CHANGES IN ENZYME ACTIVITIES DURING VERMICOMPOSTING AND NORMAL COMPOSTING OF VEGETABLE MARKET WASTE

Ch.S. Rama Lakshmi*, P. Chandrasekhar Rao, T. Sreelatha, M. Madhavi, G. Padmaja and A. Sireesha
Regional Agriculture Research Station Anakapalle, Visakhapatnam-531 001, India

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ABSTRACT

The present investigation was carried out at changes in enzyme activities during composting which offers a promising solution for assessment of quality of compost. The results revealed that, in both the composting methods the enzyme activity decreased with increasing the composting period. However per cent decrease from initial to a particular period of time was more in vermicomposting than conventional composting and maximum activity was recorded in vermicomposting than conventional composting. The dehydrogenase activity was 79 and 44 mg TPF produced g⁻¹ hr⁻¹ at 30 and 60 days of vermicomposting, whereas in conventional composting at 30 and 110 days it was 36 to 29 mg TPF produced g⁻¹ hr⁻¹. The acid and alkaline phosphatase activity (µg PNP released g⁻¹ hr⁻¹) did not significantly changes with incubation in both the composting methods. However more phosphatase activity was recorded in vermicomposting than conventional composting and it was 48 and 26 % increase of acid and alkaline phosphatase activity in vermicomposting than conventional composting. The present study revealed that the vermicomposting of vegetable market waste recorded higher enzyme activities than conventional method of composting and low enzyme activity at maturity compared to initial stages of composting.

Key words: Conventional composting, Enzyme activity, Vegetable market waste, Vermicomposting.

INTRODUCTION

In India, about 340 million tonnes of agricultural wastes are generated annually, of which vegetable waste alone is in major portion (Anonymous 2010). The biological treatment of these wastes appears to be most cost effective and carry a less negative environmental impact. Poor soil management ensuring continued maintenance and build up of soil fertility is indispensable for greater productivity from agricultural land. Due to energy crisis, prohibitive cost of fertilizers and poor purchasing power of marginal and small farmers, it is imperative to develop strategy to use organic wastes to its maximum potential with proper technology to meet the shortage of fertilizers and for improving soil fertility. The biological decomposition of organic matter is mediated by a variety of biochemical processes in which enzymes play a key role. The quantification of enzyme activity during composting can reflect the dynamics of composting process in terms of decomposition of organic matter and mineral transformation. Therefore in the present study, Changes in different enzyme activities during vermicomposting and normal composting of vegetable market waste was carried out to determine and compare the different enzyme activities i.e urease, dehydrogenase, acid and alkaline phosphatase and cellulase at different stages of vermicomposting and normal composting of vegetable market waste.

MATERIALS AND METHODS

The present investigation involves preparation of different vermicomposts and normal composts from varied organic residues and comparative assessment of different enzyme activities was carried out at Regional Agricultural Research Station, Anakapalle, Visakhapatnam district during 2010.

*Corresponding author's e-mail: sitaramalakshmi20@yahoo.com
The basic raw material used for vermicomposting and normal composting was vegetable market waste, which was collected from Anakapalle vegetable market, Visakhapatnam district of Andhra Pradesh. The earthworm species Eisenia fetida was used for vermicomposting @ 1 kg per ton of organic residue and 1 % N as urea and 2 % SSP were used as chemical additives for normal composting. Both methods of composting were carried out in cement pits with 6 x 2 x 0.6 m size. The compost samples at 15, 30, 45 and 60 days interval for vermicomposts and 15, 30, 45, 60 and 110 days interval for normal composts were collected from each treatment for assay of different enzymes. The urease activity was assayed by quantifying the rate of release of NH$_4^+$ from the hydrolysis of urea as described by Tabatabai and Bremner (1972) but with some modifications as suggested by Sankara Rao (1989). Dehydrogenase activity was assayed by quantifying the mg of TPF (2,3,5-triphenyl formazan) produced by reaction with 2,3,5-TTC and expressed as g$^1$ sample h$^1$ as described by Cassida et al. (1964). The acid and alkaline phosphatase activity was assayed by quantifying the amount of p-nitrophenol released and expressed as μg of p-nitrophenol released g$^1$ sample h$^1$ as described by Tabatabai and Bremner (1969). Cellulase activity was measured by monitoring the release of reducing sugar using carboxy methyl cellulose as substrate following the procedure outlined by Pancholy and Rice (1973). This includes two steps viz., extraction and estimation.

