VERMITECH: AN INNOVATION IN ORGANIC SOLID WASTE MANAGEMENT

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Abstract
In recent years, the disposal of organic wastes from domestic, agricultural and industrial sources has caused increasing environmental concerns. In this regard, the recycling of utilizable waste is feasible. This can be solved by combination of effective technologies like Biodung composting and Vermitech (incorporating earthworms for the production of vermicompost). The present work 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.
Organic amendments like vermicompost increase the organic matter content necessary for the maintenance of soil properties, which is beneficial for long-term sustainability and crop productivity. Considering the above it is proposed that large-scale production of vermicompost through vermitech to recycle organic waste could effectively help in managing solid waste, and farmers for crop productivity could apply vermicompost thus produced. This could lead to a suitable environment-friendly effort towards a balanced ecosystem.

Keywords: *Organic waste, biodung composting, vermitech, vermicompost, earthworms*

Introduction

In recent years, disposal of organic wastes from various sources like domestic, agriculture and industrial 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. The role of earthworms in organic solid waste management has been well established since first highlighted by Darwin (1881) and the technology has been improvised to process the waste to produce an efficient bio-product vermicompost (Kale *et al.,* 1982; Ismail, 1993, Ismail, 2005). 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; Kale, 1998). 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; Ismail, 2005). Compost is becoming an important aspect in the quest to increase productivity of food in an environmentally friendly way. Vermicomposting offers a solution to tonnes of organic agro-wastes that are being burned by farmers and to recycle and reuse these refuse to promote our agricultural development in more efficient, economical and environmentally friendly manner. Both the sugar and rice industries burn their wastes thereby, contributing tremendously to environmental pollution thus, leading to polluted air, water and land. This process also releases large amounts of carbon dioxide in the atmosphere, a main contributor to global warming together with dust particles. Burning also destroys the soil organic matter content, kills the microbial population and affects the physical properties of the soil (Livan and Thompson, 1997).

Guyana is a country of few million people of various origin including Indians and is dominted by agriculture practices for the cultivation of sugarcane and rice.Being A developing country it also face basic problem of organic waste management. Therefore recycling of organic solid waste from the campus at university of Guyana was carried out during the year 2006-07. Vermicomposting is the biological degradation and stabilization of organic waste by earthworms and microorganisms to form vermicompost (Edwards and Neuhauser, 1988). This is an essential part in organic farming today. It has been recognized that the work of earthworms is of tremendous agricultural importance. Earthworms along with other animals have played an important role in regulating soil processes, maintaining soil fertility and in bringing about nutrient cycling (Ismail, 1997; Lalitha *et al.,*). The objective of the study carried out was to develop combination of effective and low cost technologies to recycle organic waste like grass clippings and water hyacinth and produce biofertilizer vermicompost with rich nutrient status which could play a role in agricultural enrichment of a developing country like Guyana (Ansari and Ismail, 2001a;2001b).

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 1.9m x 1.5m x 1m 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 3mm 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).

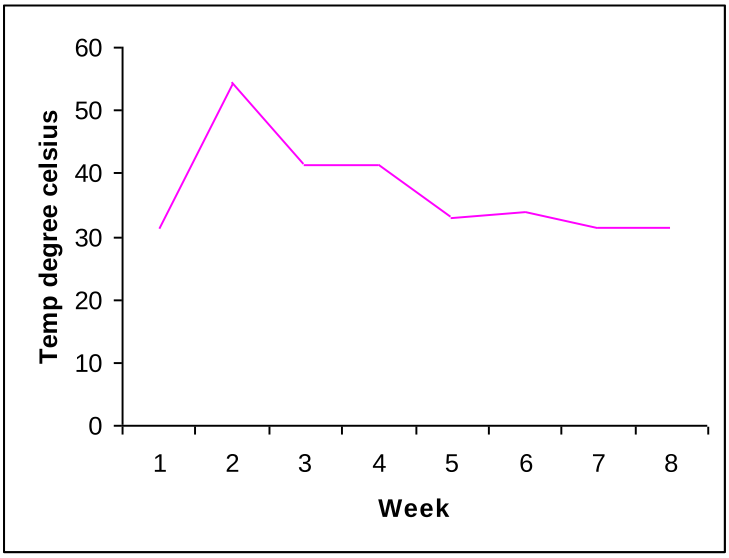
The analysis of the compost samples was done at Central Laboratory, Research Center, Agriculture Department, LBI Compound, GuySuCo.

