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Optimization of a Vegetable Waste Composting Process with a Significant Thermophilic Phase

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Abstract

Proper management of waste is a major problem in most of the metropolitan areas. Composting is one of the oldest and simplest methods of organic waste stabilization. It is a self-heating biological conversion, which generates suitable end products such as fertilizers, substrates for mushroom cultivation and bio-gas (methane). The thermophilic phase is a very dynamic phase where high microbial activity leads to accelerated degradation of organic matter. This phase also sanitizes the compost. The aim of the current study is to optimize a composting system utilizing market waste. Three methods of composting were studied and composting by heaping or piling was found to be the most efficient method as a significant thermophilic phase (highest temp. 65.9^0C) was obtained provided the moisture content was kept around 60%.

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Introduction

India generates about 50 million tons of municipal solid waste (MSW) every year from cities (CPCB, 2000). Due to the rapid expansion of cities with massive migration of population from rural to urban centers, as well as considerable increases in per capita generation of waste with each passing day, generation of MSW has continuously been increasing (Saha et al., 2010). Over 90% of these wastes are used for unscientific land filling or uncontrolled dumping on outskirts of towns and cities, which have serious implications in global warming (by green house gas

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emission) (Sharholy, 2008; Narayana, 2009). Existing MSW management systems in India, which includes storage, collection, transportation, segregation, processing and disposal of waste is poorly developed (Sharholy, 2008; Kumar et al., 2009).

According to the report by NEERI (2005), biodegradables comprise of over 50% of the municipal solid waste generated in Kolkata. The city generates 4,000 tons of municipal solid waste per day and the per capita waste generation is over 700g per day. Composting is seen as a low cost method of diverting low cost materials from landfills while creating a product for agricultural purposes (Saha et al., 2010). It is an aerobic biological process that uses the innate microbial to convert degradable organic matter into humus like product. Presently only 8-9% of the waste generated is used for compost production by various public or private enterprises. There is a wide variation among the compost manufacturing agencies with respect to the different methods and technologies being used. The quality of compost depends upon the source and nature of waste, the composting facility design, composting procedure and length of maturation (Hargreaves et al., 2008).

Considering its present urban population to be 330 million, India has an estimated potential of producing 4.3 million tons of compost each year (Saha et al., 2010). However inappropriate solid waste management technique is the main constraint in production of good quality compost. Improper sorting of the MSW at source leads to mixed (biodegradable and non-biodegradable) wastes being composted together and inferior quality product being generated which finds no takers in the market.

Biodegradable solid waste can be primarily classified into 2 categories:

Table 1: Constituents of biodegradable solid waste

Category	Constituents of waste
Type-I waste	Vegetable matter such as leaves and fruit peels, agricultural residues etc., dung, ruminal , stomach and intestinal contents.
Type- II waste	Animal matter such as inedible fats, tissues, meat trimmings, bones etc.

Composting offers several benefits such as enhanced soil fertility and soil health – thereby increased agricultural productivity, improved soil biodiversity, reduced ecological risks and a better environment. It destroys pathogens and reduces the volume of waste (Tiquia and Tam, 2000; Zhu, 2006). Furthermore, composting transforms unstable ammonia to stable organic forms of nitrogen (Zhu, 2006). When applied to soil compost provides nutrients to soil (Lee et al., 2004).

The practice of producing organic fertilizer through the biological decomposition of organic waste has been carried on for centuries as an art known as composting (Golueke et al., 1954). There are extensive literatures available on composting methodologies. A broad distinction as ‘traditional’ and ‘rapid’ can be made on the basis of the method used as conventional or recent introductions to expedite the process by involving individual or combined application of treatments like shredding and frequent turning, forced aeration and mechanical turning, use of mineral nitrogen compounds, effective and cellulolytic microorganism, use of worms etc.
Temperature plays a very critical role in composting. The high temperature phase supports the growth of high microbial activity. In this phase biodegradation is maximized and pathogenic microbes are killed. Continuous thermophilic composting is done in temperature regulated reactors (Strom, 1985) which generates a conducive atmosphere for thermophilic microbes to take over the biodegradation process.

Fungal and bacterial cultures are added to waste to accelerate the degradation process. Though use of organisms and their effectiveness has been disputed, many commercially available preparations are used to expedite the process.