

Efficiency of *Eudrilus eugeniae* Kinberg in vermicomposting three different forms of salvinia (*Salvinia molesta*, Mitchell)

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Abstract

Purpose: Ten-month long trials were conducted on different vermireactors fed with one of the following forms of *Salvinia molesta*: a) fresh whole plants, b) chopped plants, and c) sun-dried plants (24 h).

Method: The reactors were operated in two modes—semi-continuous and batch.

Results: The experiments revealed two clear trends (i) vermireactors operated in semi-continuous fashion performed better in terms of vermicast yield, earthworm growth and reproduction compared to batch reactors, (ii) sun-dried salvinia was the most preferred form of feed by *Eudrilus eugeniae*.

Conclusions: The maximum vermicast output (60.5%) and increase in earthworm zoomass (75.2%) had been achieved from sun-dried plants as feed followed by chopped and whole plants in vermireactors operated in semi-continuous mode. There was no mortality in any of the reactors. Thus, the experiments confirm that *S. molesta* can be sustainably vermicomposted in any of the forms with *E. eugeniae*.

Keywords: Vermicomposting; *Eudrilus eugeniae*; Vermicast; *Salvinia molesta*; Vermireactors

1. Introduction

It has been estimated that about half of the total fresh water systems in India are infested with aquatic weeds. *Salvinia molesta* is one of the rapid growing aquatic weed of the world grow up double in 1.5 to 11.6 days. Mitchell [16]; Lancar [14]; Ganesh kumar [9], which cause an enormous wreck to the water resources – in terms of quality and quantity, such as, shrinking the storage capacity of inland water stocks by consuming it for their growth as well as evapotranspiration. In addition, the mats of salvinia suppress the normal movement of the water body, causing stagnation and impede the sunlight before reaching the water. Due to this, the rot and dead weeds becomes unpleasant and the sound-aerated water ecosystem starts turning into decay – boosting mosquitoes and snails and discouraging fish growth. Ganesh kumar [10] Howard and Harley [12].

Two aquatic weeds which have gathered the majority of water surfaces in the world are *Eichhornia crassipes* (water hyacinth) and *S. molesta*. Water hyacinth is one of the most widespread and obnoxious weed of the world but in many regions it seems to be losing habitat to salvinia. Indeed salvinia has moved even into the Guinness Book of World Records as 'the world's worst weed'. Ad Hoc Panel [2].

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A lay observer may never trust that salvinia can jostle out water hyacinth. Yet, this is exactly what salvinia has done in Kerala, Andhra, Tamil Nadu, and Goa in India and many other parts of the world. Ad Hoc Panel [2]; Ashok Kumar [3].

To achieve success in the battle against aquatic weed species, the human being has tried a long and varied list. They include chemical spraying of all manner, mechanical removal, and biological control. Pesticides do kill the weeds but damage any vegetation they touch. Furthermore they are very expensive and they pollute the water, thus establishing a major health hazard. Mechanical removal methods are costly as well as ineffective because reinfestation occurs vigorously, thus does not eradicate it. Biocontrol is considered to be the safest and cheapest approaches and significant efforts have been made to find the animal which can consume the weeds quicker than the latter can grow. Bioinvasors [4]; Gajalakshmi [5].

In 1981 an article published in 'Nature' reported that the beetle *Cyrtobagous singularis* thwarted salvinia mats of Lake Monderra, Australia. However the beetle has never been as successful when but in action elsewhere. The major risk with biocontrol was that beetle populates themselves explosively under favorable conditions. Thomas and Room [16]; Varshiny [17]. A number of reports are available on the possible method of utilization of *Salvinia molesta*. These include use as mulch, fodder for ruminants, paper making, handicrafts and biogas generation. Ad Hoc Panel [2]; Howard and Harley [12]. The most positive assessment of utilization of salvinia is very little compared with the damage and fiscal losses that they cause. However, these practices never compensate for this weed's overall jeopardy impacts.

