Short Communication (NS-7)

BIOACCUMULATION OF HEAVY METALS THROUGH EARTHWORMS FROM WATER HYACINTH (Eichhornia crassifera Solm) CONTAMINATED VERMICOMPOST

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Received August 10, 2012 Accepted December 10, 2012

ABSTRACT

The present study was undertaken for evaluation of possible bioaccumulation of heavy metals such as cadmium, copper, iron, manganese, nickel, lead and zinc in the samples like control soil, experimental soil and body powder of different species of earthworms through vermicomposting. All these metals were detected after 90 days of vermicomposting using flame atomic absorption spectrophotometer. The results revealed that with little differences, all metals are present in the samples. It was further reported that metals like Cu, Mn, Ni and Zn are absorbed whereas Cd and Pb are excreted by earthworms. Among the earthworm species tested, Eudrilus euginae was found to be good for bioaccumulation of heavy metals as compared to other two species viz., Pheretima posthuma and Eisenia fetida.

Key Words: Heavy metals, Bioaccumulation, Vermicompost, Flame spectrophotometer, Earthworm

INTRODUCTION

Toxic heavy metal pollution of water and soil is a major environmental problem and most conventional remediation approaches do not provide acceptable solutions.1 Nowadays all over the world, most of lakes and tanks are in varying degree of environmental degradation. The main causes for the deterioration of water quality in tank are entering of pollutants due to discharge of untreated waste water from municipal sewage and domestic waste as well as discharge of organic, inorganic and toxic pollutants of industrial effluents, such material may damage and alter both natural and man-made ecosystem.2,3 The availability of some metals in soil must be determined because they are beneficial at low concentration but becomes harmful at higher concentration. On the other hand the heavy metals like cadmium and lead are most toxic and are considered non-essential.4 Their availability with the vermicompost or surrounding soil is affected by the components of the vermicompost as well as characteristics of soil like pH and salinity.5,6 Vermicomposting is one of the best ways to dispose the waste not only due to its capacity of reducing the waste, but also due to its ability to remediate and amend the soil. During vermicomposting, the activities of earthworms increases the mobility and bioavailability of heavy metals in soil, they are able to accumulate metals in their bodies from soil and complex those by other compounds so might be having less toxicity.7

In present investigation, three species of earthworms were selected for the vermicomposting as well as bioaccumulation of heavy metals from water hyacinth contaminated vermicompost. Water hyacinth is a floating macrophyte, it is well known for its appetite for nutrients and explosive growth rate has been put to use in cleaning up municipal and agriculture waste water. On other hand,
Material collection
Epigeic species of earthworms viz., Eisenia foetida and Eudrilus euginae were procured from horticulture nursery, department of agriculture, Sakri (M.S.) India. Whereas endogesic species, Pheretima posthuma was locally collected. They were kept in the mixture of partially digested cow dung and soil for 15 days before commencement of experiment. Simultaneously Water Hyacinth (WH) was collected from Panzara River (a tributary of Tapi River) near Pimpalner town and brought to laboratory. It was thoroughly washed to remove all adhered soil particles and chopped into small pieces, dried in shed at room temperature and finally ground with mechanical grinder. Similarly cow dung and quality soil were brought to the laboratory.

Vermibed preparation
Four vermibed groups were prepared in the laboratory, the content of the vermibeds are shown in Table 1. The vermibed were prepared in plastic troughs which easily accommodate 200-300 worms. After preparation, they were properly mixed and sufficient amount water was added, so that vermibed remain moist. On second day 200 worms were released in all three groups. Control was run parallel without worm, cow dung and water hyacinth. These troughs were kept in laboratory for 90 days without any disturb. Water was sprinkled at the interval of 3 to 4 days. At the end, the top layered soil was taken out for metal analysis. Similarly at the end of 90 days, for powder preparation, 10 g worms from each group were taken out and oven dried.

Sample digestion
The sample like control soil, vermicompost and earthworm body powder were subjected to acid digestion. The acid digestion were carried at approximately 100°C on a sand bath in a fume chamber for 2 hours and cooled for 15 minutes. Then addition of 5 drops of 30 % hydrogen peroxide to the extraction mixture. Heating was continued with intermittent stirring by a gentle swirling of the flask held by tongs, until 1 ml of the sample remained. The cooled digested sample was then made up to 10 ml in a volumetric flask using deionized water and stored in acid-resistant polythene bottle until required for analysis.

Sample analysis
The analysis of heavy metal i.e. accumulation of metal ion is done by flame atomic absorption spectrophotometer. The values were subjected to student-t test for stability of significance and the results were reported as concentration mg/kg of sample, it was calculated as follows

\[ \text{Mg/kg metal in sample} = \text{metal in solution} \times \frac{10}{\text{Grams of sample}} \]

RESULTS AND DISCUSSION
The results of heavy metals i.e. percentage change over control value in vermicompost and amount of metal ion bioaccumulation in body tissues of earthworm species are presented in Table 2.

