BIOCONVERSION OF TEXTILE SLUDGE EMPLOYING THE EARTHWORM *EISENIA FETIDA* AND ITS IMPACT ON THE GROWTH OF *CAJANUS CAJAN*

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**ABSTRACT**

The present research work deals with the textile sludge waste management through vermicompost. The sludge pH (8.11 in raw and 7.84 in earthworm treated), the total nitrogen (1.98% in raw and 3.58% in earthworm treated), phosphate (0.21% in raw and 1.96% in earthworm treated) and potassium (2.16% in raw and 4.58% in earthworm treated) levels were increased and toxic heavy metals zinc (2.19 ppm in raw and 1.28 ppm in earthworm treated) and copper (11.23 ppm in raw and 2.68 ppm in earthworm treated) were significantly decreased. The earthworm enriches the compost with various nutrients for plant and microbial growth. Plant growth studies were conducted in all the combination of textile sludge, maximum growth of root length (8.9cm and 7.6 in raw) and shoot length (22.6cm and 16.2 in raw). Growth of earthworm *Eisenia fetida* in different composition of dye sludge was studied. Earthworms at 10 individual were introduced after measuring the initial weights, 3.2 – 3.3 gm. The final number and weight of worm was different, the number and weight were increase in 25% compost and decrease in...

125% compost. The different composition of dye sludge vermicompost was used in plant cultivation and result confirm plant growth was healthy in 125g/kg, 100g/kg, 75g/kg and 50g/kg, 25g/kg vermicompost used cultivation plant growth was appreciatable.

Keywords: Earthworms, Textile Sludge, vermicompost, Cajanus cajan

INTRODUCTION

Textile industries are one of the biggest users of water and complex chemicals during textile processing at various processing stages. Now-a-days, the demand of textile products have increased dramatically and the latter caused proportional increase in textile industry and its wastewaters in India. There are more than 800 dyeing, bleaching and textile processing industries in Tiruppur that generate over 1,00,000 m$^3$/day of textile effluent (Ranganathan et al., 2007). The dyeing process is carried out in aqueous bath with pH variations of 4 - 12. Various classes of dye stuffs are used to colour the processed cloth depending upon the specific requirement which include vat dyes, naphthols, sulphur dyes, direct dyes etc. The release of dyes into the environment during textile fiber dyeing and finishing processes is a main source of water pollution. Individual wastewater treatment through physical, chemical or biological method is often very costly and results in large amount of sludge. Thus, there is a need to look for alternative treatment processes that covers from pre to post wastewater treatment stage. The epigeic earthworm, *E. fetida* is a suitable species for management of waste and is utilized successfully in vermicomposting (Chaudhari and Battacharjee, 2002). Vermicomposting, through earthworms, is an ecobiotechnological process that transforms energy rich and complex organic substances in to a stabilized vermicomposts (Bentiez et al., 1999). Vermicomposting is stabilization of organic material, involving the joint action of earthworms and micro organisms. Although microbes are responsible for biochemical degradation of organic matter, earthworms are important derivers of the process, conditioning the substrate and altering the biological activity (Aira et al., 2002). During vermicomposting, nutrients are released and converted in to soluble and available forms for plants (Ndegwa and Thompson, 2001). Vermicomposting


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through different species of earthworm has been studied (Edwards et al., 1998). The aim of the present investigation was to vermicompost textile sludge from a textile industry using the earthworm species, *Eisenia fetida*.

**MATERIALS AND METHODS**

The vermiconversion of textile sludge were taken in the following combination (T1: 25g/kg, T2: 50g/kg, T3: 75g/kg, T4: 100g/kg and T5: 125g/kg), remaining weight were wake up with garden soil and cow dung). The earthworm *Eisenia fetida* was used for the vermiconversion experiment, the physico-chemical parameters of the dye sludge pH, EC, total nitrogen, total phosphorus, total potassium, total zinc, total copper, total iron and total manganese were analysed. Young non-clitellated specimens of *Eisenia fetida*, weight 3.2 – 3.3 gm live weight were randomly picked from stock cultures containing 200-250 earthworms, maintained in the laboratory with cow dung and culturing material. The dye sludge samples were used on dry weight basis for biological studies and chemical studies and chemical analysis that was obtained by oven drying the known quantities of material at 110°C.