Thus, we present studies on the performance of the earthworm, *E. eugeniae* in generating vermicast from different vermireactors fed with various forms of salvinia as feed. The authors had earlier observed. Abbasi [1], that the aquatic weed loses its ability to reproduce vegetatively or sexually after it has passed through the earthworm gut. Also, vermicast is very popular as soil conditioner among the farmers. Hence, vermicomposting appears to be a highly favorable option for not only a large-scale utilization of weed, but also for its final disposal. Gajalakshmi [6].

2. Material and methods

The epigeic *E. eugeniae*, Kinberg is a manure worm which has been widely used in North America and Europe for the purpose of vermicomposting, as it exhibits voracious appetite, high rate of growth, and reproductive ability.

It was brought to India to accelerate the application in the vermicomposting of animal waste and various form of biomass. Ashok Kumar [3]; Ismail [13].

2.1. Vermireactors

Circular plastic containers (volume 7 l, diameter 16cm, depth 8cm) were used as vermireactors. Double layer of moist jute cloth was used as vermibed and 100g of salvinia (dry weight) was placed on it. In each reactor, 20 healthy, adult individuals of *E. eugeniae* were introduced. All the reactors were maintained in an identical environment with respect to temperature and moisture. Gajalakshmi [5;6].

The reactors were operated in two modes: pseudo discretized continuous reactor operation (PDCOP) and batch. PDCOP enables an operation which is not really continuous but creates an ambience of a continuous reactor operation. In it, the reactors are started with a certain fixed quantity of substrate and population of adult earthworm. After 15 days, the contents are removed and the extent of conversion of the substrate to vermicast, change of zoomass of the adult earthworms and fecundity (in terms of number of juvenile and cocoons generated) are quantified.

Within minutes, the reactors are restarted with fresh substrate and the same adult earthworms that were employed initially. In this way, it is possible to record the rate of vermicast production per adult earthworm as a function of time. By removing unconsumed substrate—which would otherwise biodegrade even without the action of the earthworms—the impact of happenings other than ingestion by the earthworms is minimized. Also, the earthworms are always grazing upon nearly fresh, substrate as they would have in a truly continuous vermireactor. Additionally, since the juveniles that are produced are removed before they grow significantly big to consume significant quantities of substrate, it is possible to dampen their influence on the reactor performance as well.

Batch reactors were started with the same quantity of feed and the same earthworm density as PDCOP reactors. Once every 15 days, the vermicast was removed and quantified. The zoomass of the 'parent' earthworms and the number of juveniles/cocoons produced were assessed. No fresh feed was introduced.

3. Results and discussion

After over ten months of continuous operation, the performance of all the reactors fed with different forms of salvinia, in terms of production of castings, was increasing progressively, as can be seen from Figure 1.