Cadmium and Lead
The amount of non-essential metals like Cd and Pb were significantly decreased in all groups of vermicompost i.e. -27.61 and -9.42 %, -35.03 % and -7.85 % and -38.81 % and -10.99 % respectively. Among these metals,
Cd is shown to be maximum accumulation. It was further showed that, in the body tissues of earthworms. There is appreciable amount of Cd and Pb were accumulated i.e. 26.17 % and 10.47 %; 32.71 % and 13.62 % and 34.02 % and 16.76 % respectively. Among the earthworms, epigeic species were found to be good for bioaccumulation.

**Table 2 : The bioaccumulative values of metal ions by different species of earthworms**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Heavy metal concentration mg/ kg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cd</td>
</tr>
<tr>
<td>Control soil</td>
<td>0.0688</td>
</tr>
<tr>
<td>Vermicompost, group-I (Pheretima posthuma)</td>
<td>0.0498 (-27.61) **</td>
</tr>
<tr>
<td>Vermicompost, group-II (Eisenia foetida )</td>
<td>0.0447 (-35.03) ***</td>
</tr>
<tr>
<td>Vermicompost, group-III (Eudrilus euginae )</td>
<td>0.0421 (-38.81) ***</td>
</tr>
<tr>
<td>Animal powder (Pheretima posthuma)</td>
<td>0.0180 (26.17) **</td>
</tr>
<tr>
<td>Animal powder (Eisenia foetida )</td>
<td>0.0225 (32.71) ***</td>
</tr>
<tr>
<td>Animal powder (Eudrilus euginae )</td>
<td>0.0234 (34.02) ***</td>
</tr>
</tbody>
</table>

* Significant value: P<0.05, ** P<0.01, *** P<0.001. NS = Non-Significant (P>0.05).

Values in the single parenthesis are percentage change over control and in double parenthesis indicates amount of metal ions accumulated in body.

**Copper**

The value of copper in control soil was 5.082 mg/kg, there were significantly increases in percentage of this metal in all groups of vermicompost i.e. 19.87 %, 22.88 % and 35.57 % respectively. This table also showed that, high percentage copper is accumulated in the earthworm’s body.

**Iron**

It is another essential metal ion for plant growth. Except group-II of *Eisenia foetida*, slightly increased in amount of Fe is reported from vermicompost of *Pheretima posthuma* and *Eudrilus euginae*. The bioaccumulation values in body of worms were 18.93 %, 23.20 % and 22.47 % in group-I, group-II and group-III respectively.

**Manganese**

In control group, the value of Mn is 8.53 mg/kg. It was significantly increased in vermicompost of *Eisenia foetida* i.e. 26.26 % whereas in other two groups, the values are slightly increased. The bioaccumulation values of Mn in body of worms were found to be in considerable amount i.e. 14.31 %, 16.18 % and 26.15 % in group-I, group-II and group-III respectively.

**Nickel**

It is another non-essential heavy metal its value in control soil was 1.089 mg/ kg. Due to vermicomposting activity of earthworms, it was significantly decreased in all vermibed groups i.e. -21.48 %, -13.59 % and -8.26 %. On other hand the amount of Ni bioaccumulation in earthworms were found to be most significant i.e. 34.51 %, 46.73 % and 55.32 % respectively.

**Zinc**

Like other essential heavy metals, low concentration of Zn is essential for normal growth of plants. But its deficiency or excess causes toxicity. In present study, there is slightly increased in amount of zinc were reported in all groups i.e. 3.78 %, 0.54 and 8.65 % respectively. The appreciable amount of this metal is reported from body of worm species i.e. 21.62 %, 24.33 % and 20.55 % respectively.
Moreover, there is a considerable interest in developing cost effective and eco-friendly technologies for the remediation of waste water and heavy metal polluted soil with toxic trace element. Some plants like water hyacinth (Eichhornia crassipes) have the ability to accumulate non-essential metal such as Cd and Pb and this ability could be harnessed to remove non-essential heavy metals from the polluted soil.\textsuperscript{4-10} Vermicomposting constitutes special forms of composting because it is accomplished when earthworms metabolize and excrete of soil and organic matter. In the digestive system of worms, microorganisms are responsible for transferring some organic compounds, particularly protein, nucleic acids, fats and carbohydrates into a more stable product i.e. vermicompost. Similarly, in the process of vermicomposting, it supposes that earthworms are useful to clean up the soil from various pollutants, especially heavy metals.\textsuperscript{5,13}

CONCLUSION

In present investigation, it is proved that, significantly decrease in heavy metal concentration especially Cd, Pb and Ni indicates the capacity of earthworm to excrete heavy metal in surrounding soil or vermicompost. Similarly, most of heavy metals are accumulated in their body tissues. Some researchers etc revealed that, vermicomposting acts as a potential material for Cd and Ni absorption in contaminated soil Therefore, our results are confirmed with the work of previous researchers.

ACKNOWLEDGEMENT

Authors are thankful to the principal for providing necessary facilities and laboratory during this research. Authors express their gratitude to the In-charge, Department of Environmental Sciences, North Maharashtra University, Jalgaon, India for their cooperation and permission to use Flame Atomic Absorption Spectrophotometer for analysis of heavy metals.

REFERENCES