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Vermitechnology in Organic Waste Recycling: A Step Towards Sustainable Ecosystems in Guyana

Abdullah Ansari[1]

[1]Department of Biology, University of Guyana, Guyana (South America), E-Mail: ansari_adil@hotmail.com (A.A.)
***Abdullah Ansari; ansari_adil@hotmail.com Tel; ++592-609-0754

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 a combination of effective technologies such as Biodung composting and Vermitech (incorporating earthworms for the production of vermicompost). The present work was carried out during the year 2006-2007 at the 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 clippings and water hyacinth) were successfully processed through partial biodung composting and vermicomposting during a period of 60 days. The temperature study during biodung composting showed a two peak rise of temperature resulting in destruction of harmful microbes. Subsequent vermicomposting resulted in production of vermicompost confirming to an excellent nutrient status recorded in earlier experiments. The temperature 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. It is therefore proposed that large-scale production of vermicompost through vermitech to recycle organic waste could effectively help in managing solid waste, and farmers could apply vermicompost thus produced for assisted crop production. This could lead to a suitable environment-friendly effort towards a balanced ecosystem.

Keywords: Organic waste; Biodung composting; Vermitech; Vermicompost; Earthworms

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1. Introduction

In recent years, disposal of organic wastes from various sources like domestic, agricultural and industrial has caused serious environmental hazards and economic problems (Ansari, 2012). 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 is 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 such as *Perionyx excavatus, Eisenia fetida, Lumbricus rubellus* and *Eudrilus eugeniae* are used for vermicomposting but the local species *Perionyx excavatus* has proved to be 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*) and has been called Vermitech (Ismail, 1993; Ismail, 2005, Ansari and Sukhraj, 2010). 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 in this country by farmers and to recycle and reuse this 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 into 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, Frederickson et al., 1997, Ansari and Ismail, 2012).

Guyana is a country of fewer than a 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 faces basic problems of organic waste management. Therefore recycling of organic solid waste from the campus at the University of Guyana was carried out. Vermicomposting is the biological degradation and stabilization of organic waste by earthworms and microorganisms to form vermicompost (Edwards and Neuhauser, 1988, Ansari and Rajpersaud, 2012). 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., 2000, Ansari and Hanief, 2013*). The objective of the study carried out was to develop a combination of effective and low cost technologies to recycle organic wastes such as 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, Ansari and Jaikishun, 2012).

2. Experimental Section

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 cyclical 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* (an epigeic species of earthworms) were inoculated in all the tanks with vermitech setting. Meanwhile the vermiculture tanks were sprinkled with water on a 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 a 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.

3. 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, Ansari and Sukhraj, 2010, Ansari and Jaikishun, 2012). 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 and 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^{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 an 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 $\pm$0.83 (grass clippings + water hyacinth) (Fig 2) (Frederickson *et al.*, 1997, Ansari, 2012).

Figure 1:
Temperature changes during biodung composting

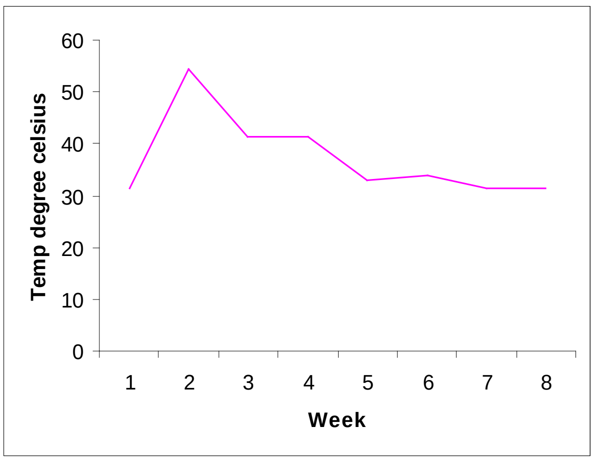

Figure 2:
Fluctuation in Temperature in Vermicomposting Units

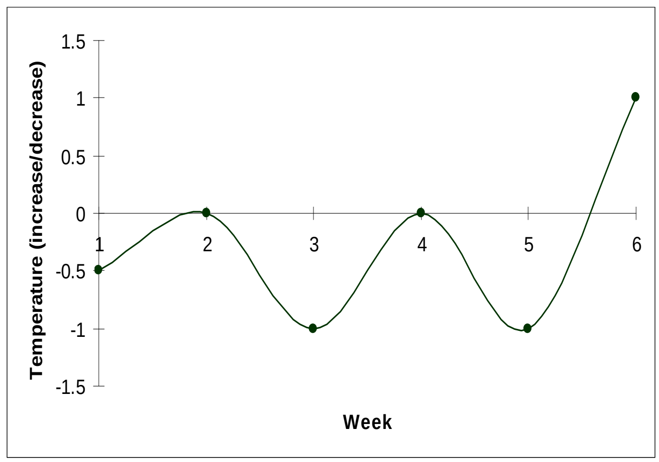

Table 1: Harvest Data (Vermicompost)

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 45^0C 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, Ansari and Ismail, 2012).

Nutrient status of vermicompost (Table 2) produced from the organic waste, is in agreement with 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, Ansari and Sukhraj, 2010).

Table 2: Physicochemical Properties of Vermicompost (Mean + SD)

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

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.

4. Conclusions

Environmental Hazards are compounded by accumulation of organic waste from different sources such as domestic, agricultural and industrial wastes that can be recycled by improvised and simple technologies. The investigations at the 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 the 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 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 but would rather result in recycling and reutilization of precious organic waste bringing about bioconservation and biovitalization of natural resources.

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Conflicts of Interest

The author declares no conflict of interest.

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