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Temporal Changes of Physical Parameters of Solid Waste During Barrel Composting

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Abstract

In this study solid waste were collected from 09 waste generating points of Mawlana Bhashani Science and Technology University during the study for composting. Volume reduction rate of solid waste was quick throughout 5-20 days and became slower during 25-35 days and finally became constant for last 10 days of observation, which indicated that quantity of nutrient materials for the bacterial growth became depleted and consequently the rate of decomposition of organic waste maybe slower at the last 10 days of observation. During the initial days, the increased temperature in the composting barrel was mainly caused by the more exothermic reactions associated with the respiratory metabolism of the microorganism involved in the composting of wastes. Volume reduction of organic wastes and the moisture contents shows similar trend. This result indicates that bacterial activities decrease with the reduction of moisture content of the wastes in the composting barrel.

Key words: Barrel composting, Moisture content, pH, Temperature

Introduction

Solid waste management is an increasing problem at Mawalana Bhasani Science and Technology University (MBSTU), because of rising waste generation in the campus and shortage of adequate disposal sites. To deal with the problem waste management methods aim at waste reduction and waste diversion, through increased recycling, composting, and incineration, and changes in consumer behavior (Prawiradinata, 2004). Solid waste disposal and management is both an urban and rural problem. Solid waste is generated by, and from different sectors including domestic, commercial, industry and others and in many instances; the waste management responsibility has been left to the government or administrative authorities (Kirunda, 2009).

Solid waste management is an important component of sustainable development for any nation and prioritizing solid waste management is greatly supported by global initiatives. Agenda 21, the Rio Declaration on Environment and Development, explicitly affirmed that environmentally sound management of wastes was among the environmental issues of major concern in maintaining the quality of Earthôs environment and especially in achieving environmentally sound and sustainable development in all countries (UNDESA, 2005). Inadequate collection and uncontrolled disposal of solid waste cause a serious health hazard to inhabitants and as well as on the environment (Goyal *et al.,* 2005). So, solid waste management has become a major environmental problem confronting urban areas in developing countries (Pfammtter and Schertenleib, 1996). Sujauddin *et al.* (2008) shows that household solid waste can be converted from burden to resource in developing countries. Like other developing countries, the major portion (about 84%) of the total solid waste is organic in Bangladesh (Moqsud *et al.,* 2005). In composting process, the organic portion of wastes is converted into stable end product of compost by bio-degradation (Hong, 2005). Through the composting of organic wastes, the volume, weight and moisture content are reduced; the potential odor and the pathogens minimized, and nutrients become available for agricultural production (Witter, 1998; Shinha, 2001). Uncontrolled dumping of waste on open dumps or landfills has become one of the most common methods of disposing waste. Globally, such dumps/landfills have remained as an anomaly in urban landscapes due to its heterogeneous nature and the environmental degradation it causes (Amritha *et al.,* 2016). This study was done to satisfy the following objectives (1) to quantify the average amount of solid waste generates from the study area and (2) to know the temporal changes of volume, temperature, pH and moisture contents of waste during composting.

Materials and methods

Solid waste was collected from the collection bins that were put in the source of generation and were separated as biodegradable materials, plastic, polythene, glasses, biodegradable paper etc. The biodegradable waste comprised of mainly kitchen garbage of raw vegetables and some cooked food waste, parts of fruits and fruits skin. There were some biodegradable paper wastes as well as fruits leftovers which were homogenized by cutting into small pieces 0.05-0.08 m in length (Moqsud, 2003). Then the organic solid wastes were deposited in the composting barrel and tighten the lid of the barrel immediately.

