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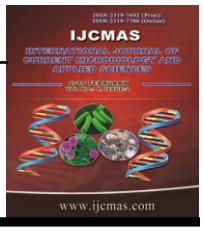

Original Research Article

Microbial Population Dynamics during Vermicomposting of three different substrates amended with cowdung

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Keywords

Earthworms, Microbial population, Pre-decomposition, Vermicompost.

A B S T R A C T

Twenty one days pre-decomposed substrates, teak leaf litter (TLL), paper mill sludge (PMS) and pressmud (PM) in combination with cowdung was subjected to vermicomposting using the epigeic earthworm, *Perionyx ceylanensis* for 60 days. The vermicompost was analysed for pH, electrical conductivity, total contents of organic carbon, nitrogen, phosphorus, potassium and C/N ratio. The total population of bacteria, fungi and actinomycetes was enumerated from each of the vermibed substrates from the start of the experiment (0 day) every ten days until the termination of the study (60th day). The vermicompost showed enhanced levels of nutrients and microbial population. The population of microbes initially showed steady growth rates until 30-40 days and then the population was maintained or slightly lowered.

Introduction

Many approaches to waste management exist. Generally, solid waste is managed through landfills, incineration and recycling or reuse. However, in developing countries, properly engineered landfills are not common, while the cost of modern incineration is too exorbitant to bear. Hence, the most common method of disposal is some form of landfill, including variants such as uncontrolled dumping in undefined areas, collection and disposal on unmanaged open dumps (UNEP, 2004). It is common to find pickers moving from door to door or sorting through communal bins to pick up recyclable materials. However, these pickers are more interested in inorganic recyclable materials such as plastics and glass, but not in organic wastes. The method of employing earthworms in the degradation of organic matter present in the waste in to useful vermicompost is called as vermicomposting. Vermicomposting, also known as worm composting, is simply the way earthworms transform decaying organic matter into worm castings. It is all-together a natural system in which the earthworms play their major roles in degrading the organic portion of the waste. The use of earthworm in

organic waste management is called as vermicomposting or vermistablization (Edwards et al., 1988).

Vermicompost has been shown to have high levels of total and available nitrogen, phosphorous, potassium (NPK) and micro nutrients, microbial and enzyme activities and growth regulators (Edwards, 2004; Karmegam and Daniel, 2009a; Prakash and Karmegam, 2010). Vermicompost, an organic soil conditioner is known to enhance the plant growth and yield (Zaller, 2007; Karmegam and Daniel, 2008). The utilization of vermicompost and vermicasts as substitute for peat in horticultural potting media and carrier media in air-layering for ornamental plant has been recently reported (Zaller, 2007; Karmegam and Daniel, 2009b). The methods used in municipal solid waste disposal in the majority of cities and towns in the India are non-systematic and unscientific, involving dumping in low lying areas in the outskirt of the towns. In an attempt to streamline waste management, the Ministry of Environment and Forest (MOEF) has promulgated the ‘‘Municipal Wastes (Management and Handling) Rules, 2000” under Environment (Protection) Act, 1986, addressing all aspects of waste management from collection, transportation, storage, recycling, and processing to final disposal. The rules emphasize integrated solid waste management from door-to-door collection to processing of organic waste and scientific disposal of inert materials (Lal and Rajnikant, 2010). These wastes need to be recycled to avoid environmental pollution and loss of nutrients, and also to get valuable end product vermicompost for agricultural purposes. In India, earthworms has been successfully utilized for vermicomposting of leaf litters (Karmegam and Daniel, 2000), municipal solid waste (MSW) (Kaviraj and Sharma, 2003), paper waste (Prakash et al., 2008), silkworm litter (Rajasekar and Karmegam, 2009) and beverage industry sludge (Singh et al., 2010). The present study has been carried out to find the vermicomposting of three different substrates, teak leaf litter (TLL), paper mill sludge (PMS) and Pressmud (PM) in combination with cowdung using the earthworm, *Perionyx ceylanensis* and the population dynamics of bacteria, fungi and actinomycetes were enumerated to assess their dynamics during vermicomposting.

