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Biodegradation of Organic Materials under Aerobic Conditions

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Abstract. Increasing population and rapid urbanization accelerates the generation rate of municipal solid waste (MSW). Composting is one of the best methods of recycling organic materials. The objective of this study was to do a quantitative and qualitative analysis of composts in India through an Internet survey and laboratory elemental analysis. The largest numbers of compost companies (with Internet addresses) are in Karnataka. Most private sector companies produce compost using various organic materials like garden and kitchen waste, plant waste and human excreta, cow dung and biomass, dung, bone meal, food waste, etc. The quality of compost produced depends mainly on the nature of organic materials and the method of composting. Eleven compost samples were collected and tested for their elemental composition. The elemental analysis report shows that essential nutrients like N, P, and K are in less than required quantities which indicate poor compost quality.

Keywords: Municipal solid waste, Biodegradation, Composting, Organic materials.

1. Introduction

The unwanted, useless or used solid materials generated from combined residential, industrial and commercial activities are known as solid waste. As per the Municipal Solid Waste (Management &Handling Rule, 2000), garbage is defined as Municipal Solid Waste (MSW) which includes commercial and residential wastes generated in municipal or notified areas in either solid or semi-solid form excluding industrial hazardous wastes but including treated bio-medical wastes. Municipal solid waste consists of household waste, construction and demolition debris, sanitation residue, and waste from streets.

The Census of 2011 estimates India's population to be 1.21 billion which is 17.66% of the world population. Increasing population levels, rapid economic growth and rise in community living standard accelerates the generation rate of municipal solid waste (MSW) in Indian cities [1]. India's urban population was 285 million in 2001 and increased to 377 million in 2011 lists 366 cities which represent 70% of India's urban population and generate 130,000 tons per day (TPD) or 47.2 million tons per year (TPY) at a per capita waste generation rate of 500 grams/day. The solid waste generated in any area is generally directly dependent on the economy and the percentage of urban population.

Organic waste composting is one of the best methods for treating MSW and is a viable alternative to landfilling and incineration [2, 3, 4, 5, and 6]. Aerobic composting is defined as the decomposition of organic materials in the presence of oxygen [8]. Since composting leads to a stabilised final product, which will improve soil quality and fertility, it is one of the best options for organic waste disposal among the various strategies of waste management. The specific carbon to nitrogen ratio and the moisture content may increase the effectiveness of the process of composting [8, 9]. Factors like feed composition, moisture content, oxygen content, temperature, and pH affect the process of composting and these parameters may

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also affect microbial activities [10]. Bulking agents like rice husk, sawdust and rice bran increase the quality of food waste [8]. Urea addition in crop waste was in practice in the past to reduce the C/N ratio [11], but in recent practice, nitrogen rich organic wastes are using in organic farming for which, poultry litter and cow dung wastes are supplements (low C/N ratio<12) [12].

The objective of this study was to do a quantitative and qualitative analysis of composts in India through an Internet survey and laboratory elemental analysis.

2. Materials and Methods

2.1. Data collection

A list of composting companies in India with Internet addresses was available for www.compost-india.com. An analysis of composting companies, and their products in India was done to determine the following factors: number of composting companies in each state, raw materials used, cost per kg of compost, if compost quality was tested, and method of composting. Eleven compost samples were also collected and tested for their elemental composition and their description is given in **Table 1**.

Table 1: Compost samples and their description

Sl. No.	Compost Sample ID	Description
1	BHR 2	Bhadreswar Compost (Vermi-compost)
2	DHP 2	Dhapaland Compost (Windrow)
3	AHD	Ahmadabad Compost (Compost)
4	AGR	Agriculture Gross Compost (Vermi-compost)
5	BGK 1	Bagalkot Compost 1 (Vermi-compost)
6	BGK 2	Bagalkot Compost 2 (Vermi-compost)
7	HC	Kharagpur Home Compost
8	NPC	Neem Patta Compost
9	BMC	Bone Meal Compost
10	OC 1	Orissa Compost 1
11	OC 2	Orissa Compost 2

2.2. Measurement and analysis

Moisture content, bulk density, total solids (TS), volatile solids (VS), fixed solids (FS) were measured according to APHA, 1998. Scanning electron microscope (ZEISS EVO 60, Carl ZEISS SMT, Germany) images were used to obtain information about the sample's surface topography. Also, Energy Dispersive X-ray Spectroscopy (EDX) was performed to determine elements in or on the surface of the sample for qualitative information about compost composition.

