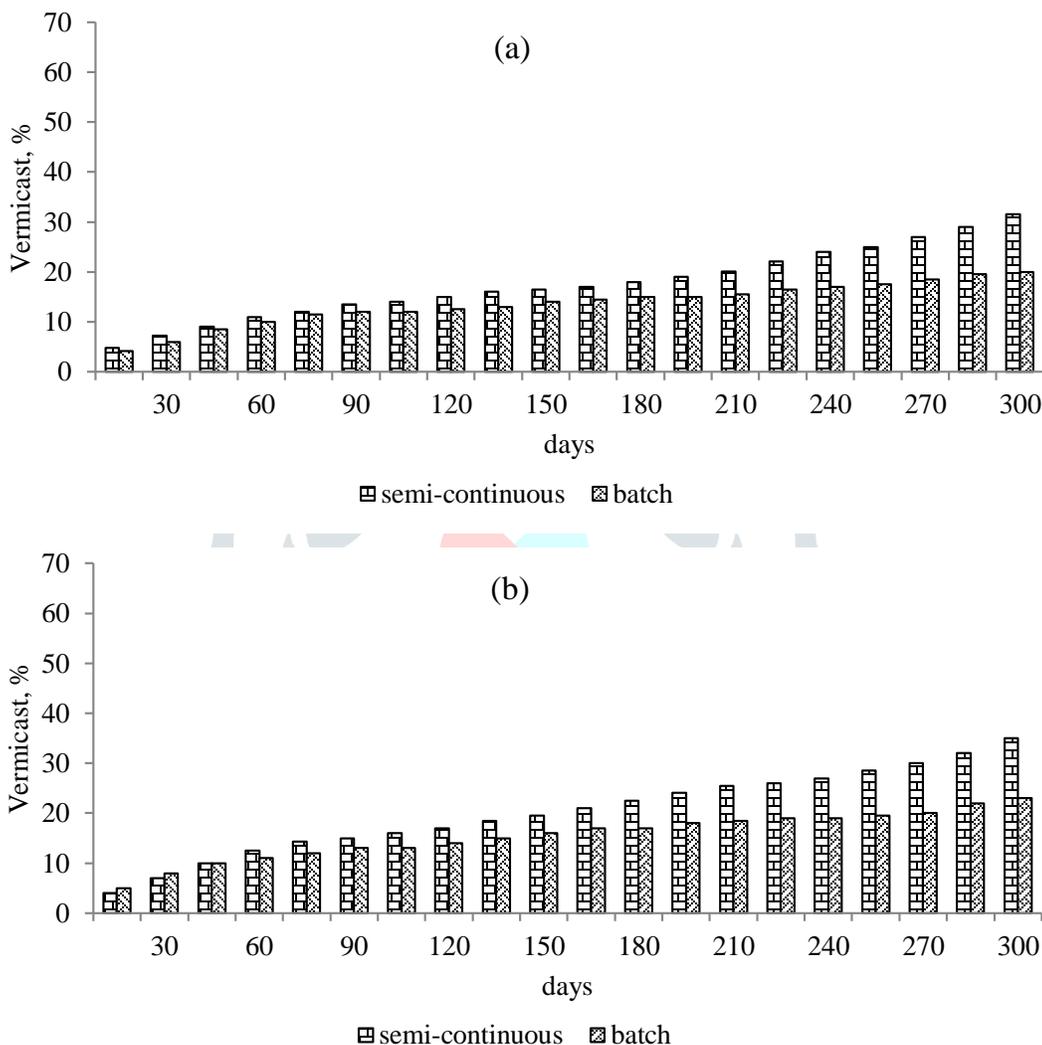
Batch and pseudo discrete continuous reactor (PDCR) were the two modes of operation for the reactors. Although the operation is not truly continuous, PDCR creates the illusion of an uninterrupted reactor operation. Its reactors start out with a fixed amount of adult earthworm population and substrate. Following a period of fifteen days, the contents are extracted, and measurements are made regarding the degree of vermicast conversion of the substrate, the adult earthworms' altered biomass, and the fecundity (measured by the quantity of juvenile and cocoons produced).

In a matter of moments, the vermi-reactors are reactivated using new substrate and the original adult earthworms. This allows the quantity of vermicast output per adult earthworm to be recorded as a function of duration. The impact of events other than the earthworms' ingestion is reduced by eliminating unconsumed substrate, which would then biodegrade even in the absence of the earthworms' activity. Also, just like in a vermireactor that is genuinely continuous, the earthworms are constantly feeding on almost fresh substrate. Furthermore, young animals that are produced can also be dampened in their influence on reactor performance, since they are taken out before they become large enough to consume large amounts of substrate.

The same amount of feed and earthworm density were used to start batch reactors as well as PDCR reactors. The vermicast was taken out and quantified once every fifteen days. The total number of juveniles or cocoons developed and the zoomass of the "parent" earthworms were measured. There was no introduction of new feed.

