BIO-TRANSFORMATION OF POULTRY WASTE INTO VERMICOMPOST BY USING AN EPIGEIC EARTHWORM, EUDRILUS EUGENIAE

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Abstract: Three vermibeds were prepared by mixing the processed poultry waste (Egg Layers) with groundnut husk and soil and laid. The composition of each vermibed was with 70:20:10 proportions of these selected waste materials. Six hundred Eudrilus eugeniae adult and healthy worms were introduced into each of these vermibeds. The raw poultry waste, predigested poultry waste and vermicompost were separately subjected to chemical nutrients' composition analysis. The vermicompost had increased levels of total N, P, K and Na when compared to raw poultry waste and pre-digested poultry waste. The computed C:N ratio of vermicompost was 15:1 whereas it was 21:1 in the raw poultry waste. The results of the present study obviously suggest that the poultry waste with groundnut husk and soil at 70:20:10 proportions can very well be used for converting into value added vermicompost by utilizing E. eugeniae.

Key words: Vermicompost, Poultry waste, Eudrilus eugeniae, Macro and micro nutrients.

INTRODUCTION

According to Jayakumar et al. [1] poultry droppings are the excretory products of poultry birds, which contain good amount of nutrients required for plants’ growth. However, they are not suitable for direct application into the crop fields and therefore Scientists tried to utilize these wastes in different ways. Turan [2] utilized poultry litter along with natural zeolite as an ingredient during the composting process and concluded that the addition of natural zeolite to poultry litter compost was found to have a beneficial effect on the characteristics of the end product i.e., compost.

Vermicomposting is an eco-biotechnological process that transforms energy-rich and complex organic substances into stabilized humus-like product vermicompost. Benitez et al. [3] concluded that in vermicomposting process, the inoculated earthworms maintain aerobic condition in the organic wastes, convert a portion of the organic material into worm biomass and respiration products and expels the remaining partially stabilized product, since the potential of some epigeic earthworms to recycle organic waste materials into value-added products is well documented [4-10]. Vermicompost has been shown to have higher levels of organic matter, organic carbon, total and available NPK and other
micronutrients, microbial and enzyme activities, as well as plant growth regulators [11-13].

Sherman [14] investigated that the windrows are usually used for large scale vermicomposting process. Windrows are generally built outdoors on a concrete sloped surface to drain water and avoid pests. A typical height of a windrow is three feet or less and distance between windrows is no more than two feet.

The composting efficiency and biology of tropical earthworm species, *i.e.*, *E. eugeniae* is well documented in literature. Several workers reported the vermicomposting potential of *E. eugeniae* by using a variety of waste materials such as animal dung [15, 16 and 17]; industrial waste [18], etc. The poultry droppings are produced in large quantity in India in general and particularly in and around Namakkal district of Tamil Nadu, have not been previously tested as feeding substances for *E. eugeniae*. Therefore, there exist vast opportunities to explore the composting potential of this species to manage the poultry droppings and convert them into vermicompost. The main objective of this study was to test the efficiency of a tropical earthworm *E. eugeniae* to recycle poultry droppings of Egg layers after mixing with groundnut husk and soil in 70:20:10 ratio.

**MATERIALS AND METHODS**

The present study was carried out between October 2008 and December 2008 in a Poultry farm (of Egg layers) near Namakkal. *E. eugeniae* was selected for the present study because of its surface feeding behaviour. The selected poultry wastes were collected from Sri Venkateshwara Poultry Farm near Namakkal. Groundnut husk and soil were also collected and shadow dried. 1015 kg of fresh poultry droppings was mixed thoroughly with 290 kg of groundnut husk and 145 kg of soil. This mixture was placed in the form of heaps under shady place. Watering was done regularly twice in a day in order to maintain the optimum temperature and moisture. This set up was maintained for 25 days.

