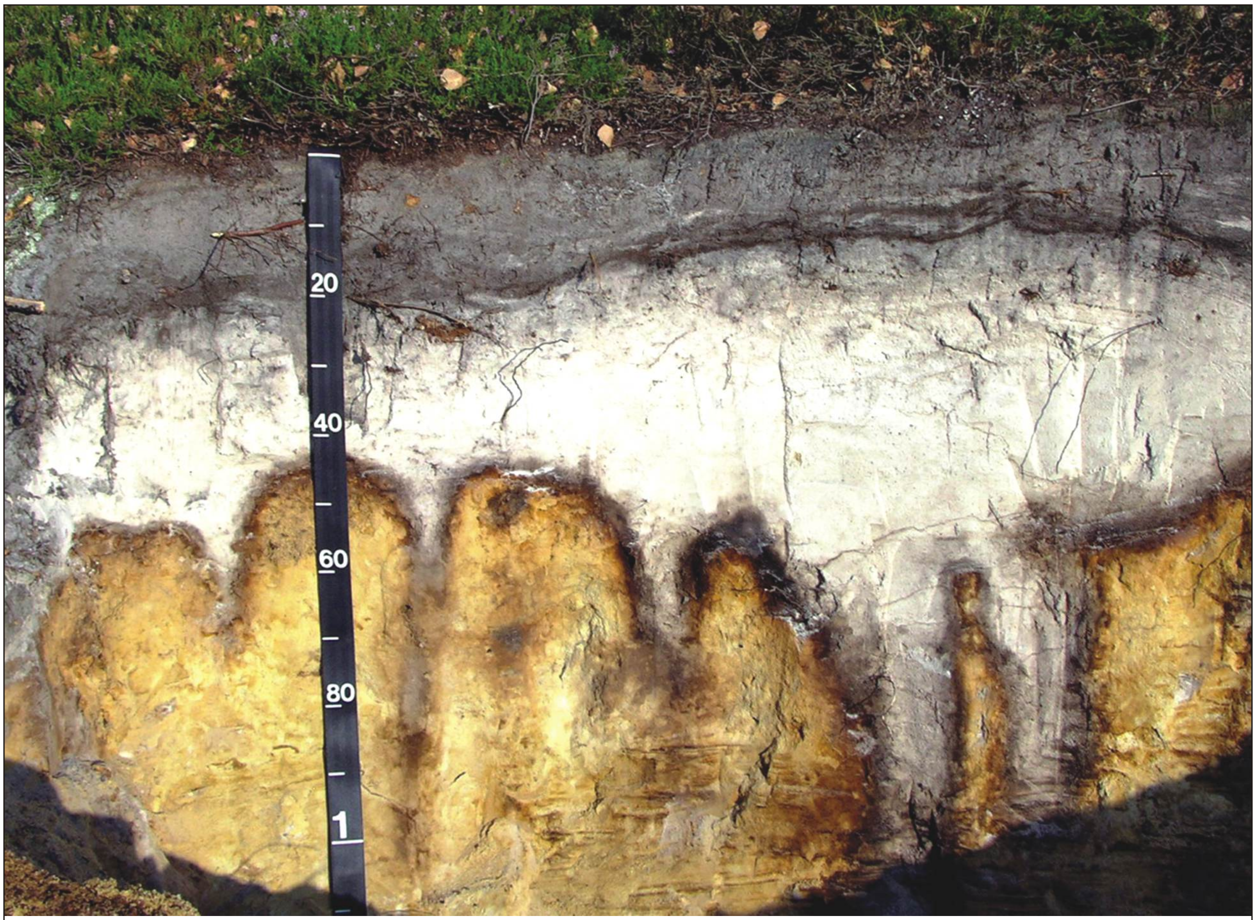

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Worm Powered Environmental Biotechnology in Organic Waste Management

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ABSTRACT

Every city generates tonnes of garbage that includes organic biodegradable waste like kitchen waste, fruit and vegetable market waste, which poses a serious problem of disposal. However, if handled and treated properly, this could provide useful organic manure for agricultural application. This problem can be solved by combination of effective technologies like Biodung composting and Vermitech (incorporating earthworms for the production of vermicompost). The present study was carried out during the year 2006-2007 at University of Guyana, Georgetown to recycle grass clippings, water hyacinth and cattle dung by using *Eisenia fetida* the locally available surface species of earthworm. The results indicated that the organic waste (grass clipping s and water hyacinth) were successfully processed through partial biodung composting and vermicomposting during the period of 60 days. The temperature study during biodung composting showed two peak rise of temperature resulting in destruction of harmful microbes. Subsequent vermicomposting resulted in production of vermicompost confirming to the excellent nutrient status recorded in earlier experiments. The temperature study during vermicomposting showed that fluctuation was restricted to +0.83.