Materials and Methods

Teak leaf litter (TLL) was collected from an agroform near KSK College, Kanchipuram. The paper mill sludge (PMS) was procured from a private mill near Kanchipuram. The filter mud or pressmud (PM) was collected from Cheyyar Co-operative Sugar Mills Ltd., located in Thenthandalam, Anakkayur, Thiruvannamalai District, Tamil Nadu. The cowdung was collected from nearby cattle sheds in fresh form and allowed to stabilize for one week and used for the study. The organic substrates, TLL, PMS and PM were subjected to initial decomposition in rectangular draining cement tanks of 75cm×60cm×45cm size by sprinkling water, regular mixing and turning of the substrates for 20 days. The earthworm, *Perionyx ceylanensis* Mich. for the study, originally collected from culture bank of the Department of Biology, Gandhigram Rural Institute- Deemed University, Tamil Nadu, India was mass multiplied in cow dung and used for vermicomposting studies. Based on the studies reported by Karmegam and Daniel (2009a and 2009b) and Prakash and Karmegam (2010) on vermicomposting of different organic substrates using *P. ceylanensis*, the ratio of organic substrate mix, i.e., 1:1 (50:50) proportion on dry weight basis was used in the present study. Accordingly, the pre-decomposed organic substrates were mixed with cowdung in 1:1

ratio on dry weight basis, transferred to vermibeds and moistened to hold 60-70% moisture content. The vermicomposting studies were carried out for 60 days using *P. ceylanensis* in three replicates twice under controlled conditions. The microbial population count, i.e., bacteria, fungi and actinomycetes and the characteristics of vermicompost were analysed as described in Prakash and Karmegam (2010). The microbial population was assessed every 10 days from the start of the experiment till the termination of the study, i.e., 60th day.

Results and Discussion

The characteristics of vermicompost obtained from three different substrates in combination with cowdung prepared using *P.ceylanensis* is given in Fig. 1. The pH of the vermicompost was in the range of 7.1 to 7.3 and E.C. in the range of 3.2 to 5.1 mS/cm. The organic carbon content and C/N ratio was found between 26.5 and 28.1%, and 19.28 and 22.84% respectively. The NPK contents were good. They are quite beneficial as sufficient quantities of these elements are present. The data so obtained, as seen from the Fig. 1, are in agreement with the various parameters of the vermicompost obtained at ICRISAT, Hyderabad (Nagavallemma *et al.*, 2004; Prakash and Karmegam, 2010a). The results of the present study showed that the vermicomposts of six different organic material combinations with *P. ceylanensis* is rich in nutrients, suitable to be used as organically rich source of biofertilizers for any crop. Several researchers have used different ratios of organic materials such as leaf litter, pressmud and paper mill sludge with cowdung for vermicomposting (Kaviraj and Sharma, 2003; Karmegam and Daniel, 2009b; Prakash and Karmegam, 2010).

The total microbial populations *viz.*, during vermicomposting of three different substrates in combination with cowdung are shown in Figs. 2-4. The microbial population increased from day 0 to 60th day in all the vermibeds. The total bacterial population of 56, 75, 89, 146, 279, 287 and 193 CFU × 10^6 g^{-1} were recorded during vermicomposting of TLL+cowdung on 0, 10, 20, 30, 40, 50 and 60 days respectively. The trend of increase of fungal and actinomycetes population was parallel to that of bacteria observed vermicomposting of TLL+cowdung (Fig. 2). Similar changes were also recorded for PMS+cowdung and PM+cowdung (Fig. 3 and Fig. 4).

In all the substrates used in the present study, it was observed that the population of bacteria dominated till the end of the study followed by fungi and actinomycetes. A steady increase of microbial population was observed up to 40th day of vermicomposting, then the population was maintained or slightly decreased.

