Vermi-technology of organic solid waste with using earthworm 

*Eudrilus Eugeniae*

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**Abstract**

In a developing country like India, distillery industries have become a major source of pollution, as 88% of its raw materials are converted into waste and discharged into the water bodies causing water pollution. The disposal of biodegradable waste without adequate treatment results in significant environmental pollution. This is the major source of aquatic and soil pollution. Vermicomposting is considered as excellent organic source to bioconversion of distillery solid waste, has reduced levels of contaminants and tends to hold more nutrients over a longer period without impacting the environment. The experiments were carried out on the research farm of Sri Vasavi College (Affiliated Bharathiar University), Erode District of Tamil Nadu, during the cycles 2013 to 2014 to study the effects of enduring organic manures, distillery solid waste (DSW) and Sugarcane trash (ST) bioconversion of vermicomposting. The experiment was prepared out in a randomized container design with four replications. Treatments consisted of three combinations of different organic materials, (60:40; 70:30 and 80:20 ratios) of DSW and ST were prepared with using of earthworm species *Eudrilus eugeniae* were introduced for their efficiencies in biodegrading organic wastes for 45 days. As a results of pH has neutralized, total nitrogen (TN), total Phosphorous (TP), total Potassium (TK), total Calcium (TCa) and total Magnesium (T Mg) were significantly increased, Total Organic Carbon (TOC), Electrical Conductivity (EC) have reduced and Carbon Nitrogen (C/N) ratio also equalized. The present study thus indicates that combinations of DSW + ST were economically feasible and improve the nutrient assessment method of vermicomposting.

**Keywords:** Vermicomposting, Distillery sludge, Sugarcane trash, Earthworm

1. Introduction

Distillery industry is one which produces enormous quantity of liquid and organic solid wastes that can be a great source of energy for recycling through green technologies. This not only be proved to be manure but also to a certain extent a solution to the problem of pollution. During the production of sugar the wastes in the form of sludge and effluents represent an important environmental problem in many parts of the world (Chapman et. al 2001) [3]. These wastes can be efficiently utilized for our agricultural processes in a way, which is mixing the distillery wastes with Sugarcane trash. Eventually the mixture can be converted into manure which helps to agriculture. Usually sugarcane farmers dispose-off the trash by burning in the field itself, because the need of large number of laborers and the lack of appreciation of the value of the trash as a source of organic carbon and nutrients. When burning the trash in the field, (i) the organic matter is burnt and thus lost, (ii) the environment is polluted by smoke, (iii) heat is generated during the burning process kills favorable soil microorganisms and earthworms, thus affecting the soil biological activities.
By recycling the sugarcane trash, these undesirable effects on soil, environment loss of nutrients thus can be avoided. Meanwhile, it seems to be a good source of organic carbon.

In general, composting is the most widely applicable process of handling biodegradable organic wastes. Vermicompost, a by-product of earthworm mediated organic waste re-cycling, is rich in plant nutrients and growth promoting substances and it is considered as an inseparable component of sustainable farming (Chaudhuri et. al. 2001 [4]; Giraddi 2001[8]; Reddy and Ohkura 2004).

The present investigation was undertaken to assess the physico-chemical properties of the distillery solid waste with sugarcane trash consequently as to explore the possibilities of bio-conversion of organic wastes into manure through vermicomposting for the agricultural purposes and improve the nutrient values of nitrogen, phosphorous and potassium.

2. Materials and Methods
Distillery sludge was collected from the Distillery Unit in Erode, District, Tamil Nadu, India. The earthworms *Eudrilus eugeniae* were collected from one of the earthworm unit at Nasiyanur in Erode District. Sugarcane trash was collected from nearest agricultural field, Erode District.

2.1. Vermibed Preparation
The vermicompost beds were prepared using wooden box (80x40x25cm) containing distillery sludge with sugarcane trash in different ratios (60:40; 70:30 and 80:20 ratio) respectively with 3 replicates for 45 days. Twenty five numbers of mature earthworms were introduced in each bed. The bedding was maintained the moisture (65% to 80%) throughout the experiment by regular watering. The vermicomposting samples were collected from 0, 15, 30 and 45 days and analysed for the following parameters such as, pH, EC, TOC, TN, TP, TK, TCa and TMg as per standard methods.

