Use of manure worm (*Eisenia andrei*) in direct vermicomposting of an aquatic weed
salvinia (*Salvinia molesta* Mitchell) by applying the concept of high-rate
vermicomposting: a reconnoitery study

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Abstract

An epigeic earthworm species *Eisenia Andrei,* (Bouche) which is known to be a manure worm as it predominantly
dwells in the midst of animal manure, was explored as potential bioagent for vermicomposting the highly invasive aquatic
weed salvinia (*Salvinia molesta,* Mitchell). The concept of high-rate vermicomposting and associated technology earlier
developed by S.A. Abbasi and co-workers were employed for the purpose. As reported in this paper, *E. andrei* was able to
convert salvinia into vermicast without the need of any pre-composting or supplementation of animal manure. In a semi-
continuous, pulse-fed, reactor operation at solids retention time of 20 days, a rising trend in the vermicast production was
seen over the course of 100 days of the experiments indicating that the epigeic was taking increasingly to salvinia. There was
no animal mortality; rather there was reproduction as seen in the formation of juveniles and cocoons in the vermireactos.

Keywords: high-rate vermicomposting, salvinia, *Eisenia andrei*

Introduction

Salvinia (*Salvinia molesta,* Mitchell) is regarded as
the fastest growing of all invasive plants, with the
possible exception of water hyacinth (Abbasi and
Nipaney, 1986, 1993). The weed is capable of rapidly
colonizing water-bodies, and does it so completely that it
covers lakes, canals, and ponds from edge to edge, putting the underlying water out of sight. As a consequence, salvinia infestation plays havoc with the water quality and the aquatic biota, leading to enormous losses. As there is no process in existence with which salvinia can be utilized at the scales at which it is generated in nature, there is imperative necessity to develop such processes. In pursuance of this objective we have explored the possibility of using salvinia to generate organic fertilizer in the form of vermicast.

The epigeic earthworm species *Eisenia andrei* (Bouche)
was employed for the purpose, *E. andrei* is called, a
manure worm because, similar to *E. fetida,* it dwells
predominantly in the midst of animal manure and has been used in the past in vermicomposting of animal
manure (Elvira et al., 1997; Pizl and Novakova, 2003;
Aira et al., 2011). A few studies also exist on the use of *E.andrei* in processing manure-phytomass blends
(Frederickson et al., 1997; Dominguez et al., 1997;
Elvira et al., 1999; Tajbaksh et al., 2008; Degefe et al.,
2012; Mendoza-Hernandez et al., 2013), but no report
exists on its successful use in direct vermicomposting of
phytomass. As *E. andrei* often dwells along with *E.
fetida* and has similar size and habits, is often mistaken
Materials and Methods

In the high-rate vermicomposting paradigm (Gajalakshmi et al., 2002; 2005; Abbasi et al., 2009; Sanker Ganesh et al., 2009; Abbasi et al., 2011; Tauseef et al., 2013 b) reactors with very high surface-to-volume ratios are used so as to have substrate height within 6-8 cm. Moist jute cloth is used as bedding to maximize the use of reactor space and the substrate is pulse-fed, with concomitant harvesting of vermicast, at solid retention times (SRT) of 15 ± 5 days. Earthworms are employed in densities of 50-75 animals per Kg of feed. In the present experiment rectangular reactors made up of 5 mm thick card-board were used. They were lined with plastic sheet to prevent leakage of water and escape/predation of earthworms. Bedding consisted to two jute cloth sheets of 3 mm thickness, each saturated with water. After 2 kg of freshly harvested and rinsed salvinia was laid over the bedding, 50 adults of E. Andrei were released into it. We used an earthworm density which was much lesser than ideal for high-rate vermicomposting because we intentionally kept the substrate well in excuses of that which the earthworms could consume in 20 days. This was done to obtain values of maximum vermiconversion per worm achievable in these reactors. With this information it is possible to work out the number of worms needed per unit mass of substrate to achieve a near complete conversion at a given SRT. The reactors were kept at 30 ± 5%. At 20-day intervals the reactor contents were removed and placed in a separate container for the quantification of vermicast, zoomass change in adults, and production of juveniles and cocoons. Within a few minutes reactors were re-started with everything else same as at start except that form earthworms removed from the previous run, only adults were reintroduced into corresponding reactor and, for the vermicast harvested,

Table 1. Conversion of salvinia (2 kg) to vermicast by 50 adults of E.andrei

<table>
<thead>
<tr>
<th>Number of days of reactor operation</th>
<th>Vermicast generated</th>
<th></th>
<th>Vermicast per worm, per day (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fresh weight</td>
<td>Equivalent dry weight</td>
<td>As a fraction of dry weight equivalent of feed mass %</td>
</tr>
<tr>
<td>20</td>
<td>39.4</td>
<td>19.4</td>
<td>10.5</td>
</tr>
<tr>
<td>40</td>
<td>67</td>
<td>25.2</td>
<td>13.1</td>
</tr>
<tr>
<td>60</td>
<td>72</td>
<td>27.6</td>
<td>14.9</td>
</tr>
<tr>
<td>80</td>
<td>87</td>
<td>30.8</td>
<td>16.6</td>
</tr>
<tr>
<td>100</td>
<td>98.7</td>
<td>32.6</td>
<td>17.2</td>
</tr>
<tr>
<td>120</td>
<td>105.1</td>
<td>34.7</td>
<td>18</td>
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<tr>
<td>140</td>
<td>108</td>
<td>35.5</td>
<td>18.7</td>
</tr>
<tr>
<td>160</td>
<td>102.4</td>
<td>34.9</td>
<td>18</td>
</tr>
</tbody>
</table>
an equivalent quantity of salvinia was introduced. This was in accordance with the pseudo discretized continuous operation protocol (PDCOP) earlier developed by us (Gajalakshmi et al., 2002, 2005; Sanker Ganesh et al., 2009). All quantities were adjusted so that the feed and the casting mass as reported in this paper represent dry weights (taken after oven-drying at 105°C to constant weight).

Fig. 1. Morphology of *E. fetida* and *E. andrei*

Results and Discussion

The vermicast production began within 24 hrs of the start of the reactor and significant conversion of the weed to vermicast was seen during the very first harvesting done on the 20th day (Table 1). The findings were reproducible within a relative error of less than 10%. As the earthworms had been cultured on cowdung as feed, they appeared to be acclimatizing to all-salvinia feed–this is reflected in the fact that in subsequent days the rate of the vermicast production increased and reached a plateau of 15.8 ± 0.8% by 120th day. There was no earthworm mortality. Rather the animals seemed to quickly adapt to the new all-salvinia deed as well as the environment of their new dwelling in the high-rate vermireactors. They began reproduction briskly juveniles producing over 3 cocoons per worm in each run.

During vermicomposting 50-60% of the organic carbon of the substrate is lost by way of respiration by earthworm (Hussain et al., 2015). Hence the vermicast actually represents the utilization of about double that amount of salvinia (ca 32%). It can be surmised that thrice the earthworm density used in the present experiment, in other words 75 animals per Kg of salvinia, would achieve near complete utilization of salvinia in generating vermicompost at the SRT of 20 days. This is several times faster than 3-4 months needed by conventional vermireactos even in processing animal manure.

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References


Channgam et al., 2015