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Combined Aerobic Composting of Municipal Solid Waste and Sewage Sludge

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Abstract: This paper examined the variability which occurs in key parameters like pH, temperature, moisture content, organic carbon, volatile solids etc. during the 41days regular monitoring of composting process. A 25 kg of municipal solid waste was mixed with 5 kg of sewage sludge so as to make 5:1 ratio for composting. Composting was done by using a box model composter made up of wood with proper aeration and drainage facility and was kept in semi sun rays condition. pH ranging 7.1 in the first phase, 5.9 in the middle phase, 8.5 at the end stage and then become stable. Temperature rise from the first day of process and become 60°C on 26th day then decreased to 28°C at the end of process and became practically constant after 35 days. Moisture content in compost was unstable throughout the process due to changing microbial population. Organic carbon was 30% and gradually increased to 59% in distinct time of interval, volatile solids were 52% in final compost. The percent concentrations of heavy metals, Cu, Fe, Ni, Mg, Mn and Zn were 0.0021, 0.0036, 0.0045, 0.0036 0.0022 and 0.0009, respectively in the finished product. The NPK content of final compost was 1.4, 1.8 and 2.2%, respectively Results obtained from composting treatment given to MSW and sewage sludge indicate that combined composting will be an attractive method for management of municipal solid waste and disposal of sewage sludge in the Indian context.

Key words: Municipal solid waste · Sewage sludge · Composting · Key parameters

INTRODUCTION

Due to increasing population as well as industrial and economical development, the output of the municipal solid wastes (MSW) has been increasing in India**.** On the other hand, sanitation landfill would occupy a lot of lands and lead to two-step solution by less developed technology [1]. Solid waste management is considered to be one of the most serious environmental problems confronting urban areas in developing countries. Composting of MSW reduces the volume of the wastes, kills pathogens that may be present, decreases germination of weeds in agricultural fields and destroys malodorous compounds [2]. Inadequate collection and uncontrolled disposal of solid wastes results in a serious threat to the inhabitants as well as an environment. Disposal of municipal sewage sludge in a manner which is not harmful to the environment, minimizes health risks, is economically feasible and has become a critical concern in many areas of the world. Many cities are turning to composting as a means of sewage sludge disposal and resource recovery. Waste recovery such as recycling and composting is an option of reducing the waste amount to be disposed**.** Composting MSW is seen as a method of diverting organic waste materials from landfills, while creating a product, at relatively low-cost, that is suitable for agricultural purposes [3, 4]. Many studies have been carried out on the speciation of heavy metals in soils and soils amended with composted biosolids or raw sludge [5, 6]. Composting satisfies the health and aesthetic aspects of waste disposal by destroying almost all pathogens. In addition, the product becomes having agricultural and horticultural benefits as a soil conditioner and fertilizer [7].

Objectives: The objective of the study carried out was to develop combined effective technology for two waste products municipal solid waste and sewage sludge generated in large amount in Jalgaon city. As both the waste products supplement each other in composting process it was hoped that good quality compost can be produced by their combined composting. Study was done to know the actual fraction changes in pH, temperature, moisture content, organic carbon and volatile solids during the composting process, which will be helpful to know what factors, are responsible for speed of composting process and quality of product.

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MATERIALS AND METHODS

Experiments on combined composting were conducted at a private nursery situated at Jalgaon, Maharashtra, India, to study the effectiveness of two waste products municipal solid waste and sewage sludge. The amount of generation and composition of solid waste varies from place to place within the study. For the present study, sample of municipal solid waste was collected from Pimprala suburban site which is located at west end of the Jalgaon city. Collection of sewage sludge was done from the municipal water treatment plant situated in the north-east end of Jalgaon city. Sewage sludge sample was in semi solid form and collected in air tight plastic bins to enclose it from surrounding. A 25 kg segregated vegetable waste was mixed with 5 kg sludge so as to make ratio for composting as 5:1.