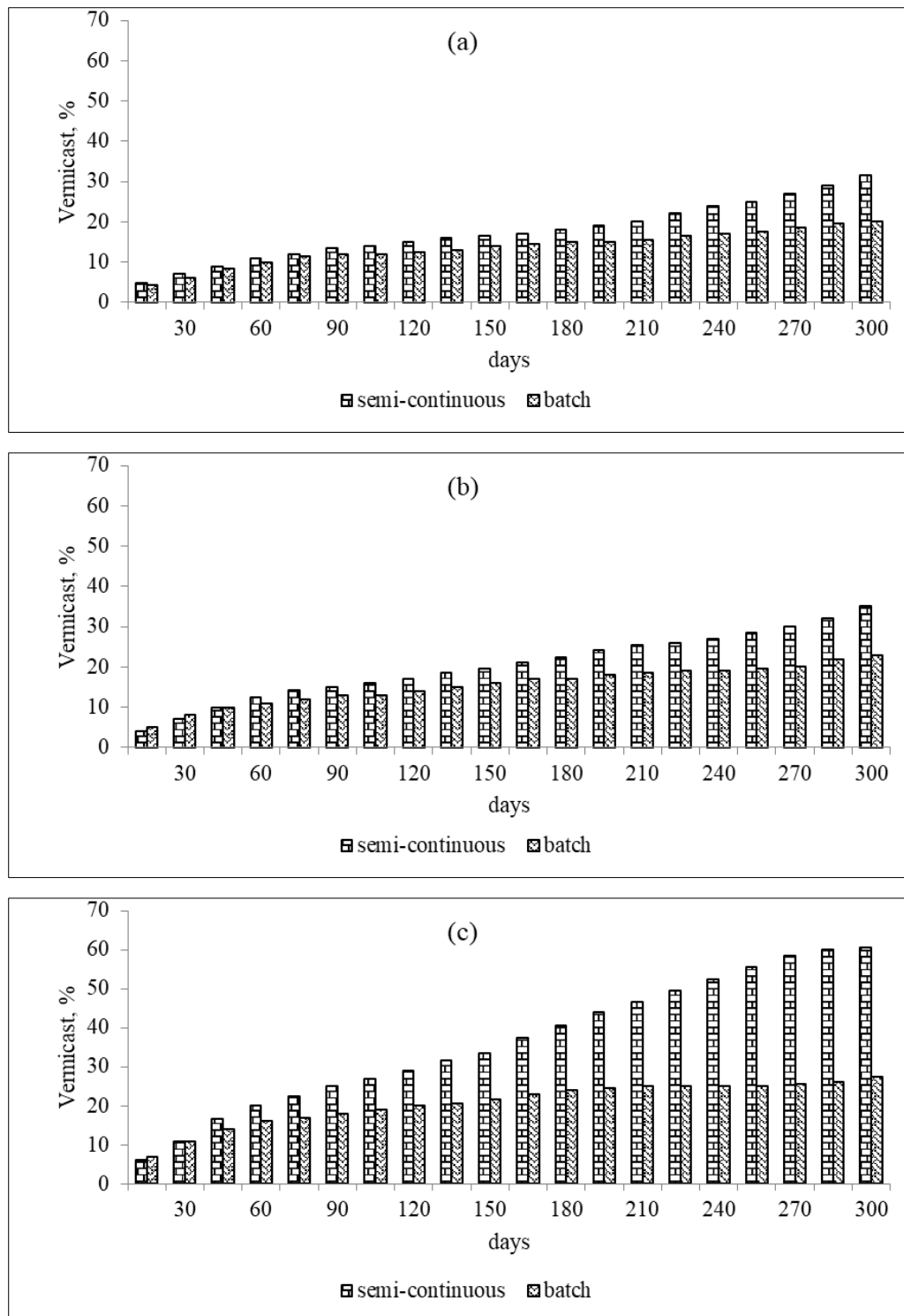


Figure 1 Vermicast output, % of feed mass, in reactors operated with different forms of salvinia a) fresh whole b) chopped and c) sundried

During the first three fortnight of operation, the vermicast output as well as growth of the worms was low. As the worms had been cultured to adulthood on cowdung feed before they were introduced to the chiefly salvinia-fed reactors, they

had obviously taken some time to adapt to the fresh feed. After that, the worm activity became noticeably brisk with salvinia. Gajalakshmi [5].

An interesting finding is that sun-dried form of salvinia plants were converted in to vermicast easier than chopped and whole plants. Also sun-dried form was voraciously consumed by earthworms. The reason why earthworms are able to feed upon the dried weed more easily than fresh form is that the dried plants become flimsy and become more easily ingestible by the worms than the harder and more tensile plants. The same trend was observed in vermireactors operated with water hyacinth. Gajalakshmi [6].

The maximum vermicast output of 60.5% had been achieved from sun-dried plants in 20th run of the reactor operated in semi-continuous mode followed by chopped and whole plants.