Three vermibeds of 170 cm×60 cm×50 cm were laid with 160 kg of predigested waste materials in each windrow. In each vermibeds, 50 clitellate *E. eugeniae* worms were introduced. On the subsequent day, 550 earthworms were additionally introduced into each windrow. Watering was done regularly twice in a day in order to maintain the temperature and moisture content of the medium during entire composting period. After 30 days, the vermicompost was collected, sieved, air dried and weighed separately from each windrow. The vermicompost was then analysed to quantify its chemical nutrients' composition. Besides, the raw poultry waste and pre-digested poultry waste were also separately subjected to chemical nutrients' composition analysis. Further, after the harvest from each windrow the number of cocoons and young ones were counted and recorded.

Various physico-chemical parameters such as pH, Electrical Conductivity (EC), Organic Carbon (OC) and the macro and micro nutrients such as Total Nitrogen (N), Total Phosphorous (P), Total Potassium (K), Total Calcium (Ca), Total Magnesium (Mg), Total Sodium (Na), Total Sulphur (S) and C:N ratio were estimated by following the method suggested by Murugesu Boopathi et al. [19]. The data were subjected to appropriate statistical analysis and the same are presented in this paper.

**RESULTS AND DISCUSSION**

Mean number of days required for the biotransformation of selected poultry waste into vermicompost was 30 days. The mean total weight of the vermicompost obtained after vermicomposting of poultry waste was 81 kg. The percentage of conversion of vermicompost was 51 (Table 1). The mean number of cocoons and young ones produced by *E. eugeniae* was found to be 292 and 261 respectively during the composting period (Table 1).

The magnitude of various chemical parameters of raw poultry waste, pre-digested poultry waste and vermicompost are given in Table 2. The
nutrient status of vermicompost depends on the type of waste material processed by the earthworms [20].

An increase in the values was observed in the following parameters such as total N, P, K and Na in the pre-digested poultry waste when compared to raw poultry waste. In contrast, a decreasing trend in the values was observed in pH, EC, moisture, OC, Ca, Mg and C:N ratio in the pre-digested poultry waste when compared to raw poultry waste (Table 2).

It is obvious from the results that the vermicompost had comparatively higher quantities of total N, P, K and Na than the raw poultry waste; and lower quantities of pH, EC, moisture, OC, Ca, Mg and C:N ratio in the pre-digested poultry waste when compared to raw poultry waste (Table 2).

The pH values appeared to vary marginally between pre-digested poultry waste and vermicompost. An increasing trend was observed in the parameters viz., total N, P, K, Na and C:N ratio in the vermicompost when compared to pre-digested poultry waste. On the other hand, the values of EC, moisture, OC, Ca, and Mg were comparatively lower in vermicompost than the pre-digested poultry waste (Table 2).

In this study, a reduction in the pH was recorded at the end of the experiment. The variability in pH could be due to the production of CO₂ and organic acids during organic waste decomposition. Haimi and Huhta [21] during their study on the vermicomposting of some organic residues concluded that the lowered pH level at the end might be due to the production of CO₂ and organic acids by microbial decomposition during the process of bioconversion of different substrates in the beds. According to Ndegwa et al. [22] the shifting of pH to lower levels could be attributed to mineralization of nitrogen and orthophosphates and bioconversion of organic materials into intermediate products such as organic acids.

The quantity of electrical conductivity of vermicompost depends on the raw materials used for vermicompost and their ion concentration [23]. According to Bhatnagar and Palta [24] a decrease in the electrical conductivity values in vermicompost may be due to the presence of exchangeable Ca, Mg and K.

In general, Organic Carbon loss has been observed during the vermicomposting process [4, 5, 10]. Earthworm modifies substrate conditions, which consequently affects carbon losses from the substrates through microbial respiration in the form of CO₂ and even through mineralization of organic matter. Elvira et al. [5] stated that a large fraction of organic matter in the initial substrates was lost as CO₂ (between 20 and 43% as total organic carbon) by the end of the vermicomposting period.
The inoculation of worms in waste material considerably enhances the amount of N due to earthworm mediated nitrogen mineralization of wastes. It also suggested that the earthworm also enhances the nitrogen levels of the substrate by adding its excretory products, mucus, body fluid, enzymes and even through the decaying tissues of dead worms in vermicomposting sub-system [10]. According to Lee [25] the passage of organic residue through the gut of earthworm, results in phosphorous converted to forms, which are available to plants. The release of phosphorous in available form is performed partly by earthworm gut phosphatases, and further release of P might be attributed to the P-solubilizing microorganisms present in worm casts. Le Bayon and Binet [26] observed earthworm-mediated phosphatase enhancement in soils. Some previous studies also indicate enhanced potassium content in vermicompost by the end of the experiment [6 and 10]. The results obtained in this study are similar to those by Delgado et al. [27] who demonstrated higher potassium concentration in the end product obtained from sewage sludge.