The chemical parameters were determined at School of Environmental and Earth Sciences, North Maharashtra University, Jalgaon. To know the trends which occur in the composting process a regular monitoring of key role parameters, pH, temperature, moisture content, organic carbon and volatile solids was done for 41 days period. Physicochemical analysis of finished compost was done for pH, conductivity, total nitrogen, organic carbon [8]. Total Phosphorous were determined colorimetrically, Volatile solids by the ignition at 600°C for 4h [9]. Potassium was determined by flame emission spectrophotometry, while heavy metal concentrations were determined with an atomic absorption spectrophotometer [10].

RESULTS AND DISCUSSION

Many investigations have been carried out on industrial level for large scale composting of organic wastes in municipal setting [11, 12].The present study proved that sewage sludge accelerates the composting process in combination with municipal solid waste. Table 1 shows the physiochemical characteristics of compost obtained. During monitoring of composting, pH was neutral (7.1), in the first phase latter it tends towards acidic (5.9) and at the end it was 8.5 and becomes stable (Fig. 1). This increase in pH during the composting process may be due to the formation of calcium carbonate during the aerobic decomposition of waste [13]. Increase in temperature has been observed from the first day of process and was tends towards 60°C on 26th day then decreased to 28°C at the end of process (Fig. 2).

Table 1: Physicochemical characteristics of compost obtained from municipal solid waste and sewage sludge (n=3)

Parameter	Value (Average ± SD)
pH	8.5 ± 0.2
C/N ratio	29.0 ± 0.9018
Organic Carbon (%)	56.35 ± 0.0152
COD (mg/l)	244.0 ± 1.57
Chlorides (%)	0.64 ± 1.62
Nitrogen (%)	1.41 ± 0.02
Potassium (%)	2.20 ± 0.11
Phosphorous (%)	1.85 ± 0.44
Copper (%)	0.0021 ± 0.0002
Iron (%)	0.0036 ± 0.0001
Nickel (%)	0.0045 ± 0.0001
Magnesium (%)	0.0036 ± 0.0002
Manganese (%)	0.0022 ± 0.0001
Zinc (%)	0.0009 ± 0.0001

Temperature rises from the initial day and it rises to maximum between 3-4 weeks. After that the temperature began to fall and became practically constant after 35 days.

Moisture content in compost was unstable throughout the process due to changing microbial population. On 11th day it gets increased till 59% and after that continuous decrease was observed (Fig. 3). Organic carbon was 30% initially which gradually increased to 59% in distinct time of intervals as the microbes were enhancing the process. As their population increases, degradation process become rapid and breakdown of waste organic matter leads into residue in the form of carbon source material, hence the amount of carbon content till the end of process was continuously increased (Fig. 4). During the composting process, the majority of the reduction in volatile solids occurred during the first 2-4 weeks. In the higher temperature considerable decrease in volatile solids was detected during the maturation process. On 21st day an increase in volatile solids indicates some activity of thermophilic bacteria in the process, but suddenly further reduction and stabilization occurred in volatile solids afterwards (Fig. 5).

Some authors suggested that when the potential toxic metals concentrations of compost are high, the leachability of metals associated with compost is of concern [14]. The finished compost obtained from the combination of these two waste product shows NPK content as 1.4, 2.2 and 1.8%, respectively (Fig. 6). The apparent increase in total nutrient content in compost is not only due to enrichment, but also due to the reduction in weight because of decomposition [15]. Michel *et al.* [16] showed that the initial C: N ratio of waste correlated significantly with the loss of total nitrogen.