Results and Discussion

Many investigations have been carried out on industrial level large scale composting of organic waste in municipal setting (Carra and Cassu, 1990; Chistopher and Asher, 1994; Ansari and Ismail, 2001; 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.

Fig. 1 Temperature changes during biodung composting



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^{0}C and 6th week-34^{0}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 $\underline{+}$0.83 (grass clippings + water hyacinth) (Fig 2).

Fig. 2 Fluctuation in temperature in vermicomposting units

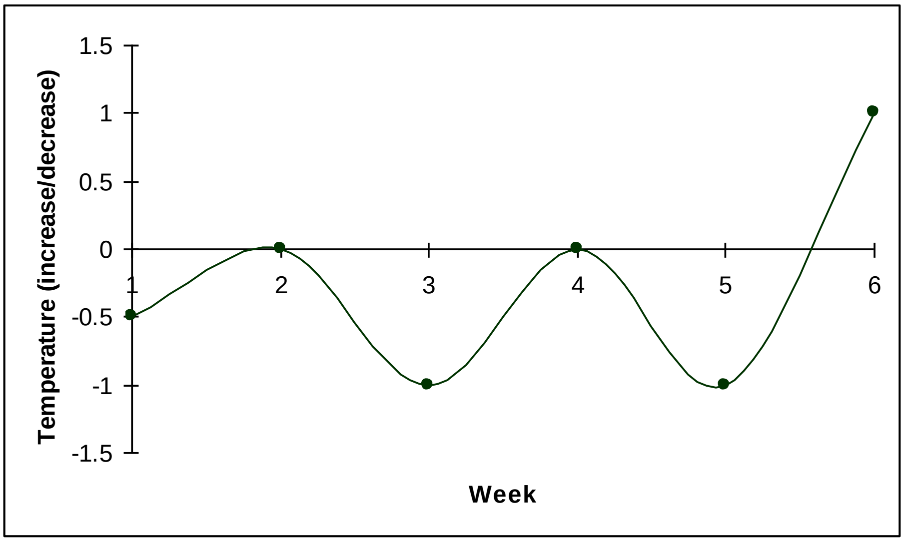


Table 1
Harvest data (vermicompost)

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 percent moisture	41
Productivity of vermicompost (%)	**34.17**

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^{0}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 (Yung Chang, 1967; Yung Chang and Hudson, 1967; Hayes and Lim, 1979).

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

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) and moreover, contains growth promoting substances like auxins and cytokinins (Krishnamoorthy and Vajranabhiah, 1986). Thus, vermitechnology is a system harnessing earthworms for bio-conversion 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

Environmental Hazards are compounded by accumulation of organic waste from different sources like domestic, agricultural and industrial wastes that can be recycled by improvised and simple technologies. The investigations at University of Guyana were taken up in this regard where organic waste was processed through biodung composting followed by vermicomposting. The temperature was monitored during the process of recycling. The harvested vermicompost was subjected to physicochemical analysis for quality control check. The investigations showed that the combinations of effective technologies like biodung composting and vermicomposting results in reduction of time period of recycling with maximal resource utilization at an affordable cost. The temperature increase during biocomposting process resulted in reduction of harmful microbes in the organic waste rendering it completely safe to handle. The earthworms processed it further with its vermicastings in the vermicompost thereby enriching it further. The nutrient status of the product vermicompost obtained confirmed to the standards recorded in the earlier experiments. Vermicompost could be effectively used for the cultivation of many crops and vegetables, which could be a step towards sustainable organic farming. 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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