The change in waste volume, temperature, pH and moisture content were monitored during composting. After 45 days, the decomposing organic wastes were collected from the top round opening of the barrel and layered in the sunlight for maturing for one week. One of the main objectives of composting is to reduce the volume of the organic waste. Waste reduces volume from its initial value during the composting process. The total volume of the waste was calculated everyday by measuring the height of the waste and was compared with the previous dayøs volume. Temperature is an important controlling parameter for proper composting operation (Sundberg and Smars, 2004). Variation in temperature was measured daily during composting by inserting thermometer (range 0 to 100^0 C) 0.1 m above from the bottom through the circular side-openings in the barrel. The reading was equilibrated for 5 minutes. Measurements of pH in the compost were done by adding 0.010 kg of compost sample (taken from 0.10 m above the bottom of the barrel) in 0.0001 m^3 distilled water and mix thoroughly for several minutes (Sundberg and Smars, 2004; Jackson, 1973). The pH was measured by a digital pH meter (JENWAY -3051) by inserting the probe into the water-compost mix solution. The variation of moisture content was determined by gravimetric procedure of weighing samples before and after the water is removed. The sample was weighted first to get its wet weight. Then it was dried for 24 hours in a 110ºC oven. After weighting the sample and subtracted the weight of the container the dry weight was achieved. The difference between the wet and dry weights was the weight of the water that the sample originally contained. By dividing this water weight by the wet weight gave the moisture content as a fraction. The following equation (1) was used for determining the moisture content of the compost. Moisture content (%) = {(wet weight-dry weight)/ wet weight} x 100 (1)

Results and Discussion

Volume reduction of the waste

The variation of volume change of organic solid waste is shown in Fig. 1. It is observed that the composting was completed in 40-45 days, by this time the volume of waste reduced to 50-55% from its original volume. After 5 weeks of observation, volume was reduced to 50% from its original volume (Fig. 1). According to the Fig. 1, volume reduction rate was quick throughout 5-20 days and became slower during 25-35 days and finally became constant during last 10 days of observation, which indicated that quantity of nutrient materials for the bacterial growth became depleted and consequently the rate of decomposition of organic waste maybe slower at the last 10 days of observation.

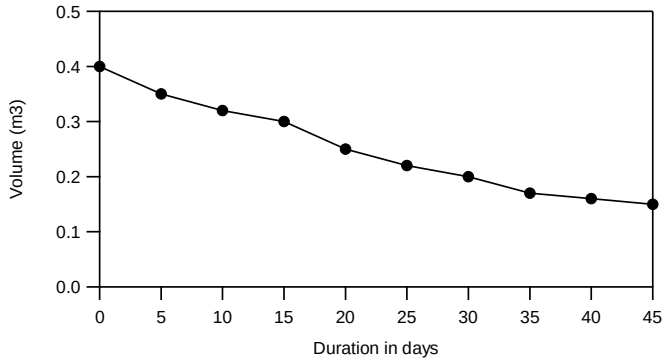

Fig. 1. Changes of waste volume during composting period

Temperature changes during composting

Fig. 2 shows the variation of temperature during composting. As shown in Fig. 2, temperature showed an increasing trends from the beginning and reached to maximum (40°C) at 25^{th} days of observation after that it start to fall and it continued up to 45 days of composting. The broad range of optimum temperatures for composting process is from ~50^0C (Sundberg and

Smars, 2004), which allows a large variety of micro-organisms to participate in the process. However, if the peak temperature is more than 72^0C, some useful bacteria, which are responsible for the aerobic decomposition, will die (Ahmad and Rahman, 2000). The temperatures, which are generated during composting of organic wastes by the mesophilic and thermophilic bacteria lead to the destruction of disease causing microorganisms (Sunar *et al.,* 2009). During the initial days, the increased temperature in the composting barrel was mainly caused by the more exothermic reactions associated with the respiratory metabolism of the microorganism involved in the composting of wastes (Sundberg and Smars, 2004; Technobanglous, 1977).

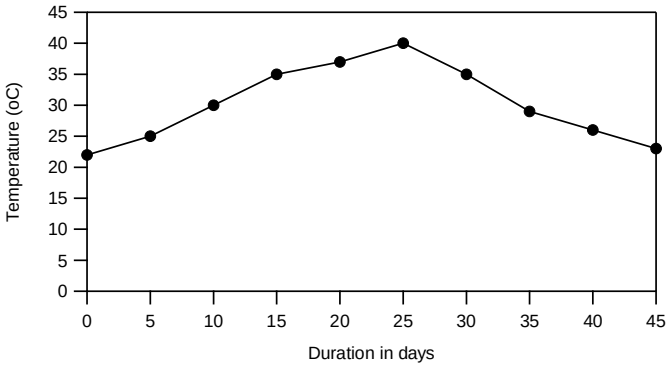

Fig. 2. Variation of temperature during composting of wastes

Changes of pH during composting

The variation of pH with time during the composting process is shown in Fig. 3. This variation directly indicates the extent of decomposition within the compost mass.