Key words: Waste management, vermicomposting, *Eisenia fetida*, organic waste

INTRODUCTION

In recent years, disposal of organic wastes from various sources like domestic, agriculture and industries has caused serious environmental hazards and economic problems. In this regard, recycling of organic waste is feasible to produce useful organic manure for agricultural application. In this regard, the recycling of utilizable waste is feasible. It has been demonstrated that earthworms can process household garbage, city refuse, sewage sludge and waste from paper, wood and food industries (Senapati and Dash, 1982; Ansari and Ismail, 2008). The role of earthworms in organic solid waste management was first highlighted by Darwin (1881) and thus, their role in organic solid waste management has been well established (Bouche, 1979; Kale *et al.*, 1982; Ismail, 1993, 1997, 2005; Edwards and Bohlen, 1996; Ansari, 2009). In tropical and subtropical conditions *Eudrilus eugeniae* and *Perionyx excavatus* are the best vermicomposting earthworms for organic solid waste management (Kale, 1998; Ismail, 2005; Ansari, 2007).

Technology referred to as Vermitechnology has been developed to process the waste to produce an efficient bio-product vermicompost (Kale *et al.*, 1982; Ismail, 1993; Ansari, 2007, 2009). Epigeic earthworms like *Perionyx excavatus*, *Eisenia fetida, Lumbricus rubellus* and *Eudrilus eugeniae* are used for vermicomposting but the local species like *Perionyx excavatus* has proved efficient composting earthworms in tropical or sub-tropical conditions (Ismail, 1993; Edwards and

Neuhauser, 1988; Kale, 1998; Ansari and Ismail, 2003). The method of vermicomposting involving a combination of local epigeic and anecic species of earthworms (*Perionyx excavatus* and *Lampito mauritii*) is called Vermitech (Ismail, 1993; Ansari, 2007, 2009).

MATERIALS AND METHODS

Solid waste management unit were established based on the infrastructural guidelines of Vermitechnology. Organic solid waste (large quantity) was processed through biodung composting (pre-digestion) and then loaded into the vermicomposting units in a cyclic manner. Vermicompost was harvested after every sixtieth day from the start of biodung composting. Temperature was recorded regularly during the process of biodung composting. The concept of vermitech (vermiculture and vermicomposting) was developed to perfection for implimentation successfully. A shed and platform with three vermiculture tanks of dimension 1.9×1.5×1 m were constructed. *Eisenia fetida* (epigeic species of earthworms) were inoculated in all the tanks with vermitech setting. Mean while the vermiculture tanks were sprinkled with water on weekly basis to maintain moisture. Biodung composting units were set up (in triplicate), by using the combination of water hyacinth and grasses. The biodung composting were turned after 15 days and were transferred to respective vermitech units after total time period of 30 days for further processing and vermicomposting. During March, 2007, vermicompost from the three tanks was harvested.

Temperature was recorded regularly during the process of biodung composting. Vermicompost after harvesting was sieved through 3 mm sieve. It was subjected to chemical analysis (pH, electrical conductivity, organic carbon, nitrogen, phosphorus, potassium, calcium, manganese, iron, copper and zinc) to assess its nutrient status (Homer, 2003). Soil water suspensions (1:5) were prepared to determine pH (Hanna, 1968) and to measure electrical conductivity using a conductivity meter (Elico, India). Organic carbon was colorimetrically estimated by modified Walkley-Black partial oxidation method (Jackson, 1958). Total Kjeldahl Nitrogen (TKN) was determined as described in Jackson (1958). Available phosphate was estimated as recommended by Anderson and Ingram (1989). The analysis of the compost samples was done at Central Laboratory, Research Center, Agriculture Department, LBI Compound, GuySuCo.

RESULTS AND DISCUSSION

Many investigations have been carried out on industrial level large scale composting of organic waste in municipal setting (Carra and Cossu, 1990; Christopher and Asher, 1994; Ansari and Ismail, 2001a; Ansari, 2007). Present study conclusively proves that large scale recycling of organic waste by the application of biodung composting followed by vermicomposting is a feasible technology.

The combination of grass clippings, water hyacinth and cattle dung was used as organic waste for the process of biodung cum vermicomposting. The results indicated that the organic waste (grass clipping s and water hyacinth) were successfully processed through partial biodung composting and vermicomposting during the period of 60 days.

Biodung composting of grass which was carried out for the period of 8 weeks during which it was turned twice. The weekly temperature recorded shows that there were two major peaks of temperature increase (2nd week-54.3°C and 6th week-34°C) indicating the activity of thermophilic microorganisms. The temperature increase brings about killing of harmful microbes. The process of biodung composting involves partially aerobic and partially anaerobic process. This reduces the bulk of organic waste to one third of the volume. The cattle dung solution serves the purpose of providing inoculum of microbes which carry out degradation of organic waste (Fig. 1). After 8 weeks of biodung composting, the processed biodung compost was transferred to specific vermicomposting unit. Temperature was also observed during the process of vermicomposting in the 3 vermicomposting units. The temperature study showed that fluctuation was restricted to +0.83 (grass clippings+water hyacinth) (Fig. 2).