3. Results and discussion

Figure 1 shows that after more than ten months of nonstop operation, all of the vermi-reactors supplied with various types of salvinia were performing better and better in terms of casting production.



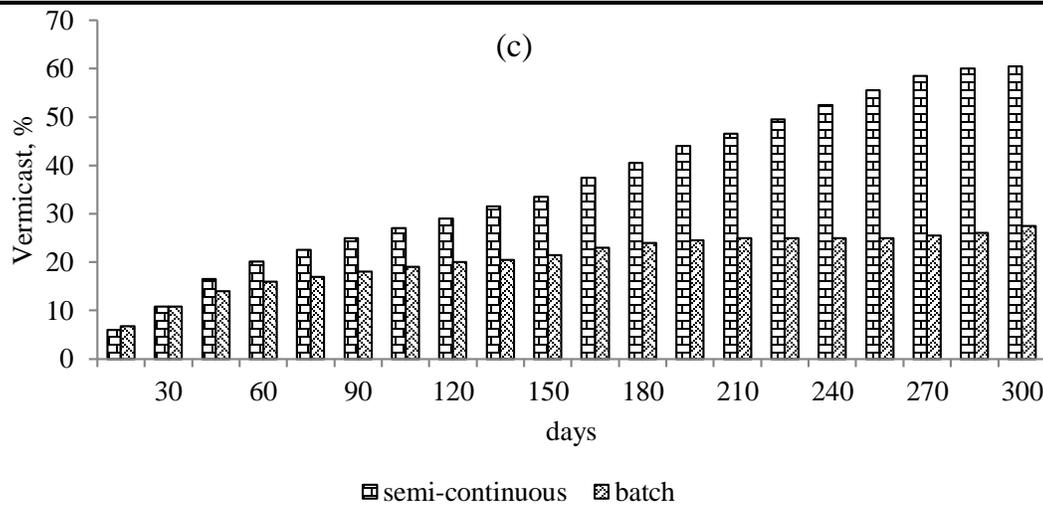


Figure1. Vermicast output, expressed as a percentage of feed volume, in reactors using one of the following salvinia types: fresh whole, chopped, or sun-dried.

Both the worms' growth and vermicast output were slow at the first three fortnights of operation. The worms had clearly taken a while to adjust to the new diet because they had been raised to young adulthood on cow manure feed prior to being placed in the reactors that were primarily fed salvinia. Following that, salvinia caused the worm activity to become notably rapid (Abbasi et al., 2001).

An intriguing discovery is that vermicast was produced more easily from sun-dried salvinia plants than from chopped or whole plants. The earthworms also gobbled up the sun-dried form. Because the dried plants become more flimsy and easier for the worms to ingest than the tougher and more tensile plants, earthworms are capable of to feed on dried weed more readily than fresh form. Vermireactors using water hyacinth showed the same pattern. (Gajalakshmi et al., 2002).

a) fresh whole				
Reactor mode	N	Mean	Std. Deviation	Std. Error Mean
Semi-Continuous	20	20.2400	7.25189	1.62157
Batch	20	12.2100	4.09183	.91496

b) chopped				
Reactor mode	N	Mean	Std. Deviation	Std. Error Mean
Semi-Continuous	20	19.7700	8.36195	1.86979
Batch	20	13.8300	4.00120	.89469

c) sundried				
Reactor mode	N	Mean	Std. Deviation	Std. Error Mean
Semi-Continuous	20	20.2400	7.25189	1.62157
Batch	20	12.2100	4.09183	.91496

a) fresh whole				
Reactor mode	N	Mean	Std. Deviation	Std. Error Mean
Semi-Continuous	20	20.2400	7.25189	1.62157
Semi-Continuous	20	24.4950	11.96501	2.67546
Batch	20	17.2050	6.73213	1.50535

Table 1. Vermicast production, group statistical analysis in reactors using a variety of salvinia preparations, including chopped, sun-dried, and fresh whole.



a) Fresh whole

Equal variances	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Assumed	4.035	.052	4.313	38	.000	8.03000	1.86189	4.26079	11.79921
Not assumed			4.313	29.985	.000	8.03000	1.86189	4.22742	11.83258

b) Chopped

Equal variances	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Assumed	10.729	.002	2.866	38	.007	5.94000	2.07282	1.74379	10.13621
Not assumed			2.866	27.267	.008	5.94000	2.07282	1.68887	10.19113

c) Sun Dried

Equal variances	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Assumed	9.358	.004	2.375	38	.023	7.29000	3.06988	1.07536	13.50464
Not assumed			2.375	29.934	.024	7.29000	3.06988	1.01989	13.56011

Table 2. Vermicast output and independent sample testing in reactors running on various salvinia species fresh whole, chopped, and sun-dried

In the 20th run of the reactor, which was run in semi-continuous mode, the highest vermicast yield of 60.5% was obtained from sun-dried plants, then followed by shredded and whole plants.