2.2. Analytical methods
The pH was analysed in sample-water suspension at 1:10 ratio by using pH meter (Falcon et al. 1987) [6]. Electrical Conductivity was analysed in sample-water suspension at 1:10 ratio by using Electrical Conductivity meter (Falcon et al. 1987) [6]. Organic carbon was analysed by chromic acid wet digestion method (Walkley and Black 1934) [18]. Total Nitrogen was analysed by Macro Kjeldahl method (Humphries 1956) [9]. Total Phosphorus was analysed using colorimetric method with molybdenum in sulphuric acid by Vanado molybdate yellow color method and Total Potassium was analysed by Flame photometric method (Jackson 1973) [19]. Total calcium was estimated by EDTA titrimetric method and total magnesium were analysed by calculation method (APHA, 2005) [1].

2.3. Statistical analysis
Tow-way analysis of variance (ANOVA) was computed using SPSS (Version No. 10). Statistical significance was set at <0.05.

3. Results and Discussion
After completion of composting, earthworms were introduced in the compost mixture for vermicomposting. The vermicomposting physico-chemical parameters by adopting the standard methods used different time intervals (0, 15, 30 and 45days).

3.1. pH
The pH was found in acidic nature in initial stage and significantly attained (P ≥ 0.05) the neutral at end of the experiment 45th days (Table 1). It can be concluded that the fixation of calcium carbonate by the calciferous glands of earthworms and further it prevents any fall in pH (Kale and Krishnamurthy, 1982) [13].

<p>| Table 1: pH, Electrical Conductivity and Total Organic carbon value in different combinations of vermicompost. |</p>
<table>
<thead>
<tr>
<th>Days</th>
<th>pH</th>
<th>EC(dsm⁻¹)</th>
<th>TOC%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60:40</td>
<td>70:30</td>
<td>80:20</td>
</tr>
<tr>
<td>0 day</td>
<td>6.47±0.05</td>
<td>6.3±0.05</td>
<td>6.17±0.09</td>
</tr>
<tr>
<td>15 days</td>
<td>6.95±0.06</td>
<td>6.8±0.1</td>
<td>6.55±0.15</td>
</tr>
<tr>
<td>30 days</td>
<td>7.07±0.12</td>
<td>7.0±0.01</td>
<td>6.84±0.02</td>
</tr>
<tr>
<td>45 days</td>
<td>7.1±0.12</td>
<td>7.0±0.01</td>
<td>7.04±0.02</td>
</tr>
<tr>
<td>P-Value</td>
<td>0.001*</td>
<td>0.001*</td>
<td>0.0001*</td>
</tr>
</tbody>
</table>

** Insignificant (p>0.05)  * Significant (P<0.05)
3.2. Electrical Conductivity

The Electrical Conductivity was significantly declining \((P \geq 0.05)\) at the maturity stage of vermicompost due to the enhanced microbial activity and addition of raw phosphate in the vermicompost (Sathisha, 2000) \[16\]. The significantly \((P \geq 0.05)\) declining trend of TOC noticed on 45\textsuperscript{th} days of vermicomposting. Similar results were reported by Gajalakshmi \textit{et al.} (2002) \[7\] and Moorthi and Nagarajan (2011) \[13\]. According to them, due to the increased microbial activity, the available organic carbon utilized for the oxidation processes in the vermicompost (Table 1).

3.3. Total Nitrogen, Total Phosphorous and Total Potassium

The total nitrogen, total phosphorus and total potassium showed significant increased \((P \geq 0.05)\) which is directly proportional to the increasing time (Table 2). Moorthi and Nagarajan (2011) \[13\] stated that the vermicompost conserves the nitrogen content by causing a decrease in the number of denitrifying bacteria and stimulating the growth of nitrogen fixing microflora. The increasing total phosphorous may be due to the addition of phosphate in the vermicompost by phosphobacteria. The increasing potassium may due to the better humification by the earthworms and enhanced microbial activities during the vermicomposting process, which consequently enhanced the rate of mineralization. The similar findings were also reported by Suthar (2007) \[17\].