Studies revealed that C:N ratio, which is one of the most widely used indicators of compost maturation, decreases sharply during vermicomposting process [5,18,28,29].

The present study concluded that the poultry waste at 70:20:10 concentrations can be utilized for vermicomposting by using epigeic earthworm *E. eugeniae*. The vermicompost thus prepared is found to possess desirable nutrients at desired levels such as pH (range 6.5-7.5), total nitrogen (> 1.25), C:N ratio (range 10:1-20:1) as suggested by Tandon [30] and hence it can be used for crop production and maintenance of soil fertility. In the present study, the time taken for the bioconversion of poultry waste into vermicompost was 55 days. Research work is required in order to find out a method in which the bioconversion of these waste will be completed in about 25-30 days or even a lesser than this time limit. Research works may also be carried out with different combinations of the selected wastes for the production of vermicompost and to find out its nutrients’ status. The selected waste materials may also be subjected to bio-transformation into vermicompost by other species of earthworms.

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<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Parameters</th>
<th>Raw Poultry waste Mean± SD</th>
<th>Pre digested Poultry waste Mean± SD</th>
<th>Vermicompost Mean± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>pH</td>
<td>8.92 ± 0.05</td>
<td>6.75 ± 0.07</td>
<td>6.74 ± 0.09</td>
</tr>
<tr>
<td>2.</td>
<td>Electrical Conductivity (EC) dS m⁻¹</td>
<td>10.77 ± 0.20</td>
<td>3.72 ± 0.28</td>
<td>1.64 ± 0.58</td>
</tr>
<tr>
<td>3.</td>
<td>Moisture (%)</td>
<td>27.25 ± 0.31</td>
<td>27.21 ± 0.70</td>
<td>17.49 ± 1.56</td>
</tr>
<tr>
<td>4.</td>
<td>Organic Carbon (%)</td>
<td>31.40 ± 0.35</td>
<td>23.32 ± 1.16</td>
<td>13.76 ± 0.84</td>
</tr>
<tr>
<td>5.</td>
<td>Total Nitrogen (%)</td>
<td>1.49 ± 0.42</td>
<td>2.98 ± 0.26</td>
<td>3.06 ± 0.05</td>
</tr>
<tr>
<td>6.</td>
<td>Total Phosphorus (%)</td>
<td>1.39 ± 0.05</td>
<td>1.62 ± 0.48</td>
<td>1.82 ± 0.44</td>
</tr>
<tr>
<td>7.</td>
<td>Total Potassium (%)</td>
<td>1.18 ± 0.01</td>
<td>1.32 ± 0.18</td>
<td>1.41 ± 0.25</td>
</tr>
<tr>
<td>8.</td>
<td>Total Calcium (%)</td>
<td>4.33 ± 0.05</td>
<td>3.49 ± 0.36</td>
<td>2.18 ± 0.41</td>
</tr>
<tr>
<td>9.</td>
<td>Total Magnesium (%)</td>
<td>2.13 ± 0.01</td>
<td>2.09 ± 0.08</td>
<td>1.55 ± 0.42</td>
</tr>
<tr>
<td>10.</td>
<td>Total Sodium (%)</td>
<td>0.25 ± 0.01</td>
<td>0.45 ± 0.27</td>
<td>0.54 ± 0.26</td>
</tr>
<tr>
<td>11.</td>
<td>C:N ratio</td>
<td>21:1</td>
<td>8:1</td>
<td>15:1</td>
</tr>
</tbody>
</table>

The mean and standard deviation values were obtained from three replicates.
Selvamuthukumaran and Neelanarayanan

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REFERENCES