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Vermicomposting of different types of waste using *Eisenia foetida*: A comparative study

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Abstract

A study (100 days duration) was conducted to evaluate the efficiency of an exotic earthworm species (epigeic—*Eisenia foetida*) for decomposition of different types of organic substrates (kitchen waste, agro-residues, institutional and industrial wastes including textile industry sludge and fibres) into valuable vermicompost. The percentage of, nitrogen, phosphorous and potassium in vermicompost was found to increase while pH and total organic carbon declined as a function of the vermicomposting period. 4.4–5.8-fold increases in TKN was observed in different feed mixtures at the end of vermicomposting period. The increase in TKN for different feed substrates was found in the order: textile sludge > textile fibre = institutional waste > agro-residues > kitchen waste. Available Phosphorus increased 1.4 to 6.5-fold in different feed mixtures in comparison to control. Reduction in TOC was highest in agro-residues (3-fold) followed by kitchen waste (2.2-fold), institutional waste (1.7-fold) and textile industrial wastes (sludge, 1.5-fold and fibre, 1.68-fold) in earthworm-inoculated pots than control. The data reveals that vermicomposting (using *E. foetida*) is a suitable technology for the decomposition of different types of organic wastes (domestic as well as industrial) into value-added material.

Keywords: *Eisenia foetida*; Agro-residues; Industrial waste; Vermicomposting

1. Introduction

Over the last few years, the problem of efficient disposal and management of organic solid wastes has become more rigorous due to rapidly increasing population, intensive agriculture and industrialization. Production of large quantities of organic waste all over the world poses major environmental (offensive odors, contamination of ground water and soil) and disposal problems (Edwards and Bater, 1992). Therefore, the disposal of different types of wastes has become very important issue for maintaining healthy environment (Senapati and Julka, 1993).

Although various physical, chemical and microbiological methods of disposal of organic solid wastes are currently in use, these methods are time consuming and involve high costs. Therefore, there is a pressing need to find out cost-effective alternative method of shorter duration particularly suited to Indian conditions. In this regard, vermicomposting has been reported to be a viable, cost-effective and rapid technique for the efficient management of the organic solid wastes (Hand et al., 1988; Raymond et al., 1988; Harris et al., 1990; Logsdson, 1994). Several research studies have demonstrated the ability of some earthworm species to consume a wide range of organic wastes such as sewage sludge, animal dung, crop residues and industrial refuse

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(Mitchell et al., 1980; Chan and Griffiths, 1988; Hartenstein and Bisesi, 1989; Edwards, 1998). Earthworms fragment the waste substrate and accelerate rate of decomposition of the organic matter, leading to a composting effect through which unstabilized organic matter becomes stabilized. The vermicompost has more available nutrients per kg weight than the organic substrate from which it is produced (Buchanam et al., 1988). The biological activity of earthworms provides nutrient rich vermicompost for plant growth thus facilitating the transfer of nutrients to plants. (Ismail, 2000).

Keeping in view the above facts, the present study was conducted to assess the potential of *Eisenia foetida* in composting the different types of organic substrates (i.e. textile sludge, textile fibre, institutional waste, kitchen waste, agro-residues) and quality of vermicompost thus produced.

2. Methods

2.1. Collection of organic wastes

The organic solid wastes selected for this study i.e. kitchen waste, agro-residues and institutional wastes were obtained from Guru Jambheshwar University (G.J.U.) campus and industrial waste (sludge and fibre) was procured from the textile factory (H.P. Cotton Mill Ltd.) located near Hisar, India.

2.2. Collection of earthworms

The earthworms (*E. foetida*) were obtained from the Department of Human Resource Management, Haryana Agriculture University, Hisar.

2.3. Experimental setup

The experiments were conducted in earthen pots of size (21 cm height and 25 cm diameter), each of capacity 1 kg waste, with a hole at the bottom. The composting mixture consisted of different kinds of substrates mixed individually with cow dung and soil in the ratio 6:3:1 (on dry weight basis). Total 500 gm (i.e. 300 gm waste + 150 gm cow dung + 50 gm soil) of composting mixture was taken in each experimental pot to provide initial favorable environmental conditions for the worms. In the treatment pots, seven healthy earthworms of approximately the same size (7–8 cm) and weight (2.5–3 gm) were introduced after 15 days of partial decomposition of organic wastes. This was done to avoid exposure of worms to high temperature during the initial thermophilic stage of composting. The duration of experiment was 100 days. Water was sprinkled daily on pots using an iron sprayer to maintain the moisture level of 55–60%. The experimental pots were kept under shade and covered with the gunny bags to avoid direct sunlight. There were three replicates for each feed mixture. The control (i.e. untreated) pots had no earthworm.

2.4. Chemical analysis

Vermicompost samples were drawn at different intervals i.e. 0, 20, 40, 60, 80 and 100 days. The 0 day refers to the time of initial mixing of waste with cowdung and soil before preliminary decomposition. The earthworms were removed manually at the end of the experiment. Determination of pH was done by a digital pH meter (ELICO- L1 162), electrical conductivity by a conductivity meter (ELICO-180). Total organic carbon and total Kjeldhal nitrogen were estimated by Walkley and Black rapid titration method (1934) and microKjeldhal method, respectively (Singh and Pradhan, 1981). Available phosphorus and total potassium were estimated by Bray and Krutz method (1945) and by Flame emission technique, respectively. All the determinations were carried out in triplicate.

2.5. Statistical analysis

All the reported data are the arithmetic means of three replicates. Two-way analysis of variance (ANOVA) was done to determine any significant difference among the parameters analyzed during vermicomposting at 0.05% level of significance.

3. Results and discussion

The data are presented in the Tables 1–3. Vermicomposting significantly modified the physical and chemical properties of different feed mixture tested. The lower pH recorded in the final products might have been due to the production of CO_2 and organic acids by microbial metabolism during decomposition of different substrates in the feed mixtures (Albanell et al., 1988; Chan and Griffiths, 1988; Haimi and Hutha, 1986; Elvira et al., 1998). Similar results on vermicomposting of cattle manure, fruit and vegetable wastes have been reported by Mitchell (1997) and Gunadi and Edwards (2003). It was also reported that different substrates could result in the production of different intermediate species resulting in different behavior in pH shift. Organic carbon decreased more significantly with time in all the feed substrates as compared to control. The maximum reduction in TOC was obtained in agro-residues (3-fold) and kitchen waste (2.2-fold) in comparison to institutional (1.7-fold) and textile industrial wastes (sludge, 1.5-fold and fibre, 1.68-fold) in earthworm inoculated pots than control. 1.2–1.7-fold loss of organic carbon as CO_2 was observed during vermicomposting of paper mill and