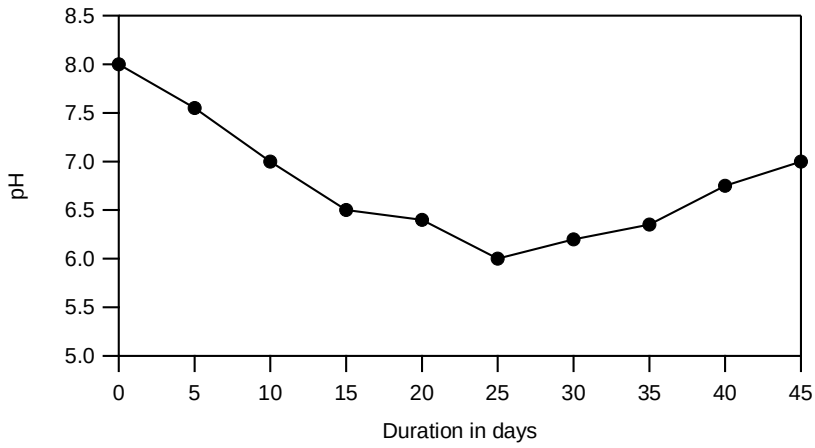

Fig. 3. Variation of pH during composting of wastes

The optimum pH range for most bacteria is between 6.0 and 7.5 (Parks *et al.,* 1998). According to the Fig. 3, level of pH showed decreasing trend from 5^{th} days of observation and continued up to 25^{th} days, finally reached to the lowest level (pH=6), which may happen due to temperature rise during the same observation period (see Fig. 2). After that pH level shows an increasing trend as the temperature decrease (Fig. 2 and 3).

Changes of moisture contents during composting

Moisture content was determined by weight loss of compost samples, which were oven dried at 110^0C for 24 h (Dresboll and Kristensen, 2005). At moisture levels above 68 %, water begins to fill the interstices between the particles of the wastes, reducing the interstitial oxygen and causing anaerobic conditions with a resultant offensive odor (Rahman, 1993; Tachobanglous, 1977). When the moisture content of the wastes dropped below

40%, the composting process becomes slow (Goyal *et al,* 2005). The variation of moisture is shown in Fig. 4. Volume reduction of organic wastes and the moisture contents shows similar trend of reduction (see Fig. 1 and 4). This result indicates that bacterial activities decrease with the reduction of moisture content of the wastes in the composting barrel.

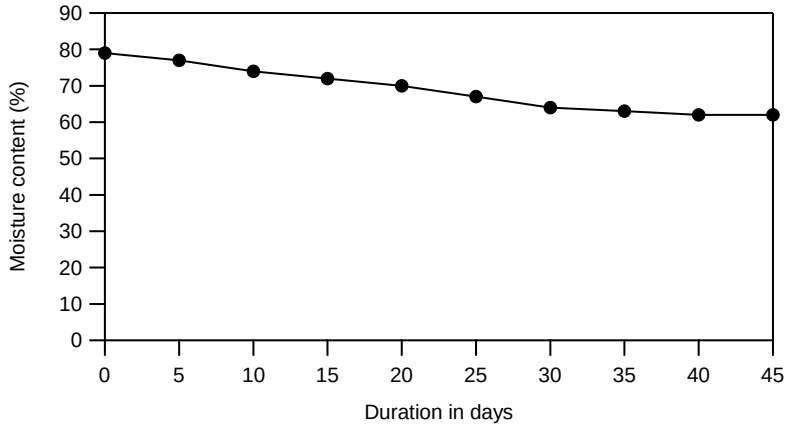

Fig. 4. Variation of moisture during composting of wastes.

Conclusions

Solid waste were collected from 09 waste generation points which includes administrative, departments, library and 5 student halls of Mawlana Bhashani Science and Technology University during the study for composting. Volume reduction rate of solid waste was quick throughout 5-20 days and became slower during 25-35 days and finally became constant during last 10 days of observation, which indicated that quantity of nutrient materials for the bacterial growth became depleted and consequently the rate of decomposition of organic waste maybe slower at the last 10 days of observation. During the initial days, the increased temperature in the composting barrel was mainly caused by the more exothermic reactions associated with the respiratory metabolism of the microorganism involved in the composting of wastes. Volume reduction of organic wastes and the moisture contents shows similar trend of reduction. This result indicates that bacterial activities decrease with the reduction of moisture content of the wastes in the composting barrel.

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