According to Nagavelamma *et al.* (2004) vermicompost when analyzed for microbial diversity and their population have indicated the presence of bacteria, fungi and actionomycetes. Several authors have noted that the earthworms play a major role in affecting population of microorganisms, especially causing changes in the soil microbial community (Coleman, 1985; Parmaelee, 1998). Nagarvallemma *et al.* (2004) recorded higher microbial populations in the partially decomposed dry organic waste material for vermicomposting than the vermicompost itself. These studies reported that partially decomposed organic waste material per gram of samples had bacterial, fungal and actionomycetes counts as $89x10^6$, $11x10^4$ and $2x10^4$, while vermicompost contained slightly less counts as $54x10^6$, $8x10^4$ and $1x10^4$, respectively. Earthworms inevitably consume the soil

microbes during the ingestion of litter and soil. It has been recently estimated that earthworms necessarily have to feed on microbes, partially fungi for their protein /nitrogen requirements (Rangannathan and Parthasarathi, 2000).

Fig.1 Characteristics of Vermicompost Obtained from Three Different Substrates Amended with Cowdung Utilizing the Earthworm, *P. ceylanensis*

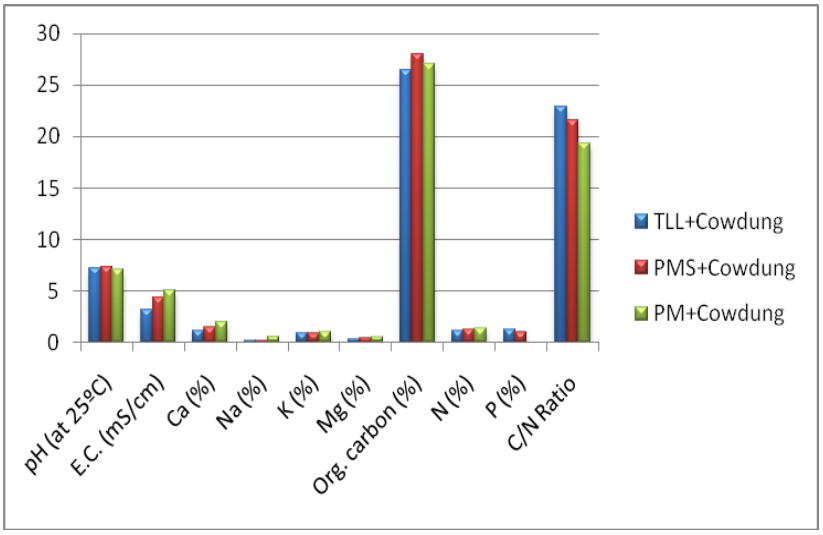


Fig.2 Total Microbial Population Dynamics During Vermicomposting of TLL+Cowdung (1:1) with *P. ceylanensis* (Values are Log Transformed Mean of Six Replicates)