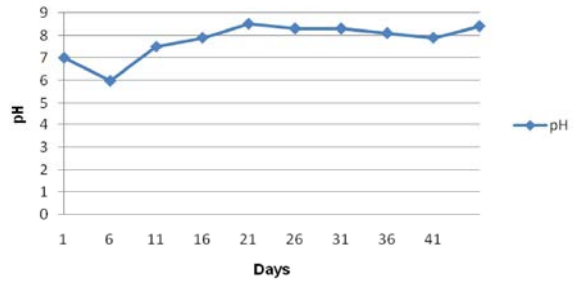

Fig. 1: pH variation during the composting process

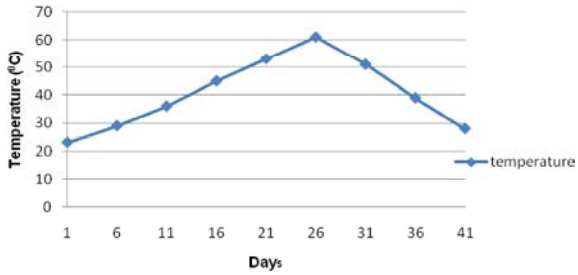

Fig. 2: Temperature profile at various stages of composting

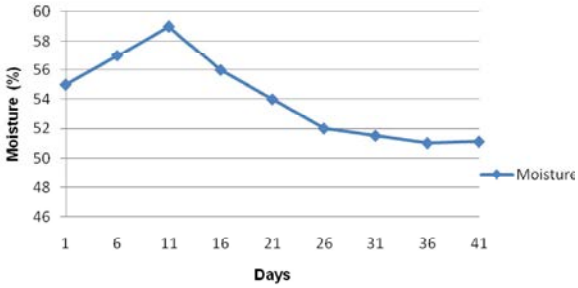

Fig. 3: Moisture content with composting period

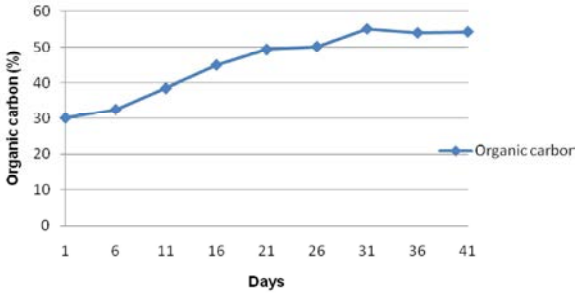

Fig. 4: Changes in organic carbon content during composting

In Conclusion, investigation carried out showed that the combination of municipal solid waste and sewage sludge was effective and sewage sludge tends to accelerate the composting process. Reduction of waste by recycling at an affordable cost with locally available resources was a practical approach for waste management

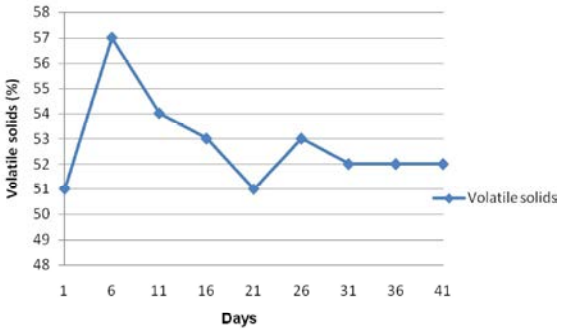

Fig. 5: Variations in volatile solids of compost

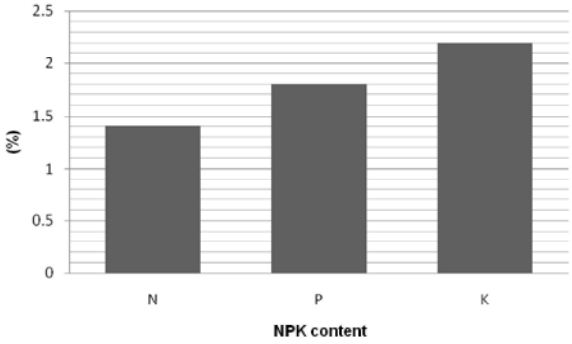

Fig. 6: NPK content of final compost obtained

and environmental protection. The nutrient status of the compost obtained was high. Such technologies in organic waste management would lead to zero waste technologies without the organic waste being wasted.

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