RESULTS AND DISCUSSION

Changes in urease activity during vermicomposting and normal composting of vegetable market waste at different time intervals: The urease activity decreased with increasing the composting period in both the methods of composting. In vermicomposting from 30 to 60 days the urease activity decreased from 512 to 415 μg NH$_4^+$ released g$^1$hr$^1$, whereas in normal composting from 30 to 110 days the urease activity decreased from 325 to 280 μg NH$_4^+$ released g$^1$hr$^1$. In composting the period from 30 to 110 days, it was reduced from 325 to 280 μg NH$_4^+$ released g$^1$hr$^1$. The high initial activity of urease in both the composting methods was due to availability of easily degradable substances which resulted in high microbial activity. The decrease at the later stages might be due to lack of availability of carbon compounds for microorganisms which leads to decrease in microbial biomass. Similar results were reported by Haritha Devi et al. (2009) in their studies on composting of organic residues. Between composting methods higher urease activity was observed in vermicomposting could be due to increased biomass of earthworms and microbes which increases the urease activity (Susan and Chhonkar, 2004). In addition to this, presence of nitrogen fixers in vermicompost might stimulate the conversion of ammonium to ammonia.

Changes in dehydrogenase activity during vermicomposting and normal composting of vegetable market waste at different time intervals: Dehydrogenase has been considered as an indicator of overall microbial activity because it occurs intra cellularly in all living microbial cells. Dehydrogenase activity is related to group of enzymes which participate in the metabolic reactions producing energy in the form of ATP through the oxidation of organic matter, which is especially interesting in the composting process.

The data presented in Table 1 and 2 revealed that the dehydrogenase activity was higher at the initial stages of composting and decreased from initial to final composting in both the methods. However higher activity was observed in vermicomposting than normal composting. During vermicomposting of vegetable market waste at 30 and 60 days, the dehydrogenase activity was 50 and 41 mg TPF g$^1$hr$^1$, whereas in normal composting at 30 and 110 days it was 36 and 29 mg TPF produced g$^1$hr$^1$. Similar results were reported by Shanthi et al. (2010) in different organic residues.

**TABLE 1:** Changes in enzyme activities at different time intervals during vermicomposting

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Urease (μg NH$_4^+$ g$^{-1}$hr$^{-1}$)</th>
<th>Dehydrogenase (mg TPF g$^{-1}$hr$^{-1}$)</th>
<th>Acid Phosphatase (μg PNP g$^{-1}$hr$^{-1}$)</th>
<th>Alkaline phosphatase (μg PNP g$^{-1}$hr$^{-1}$)</th>
<th>Cellulase (μg glucose g$^{-1}$hr$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time interval</td>
<td>30 d 60 d</td>
<td>30 d 60 d</td>
<td>30 d 60 d</td>
<td>30 d 60 d</td>
<td>30 d 60 d</td>
</tr>
<tr>
<td>Enzyme activity</td>
<td>512 415</td>
<td>79 44</td>
<td>805 810</td>
<td>1390 1405</td>
<td>845 760</td>
</tr>
</tbody>
</table>
In both the composting methods, higher activity of dehydrogenase was noticed during initial stage than in the final matured compost. This could be due to the fact that, large amounts of easily degradable organic substances available for proliferation of microbes and this might have resulted in increased microbial activity and leads to increased dehydrogenase activity. However, at later stages i.e at the final stages of decomposition they slowed down and the dehydrogenase activity is thus lower (Singh and Ganguly, 2005).