Table 2: Total Nitrogen, Total Phosphorous and Total Potassium value in Different combinations of vermicompost.

<table>
<thead>
<tr>
<th>Days</th>
<th>TN%</th>
<th>TP%</th>
<th>TK%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60:40</td>
<td>70:30</td>
<td>80:20</td>
</tr>
<tr>
<td>0 day</td>
<td>1.70±0.21</td>
<td>1.58±0.11</td>
<td>1.22±0.11</td>
</tr>
<tr>
<td>15 days</td>
<td>1.86±0.07</td>
<td>1.73±0.09</td>
<td>1.48±0.13</td>
</tr>
<tr>
<td>30 days</td>
<td>2.01±0.09</td>
<td>1.92±0.08</td>
<td>1.59±0.14</td>
</tr>
<tr>
<td>45 days</td>
<td>2.28±0.1</td>
<td>2.07±0.1</td>
<td>1.79±0.16</td>
</tr>
<tr>
<td>P-Value</td>
<td>0.001*</td>
<td>0.001*</td>
<td>0.001*</td>
</tr>
</tbody>
</table>

** Insignificant \((p>0.05)\)  * Significant \((P<0.05)\)

3.4. C/N ratio

An ideal C/N ratio of superior vermicompost ranges from 11 to 20. In most of the combinations the C/N ratio is within this range (Table 3). C/N ratio is considered to be one of the simple indices to evaluate compost maturity (Barve, 1973) \[2\]. Generally C/N ratio of vermicompost ranged from 11 to 20 with an average value of 15 (Christopher, 1996) \[8\].

Table 3: Carbon/Nitrogen, Total, Calcium and Total Magnesium values in different combination of vermicompost.

<table>
<thead>
<tr>
<th>Days</th>
<th>C/N ratio</th>
<th>Ca%</th>
<th>Mg%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60:40</td>
<td>70:30</td>
<td>80:20</td>
</tr>
<tr>
<td>0 day</td>
<td>24.11±0.09</td>
<td>27.40±0.09</td>
<td>36.57±0.08</td>
</tr>
<tr>
<td>15 days</td>
<td>20.17±0.11</td>
<td>23.69±0.09</td>
<td>28.86±0.09</td>
</tr>
<tr>
<td>30 days</td>
<td>18.01±0.09</td>
<td>20.38±0.09</td>
<td>26.84±0.13</td>
</tr>
<tr>
<td>45 days</td>
<td>15.56±0.12</td>
<td>17.93±0.12</td>
<td>21.35±0.09</td>
</tr>
<tr>
<td>P-Value</td>
<td>0.0005*</td>
<td>0.001*</td>
<td>0.001*</td>
</tr>
</tbody>
</table>

** Insignificant \((p>0.05)\)  * Significant \((P<0.05)\)

3.5. Total Calcium and Total Magnesium

The total Ca and Mg improved for the period of vermicomposting (Table 3). The more content of Ca content in the vermicompost is attributable to the catalytic activity of carbonic anhydrase present in calciferous glands of earth worms generating CaCO\(_3\) on the fixation of CO\(_2\). The higher absorption of Mg in the vermicompost reported in present study was also in consistent with the findings of earlier workers (Padmavathiamma \textit{et al.} 2008) \[14\].

4. Conclusion

In the vermicomposting, the physico-chemical properties were analysed and reported. From the periodical analysis (0, 15, 30 and 45 days) of vermicompost combinations, it was concluded that the pH, Total Nitrogen, Total Phosphorus and Total Potassium, Total Calcium, Total Magnesium were showed in ever-increasing trend. Electrical Conductivity, Total Organic Carbon and C/N ratio were showed in declining trend from its initial days of
vermicomposting. The disposal of solid wastes as manures help in meeting the nutrient requirement of crops as well as sustaining soil health by maintaining soil organic matter status.

5. References


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