All the samples were analysed in triplicate and result were averaged. Seven circular 2 kg cement pot (diameter 25 cm, 15 depth cm) were filled with dye sludge and cow dung mixed in standard procedure. The moisture content of waste was adjusted to 70-80% during the study period by spraying of distilled water. The waste was turned over manually every day for 15 days in order to eliminate volatile toxic gases. After 15 days, 10 clitellated hatchling, each weighting 3.2 – 3.3 gm (live weight) were introduced in each pot. All containers were kept at temperature 25 ± 1°C. The feed in the pot was turned out and earth worms and cocoons were separated from the feed by hand shorting, after which they counted and weighted.

**RESULTS AND DISCUSSION**
The main physico-chemical parameters of textile sludge from the raw and different combination of experimental samples are summarized in Table 1. The bioconversion of textile sludge employing the earthworm *Eisenia fetida*, drastic improvement in physico-chemical parameters such as pH (8.11 in raw and 7.84 in T1), EC (3.19 in raw and 5.32 in T1), total nitrogen (1.98 in raw and 3.58 % in T1), total phosphorus (0.21 in raw and 1.96 % in T1) and total potassium (2.16 in raw and 4.58 % in T1). Initially pH values in different treatments were in range of 7.23, 7.98, and 8.45 and in final vermicompost, ranged from 6.91, 7.45 and 7.64. Maximum reduction was recorded in T2, while minimum was recorded in T3. Gupta et al., (2007) also reported reduction in pH during vermicomposting of water hyacinth. Suthar (2009) has reported that 12.3% and 14.7% reduction in pH than initial levels in cattle wastes vermicomposting. The earthworm affects phosphorus mineralization in wastes if reared for longer periods (Suthar and Singh, 2008). Phosphorus mineralization varied significantly among different vermibeds possibly due to quality and proportion of bedding materials in feedstock. Garg and Kaushik (2005) reported higher total potassium contents in the vermicomposted sludge, at the end. They attributed this increase in K content to enhanced microflora in feed substrates, which produces acids for solubilising the insoluble K.

### Table 1 Physical and chemical characters of Dye sludge (solid waste)

<table>
<thead>
<tr>
<th>S. No</th>
<th>Name of the Parameter</th>
<th>Raw</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>T5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pH</td>
<td>8.11</td>
<td>7.84</td>
<td>7.89</td>
<td>7.91</td>
<td>7.97</td>
<td>8.02</td>
</tr>
<tr>
<td>2</td>
<td>Total Phosphorus (%)</td>
<td>0.21</td>
<td>1.96</td>
<td>1.62</td>
<td>1.32</td>
<td>1.24</td>
<td>1.08</td>
</tr>
<tr>
<td>3</td>
<td>Total Zinc (ppm)</td>
<td>2.19</td>
<td>1.28</td>
<td>1.36</td>
<td>1.68</td>
<td>1.88</td>
<td>1.92</td>
</tr>
<tr>
<td>4</td>
<td>Total Copper (ppm)</td>
<td>0.58</td>
<td>2.68</td>
<td>3.52</td>
<td>4.81</td>
<td>5.41</td>
<td>7.42</td>
</tr>
<tr>
<td>5</td>
<td>Total Iron (ppm)</td>
<td>11.23</td>
<td>7.9</td>
<td>6.52</td>
<td>6.44</td>
<td>6.32</td>
<td>5.98</td>
</tr>
<tr>
<td>6</td>
<td>Total Manganese (ppm)</td>
<td>2.36</td>
<td>6.82</td>
<td>6.56</td>
<td>5.89</td>
<td>5.62</td>
<td>5.44</td>
</tr>
</tbody>
</table>