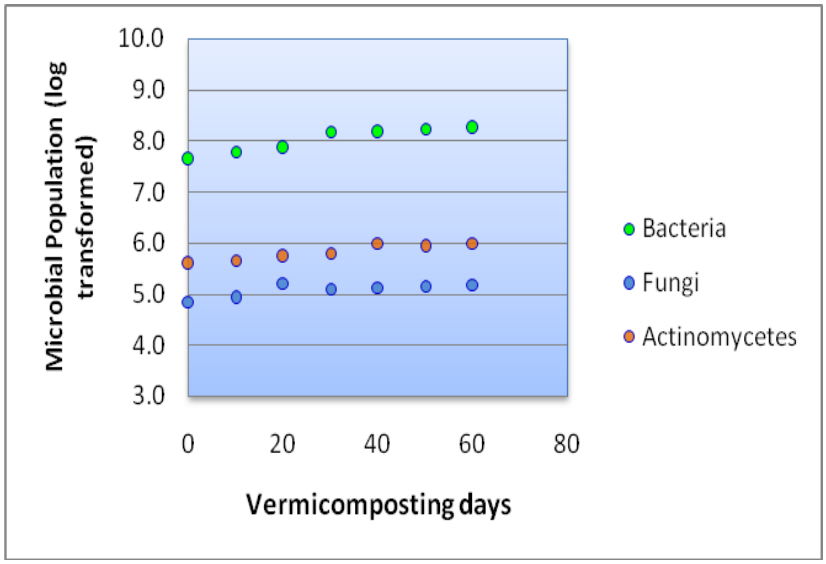


Fig.3 Total Microbial Population Dynamics During Vermicomposting of PMS+cowdung (1:1) with *P. ceylanensis* (Values are Log Transformed Mean of Six Replicates)

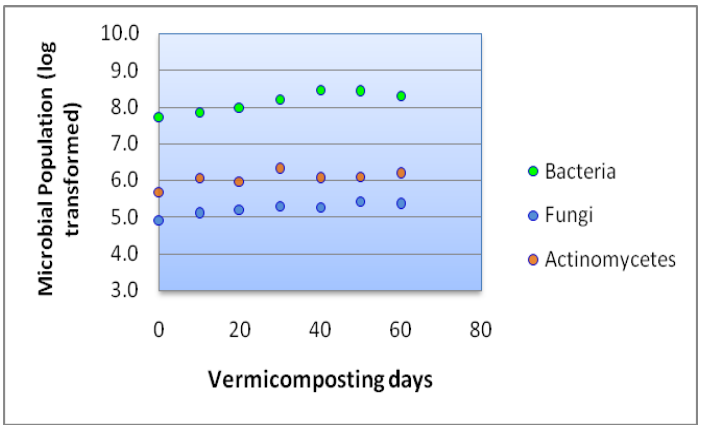
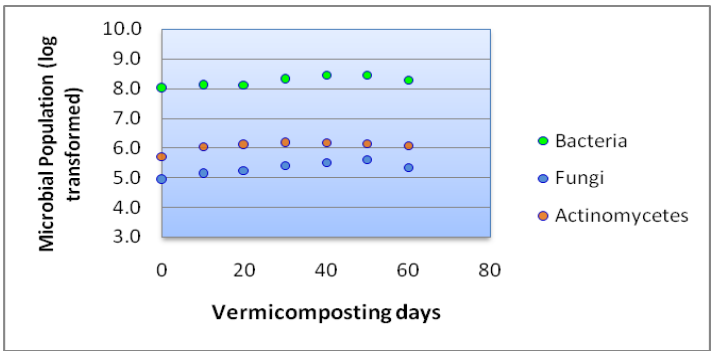


Fig.4 Total Microbial Population Dynamics During Vermicomposting of PM+cowdung (1:1) with *P. ceylanensis* (Values are log Transformed Mean of Six Replicates)



The observations made in the present study is supported by Parthasarathi and Ranganathan (1999) and Parthasarathi *et al*., (2007) who reported enhanced microbial population, microbial activity and NPK content in the vermicompost during vermicomposting of sugar industrial wastes. Stability of vermicompost depends considerably on their age, their microbial population and activity and the organic matter content (Ge *et al*., 2001). Microbial biomass, microbial activity and N P K content was found to be decreased in aged vermicasts (Parthasarathi and Ranganathan, 1999). A slight reduction of microbial population and activity and NPK contents in the older P vermicompost of 30, 45 and 60th day was mainly due to reduced moisture/low microbial growth and enzyme synthesis by microorganisms/leaching and the immobilization and inactivation of micro-organism (Parthasarathi, 2006). The present study clearly indicates that the vermicompost characteristics produced from three different substrates in combination with cowdung utilizing the earthworms, *Perionyx celanensis* for 60 days is possessing sufficient nutrient levels for plant growth. The microbial populations, bacteria, fungi and actinomycetes were found to be increasing steadily upto 40 days and then their population was maintained or slightly lowered.

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