Changes in acid phosphatase activity during vermicomposting and normal composting of vegetable market waste at different time intervals: Phosphatase is an enzyme of agronomic value because it hydrolyses compounds of organic phosphorus and transforms them into different forms of inorganic phosphorus which are assimilable by plants. Phosphatase activity is an indication of P mineralization power by microorganisms (Raut et al., 2008). This enzyme is more relevant for the evaluation of composting process since it is synthesized by microorganisms only and does not originate from plant residues.

The acid phosphatase activity (µg PNP released g⁻¹hr⁻¹) was not significantly influenced with incubation in both the composting methods. However higher phosphatase activity was recorded in vermicomposting than normal composting. The acid phosphatase activity at 30 and 60 days was 805 and 810 µg PNP released g⁻¹hr⁻¹ during vermicomposting and 395 and 390 µg PNP released g⁻¹hr⁻¹ during normal composting.

Changes in alkaline phosphatase activity during vermicomposting and normal composting of vegetable market waste at different time intervals: In vermicomposting at 30 and 60 days the alkaline phosphatase activity (expressed as µg PNP released g⁻¹hr⁻¹) was 1390 and 1405 in vegetable market waste. In composting at 30 and 110 days, it was 980 and 990 µg PNP released g⁻¹hr⁻¹. Alkaline phosphatase activity of both the was high compared to acid phosphatase activities. This was due to neutral pH range of composts at which alkaline phosphatase remained active (Pramanik et al., 2007). Similar changes in acid and alkaline phosphatase activity during composting and vermicomposting was reported by several workers (manuel Tejada et al., 2009 and Shanthi et al., 2010). The variation in acid and alkaline phosphatase activity shown by different composts may be due to variation in earthworm and microbial activity, differences in various organic phosphate compounds present in different materials and the stage of composting.

Changes in cellulase activity during vermicomposting and normal composting of vegetable market waste at different time intervals: Cellulase which is responsible for hydrolysis of cellulose, studied to understand the degradation of different organic residues. Cellulose is the most abundant organic compound in the biosphere, comprising almost 50 % of the biomass synthesized by photosynthetic fixation of carbon dioxide. Growth and survival of microorganisms are important in most of the agricultural soils depends on the carbon source contained in the cellulose. Cellulases are a group of enzymes that catalyse the degradation of cellulose (Dick and Tabatabai, 1992). The cellulase activity (µg glucose released g⁻¹hr⁻¹) decreased with incubation in both the composting methods. In vermicomposting at 30 and 60 days of decomposition, the cellulase activity recorded was 845 and 760 µg glucose released g⁻¹hr⁻¹. In case of composting at 30 and 110 days, the cellulase activity was 400 and 365 µg glucose released g⁻¹hr⁻¹. Cellulase activity decreased at maturity in both the composts and this could be probably due to the decrease in microbial population and available substrate in the organic matter. The observed lower enzymatic activity in compost than vermicompost might be attributed to the slow and incomplete stabilization of organic matter. Similar results were reported by Shanthi et al. (2010).
CONCLUSIONS

A close perusal of data on enzyme activities indicated that almost all the enzymes were high at 30 days in both the composting methods. This may be due to availability of easily degradable substances and there was a spurt in microbial activity in the initial stages. The production of metabolic intermediates including inorganic radicals might have changed the biology of the system. The initial stage of active decomposition is followed by a second stage of synthesis during composting. During this stage a change in the spectrum of the enzyme activities is expected. In the maturity stage due to lack of suitable carbon compounds for microorganisms the enzyme activity will be reduced Krishna Murthy et al. (2010). The enzyme activities i.e. urease, phosphatase, dehydrogenase and cellulose were decreased with increasing the composting period in both the composting methods of vegetable market waste. Among the composting methods higher enzyme activities were recorded during vermicomposting over normal composting. Vermicomposting is preferred over normal composting to overcome the deficiencies in the long duration for decomposition apart from low enzyme activity in normal composting.

REFERENCES