Table 1 indicated that productivity in vermicomposting units was 34.17% which was very well supported by the earthworm activity due to their preferred palatability in the processes of vermicomposting. During the process of biodung composting, mesophilic flora predominates with their metabolic activity resulting in the increase in temperature of the organic waste. They are replaced by thermophilic organisms which survive at temperatures greater than 45°C to facilitate composting. When the temperature falls, mesophilics become active again. The changes in the microflora like bacteria, actinomycetes and fungi during composting have been well studied (Chang and Hudson, 1967a, b; Hayes and Lim, 1979).

Nutrient status of vermicompost (Table 2) produced from the organic waste correlates with the earlier reports (Shinde *et al.*, 1992). Vermicompost is an excellent bio-fertilizer, which has been investigated to have favorable influence on the growth and yield parameters of several crops like paddy, sugarcane, tomato, brinjal and okra (Ismail, 1997). Vermicompost contributes to the supply of essential micro-nutrients (Kale, 1998; Ansari and Ismail, 2001b; Ansari, 2008a-c) and moreover, contains growth promoting substances like auxins and cytokinins (Krishnamoorthy and Vajranbhiah, 1986). Thus, vermitechnology is a system harnessing earthworms for bio-conversion

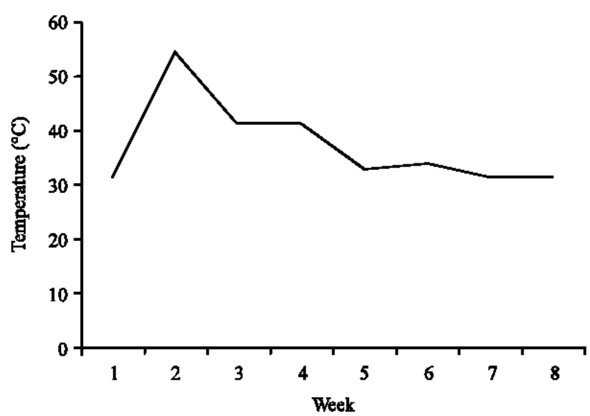

Fig. 1: Temperature changes during biodung composting

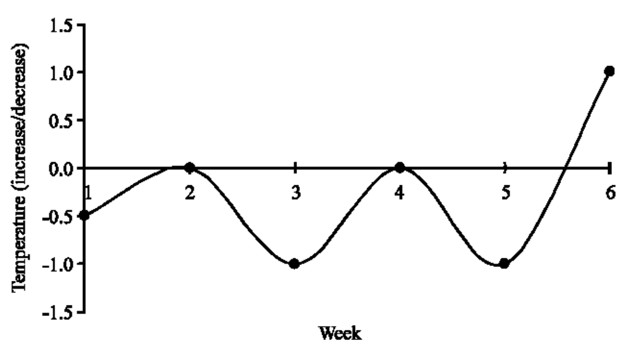

Fig. 2: Fluctuation in temperature in vermicomposting units

Table 1: Harvest data (vermicompost)

Units	BD grass+hyacinth
Initial mass (kg)	210
Transfer to vermitech unit (kg)	120
Conversion rate (%)	57.14
Harvested vermicompost (kg)	65
Dried vermicompost (kg) with 40% moisture	41
Productivity of vermicompost (%)	34.17

Table 2: Physicochemical properties of vermicompost (Mean±SD)

Parameters	Vermicompost
pH	6.12±0.03
Total salts (ppm)	3148.67±48.58
Total Nitrogen (%)	1.11±0.05
Organic Carbon (%)	9.77±5.05
C/N ratio	8.80
Available Phosphate (ppm)	597.67±0.58
Calcium (ppm)	322.33±24.91
Magnesium (ppm)	137.33±19.50
Potassium (ppm)	2428.33±326.28
Manganese (ppm)	0.69±0.01
Iron (ppm)	0.11±0.01
Copper (ppm)	0.01±00
Zinc (ppm)	2.13±0.05

of organic waste into vermicompost which has extensive application in waste management and sustainable organic farming and has proved to be one of the efficient methods of managing organic wastes with least complexity and economic viability.

CONCLUSION

The investigations carried out at University of Guyana showed that the combination of effective technologies like Biodung composting and vermicomposting results in reduction of time period of recycling with minimum resources at an affordable cost with locally available resources. The nutrient status of the product vermicompost obtained confirmed to the standards recorded in the earlier experiments. Such technologies in organic waste management would lead to zero waste techno farms without the organic waste being wasted and burned rather then would result in recycling and reutilization of precious organic waste bringing about bioconservation and biovitalization of natural resources.

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