a) Fresh whole

Reactor mode	N	Mean	Std. Deviation	Std. Error Mean
Semi-Continuous	20	3.1050	2.63947	.59020
Batch	20	1.8450	1.95488	.43712

b) Chopped

Reactor mode	N	Mean	Std. Deviation	Std. Error Mean
Semi-Continuous	20	4.4315	2.83229	.63332
Batch	20	1.8850	2.44094	.54581

c) Sun-dried

Reactor mode	N	Mean	Std. Deviation	Std. Error Mean
Semi-Continuous	20	4.5115	3.85682	.86241
Batch	20	2.9200	2.95111	.65989

Table 3. Variation in zoomass and group statistical analysis in reactors using various salvinia types fresh whole, chopped, sun-dried, and

Equal variances	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Assumed	2.340	.134	1.716	38	.094	1.26000	.73445	-.22682	2.74682
Not assumed			1.716	35.023	.095	1.26000	.73445	-.23098	2.75098

Equal variances	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Assumed	1.031	.316	3.046	38	.004	2.54650	.83606	.85398	4.23902
Not assumed			3.046	37.190	.004	2.54650	.83606	.85277	4.24023

Equal variances	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Assumed	.469	.498	1.466	38	.151	1.59150	1.08591	-.60681	3.78981
Not assumed			1.466	35.569	.152	1.59150	1.08591	-.61176	3.79476

Table 4. Zoomass shift, Independent Samples Tests in reactors using various salvinia species fresh whole, chopped, sun-dried, and

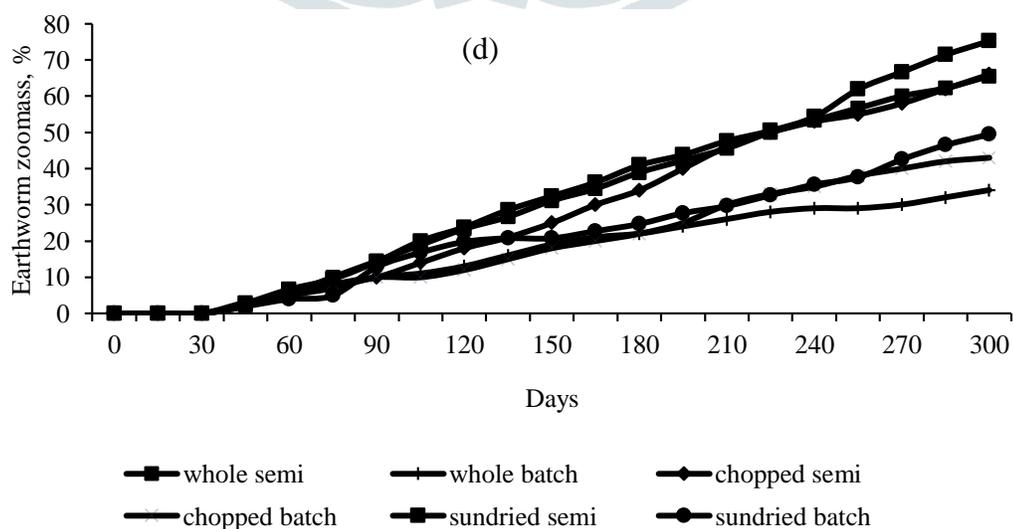


Figure2. Variations in earthworm zoomass over time in reactors using various salvinia types

Worm zoomass increased in most of the runs in reactors provided with sun-dried plants, but it increased more slowly in reactors fed with shredded and whole plants.

Table 5. Number of progeny generated in reactors supplied with various salvinia species

days	whole		chopped		sundry	
	semi	batch	semi	batch	semi	batch
0	0	0	0	0	0	0
30	0	0	0	0	0	0
60	3	0	0	0	2	0
90	4	0	0	0	4	1
120	5	3	4	0	7	8
150	4	3	3	3	6	2
180	7	5	6	4	3	5
210	6	7	9	1	5	4
240	5	6	11	3	9	1
270	8	3	5	5	15	5
300	7	9	9	6	11	8
	5	3	7	5	15	9
	5	2	9	4	16	9
	8	5	5	7	12	4
	7	6	11	7	9	3
	8	6	10	3	12	7
	9	7	13	7	22	12
	11	8	15	9	25	15
	13	10	16	11	17	9

Reactor earthworms operating in both modes regularly produced progeny (Table 2). More cocoons and hatchlings were produced in reactors supplied with dried in sunlight form and running in semi-continuous mode than in the remaining reactors.

4. Conclusions

The earthworm species *E. Eugeniae* performed better in the reactors' vermicast output when they were run in semi-continuous mode as opposed to batch mode.

None of the reactors supplied with various strains of salvinia showed any mortality. The earthworms proliferated and created young. These findings support the use of the epigeic earthworm *E. Eugeniae* in vermicomposting various salvinia species in a sustainable manner.

Salvinia plants that had been sun-dried vermicomposed more readily than those that had been shredded and whole.

Competing interests

The authors declare that they have no competing interests

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