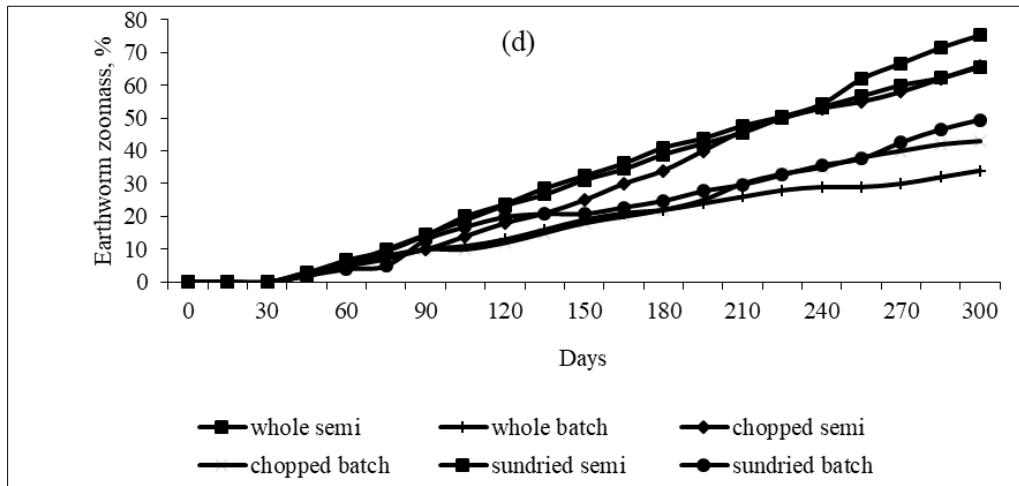


Figure 2 Change in earthworm zoomass with time in reactors operated with different forms of salvinia

In reactors fed with sun-dried plants there was, increase in worm zoomass in most of the runs and comparatively slow increase in zoomass in reactors fed with chopped and whole plants.

Table 1 Number of offspring produced in reactors fed with different forms of salvinia

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	5	3	4	0	7	8
120	7	5	6	4	3	5
150	8	6	11	3	9	1
180	7	9	9	6	11	8
210	5	3	7	5	15	9

210	5	2	9	4	16	9
	8	5	5	7	12	4
240	7	6	11	7	9	3
	8	6	10	3	12	7
270	9	7	13	7	22	12
	11	8	15	9	25	15
300	13	10	16	11	17	9

The earthworms in reactors operated in both modes consistently produced offspring (Table 2). In reactors fed with sun-dried form and operated in semi-continuous mode, the number of cocoons and hatchlings produced were more than the rest of the reactors.

4. Conclusion

- The reactors operated in semi-continuous mode, performed better in terms of vermicast output than batch mode with the earthworm species *E.eugeniae*.
- There was no mortality in any of the reactors fed with different forms of salvinia. The earthworms grew and produced offspring. These observations endorse that epigeic earthworm *E.eugeniae* can be utilized sustainably in vermicomposting different forms of salvinia. (Abbasi *et al.*, 2002).
- The sun-dried form of salvinia plants were vermicomposted better than the chopped and whole plants.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

There is no conflict of interest.

Statement of ethical approval

The present work does not harm any animals by the author.

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Author's short biography



I am **Dr. T. Ganesh Kumar**, M.Sc., MPhil., PhD., an assistant professor in the department of zoology at St. Joseph's College of Arts and Science (Autonomous), Cuddalore-1. I hold degrees in environmental science and technology from the B.Sc. to the Ph.D. 2018 saw the awarding of my Doctorate by Pondicherry Central University. I was a Rajiv Gandhi National Fellow from 2010 to 2015 while doing my Doctorate. I have published six papers includes Bioresources and Bioprocessing (BIOB) and two books (LAP, Germany) throughout the past six years of research and teaching. My research interests are in weed and earthworm vermicomposting. IUCN (International Union for Conservation of Nature) and UNEP both have me as a member (United Nation Environment Programme).