The heavy metal concentration was decrease in notable, in total zinc (2.19 in raw and 1.28 ppm in T1), total copper (0.58 in raw and 2.68 ppm in T1), total iron (11.23 in raw and 7.9

ppm in T1), total manganese (2.36 in raw and 6.82 ppm in T1) (Table - 1). Kannadasan et al., (2013) total zinc was reduced from 7.66 ppm in control and 2.98ppm to 2.54 ppm in water hyacinth treated with E. eugeniae, and the total Cu also shown similar trend (6.68 ppm in control and 1.30 ppm to 1.15 ppm in earthworm treated). The reduction of total carbon was also followed the same pattern. The percentage reduction was more in the water hyacinth among the samples treated with both species. The results showed the decrease in toxic compounds such as Zn and Cu in the treated waste reflecting the potential of both species in detoxification. Similar pattern was observed by Selladurai et al., (2009) for the treatment of tannery sludge using the same species E. eugeniae and E. fetida The micronutrients like iron concentration was 1.22 ppm in control and 19.64 ppm in treated water hyacinth waste and manganese also showed same pattern (1.92 ppm in control and 5.94 ppm in treated). However among the two micro nutrients the increase amount was observed when compared to manganese in the combinations with both species. When compared with the initial levels, concentrations of heavy metals viz Zn, Fe, Cu, Pb, Mn, Cr, Na and Co have a significant decrease in their respective values when municipal sludge treated with E. eugeniae (Selladurai et al., 2009).

<table>
<thead>
<tr>
<th>Sludge composition</th>
<th>Number of worm in initial</th>
<th>Number of worm in final</th>
<th>Weight of worm in initial (gm)</th>
<th>Weight of worm in final (gm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>10</td>
<td>15</td>
<td>3.3</td>
<td>4.65</td>
</tr>
<tr>
<td>T2</td>
<td>10</td>
<td>13</td>
<td>3.2</td>
<td>4.58</td>
</tr>
<tr>
<td>T3</td>
<td>10</td>
<td>8</td>
<td>3.3</td>
<td>3.25</td>
</tr>
<tr>
<td>T4</td>
<td>10</td>
<td>7</td>
<td>3.2</td>
<td>2.55</td>
</tr>
<tr>
<td>T5</td>
<td>10</td>
<td>5</td>
<td>3.3</td>
<td>1.60</td>
</tr>
</tbody>
</table>

Growth of earthworm Eisenia fetida in different composition of dye sludge were 10 numbers in initial, in all experimental pot. But final number of worm was different, 15 nos. in 25g/kg compost and 5 nos. in 125g/kg compost the initial weight of worm was 3.2 – 3.3 gm in all experimental pot. But final weight of worm was different, 4.65 gm in 25g/kg compost and 1.60 gm in 125g/kg compost (Table - 2). Gunadi and Edwards (2003) reported the death of Eisenia fetida after 2 week in fresh cattle solids. No mortality was observed in any animal waste during

waste during the study period, also weight and number was increase (Garg et al., 2005). In the present study different concentration of dye sludge vermicompost was used in plant cultivation pot and result confirm plant growth was health in T5, T4 and T3 but T2 and vermicompost used cultivation plant growth was appreciable. Kannadasan et al., (2013) reported that the plant growth studies the combination of water hyacinth treated with two species of earthworms (E. eugeniae and E. fetida) showed maximum growth of root length (8.9cm) and shoot length (21.6cm) in E:S:C combination of 1:1:2, treated with Eudrilus eugeniae. The root length 8.5 cm and shoot length 21.3 cm was observed in combination of 1:2:1 treated with Eisenia fetida.

CONCLUSION

Vermiconversion textile sludge with bedding materials and Eisenia fetida can solve the problem of disposal of this sludge by converting it into a nutrient rich supplement for plants in a short span of period. The final vermicomposts were homogenous, rich in important plant nutrients N, P, K, Fe, Zn, Cu and Mn which indicated their agricultural value as a soil conditioner.

REFERENCES


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