3. Results and Discussion

3.1. Survey Report

The results of the Internet survey are shown as a pie diagram in **Figure 1** and the largest numbers of companies are in Karnataka State (26). Compost companies use their products for different purposes like soil conditioner, mulch, growing media, and top soil constituents.

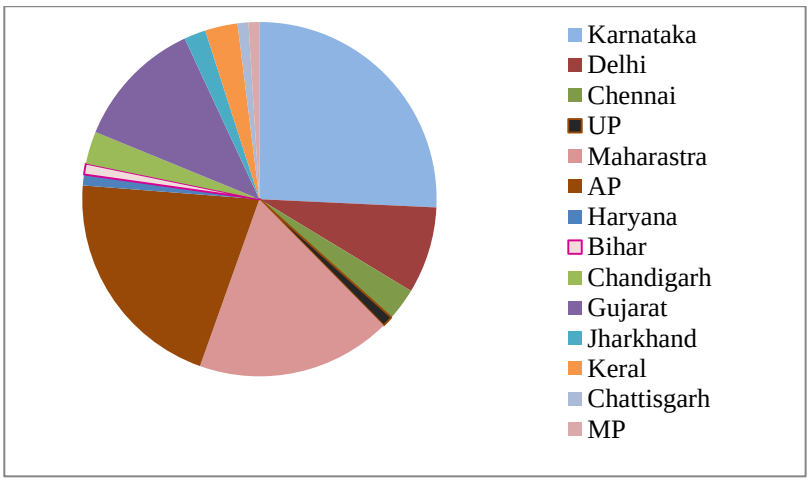

Fig. 1: State-wise distribution of composting companies in India

Compost companies produce various types of composts like commercial compost, vermicompost, farm/ manure compost, mixed municipal compost, and forest/ woodchip compost. Most of the compost companies use green waste or kitchen waste as their raw material (54%) and they also use plant waste & animal excreta as shown in **Figure 2**.

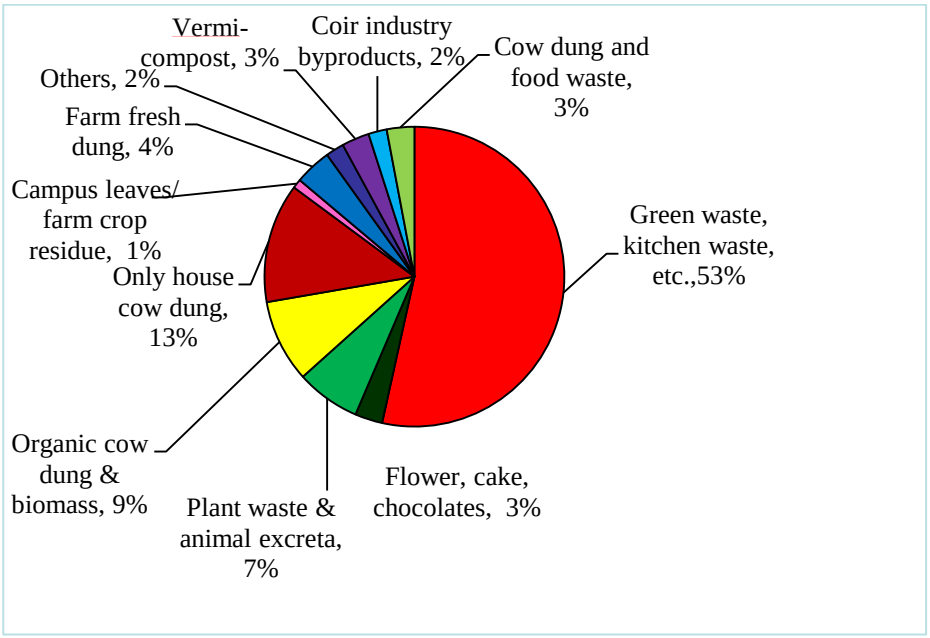

Fig. 2: Percentage organic matter composition distribution

3.2. EDX Report

It is necessary to determine the elements present in compost to decide its quality in order to find its applicability for agricultural purposes. The elemental analysis of essential nutrients like C, O, N, P, K, and S present in the composts was carried out for the 11 samples and the percentage composition of types of organic matter present in the compost and their distribution are depicted in the bar chart (**Figure 3**).

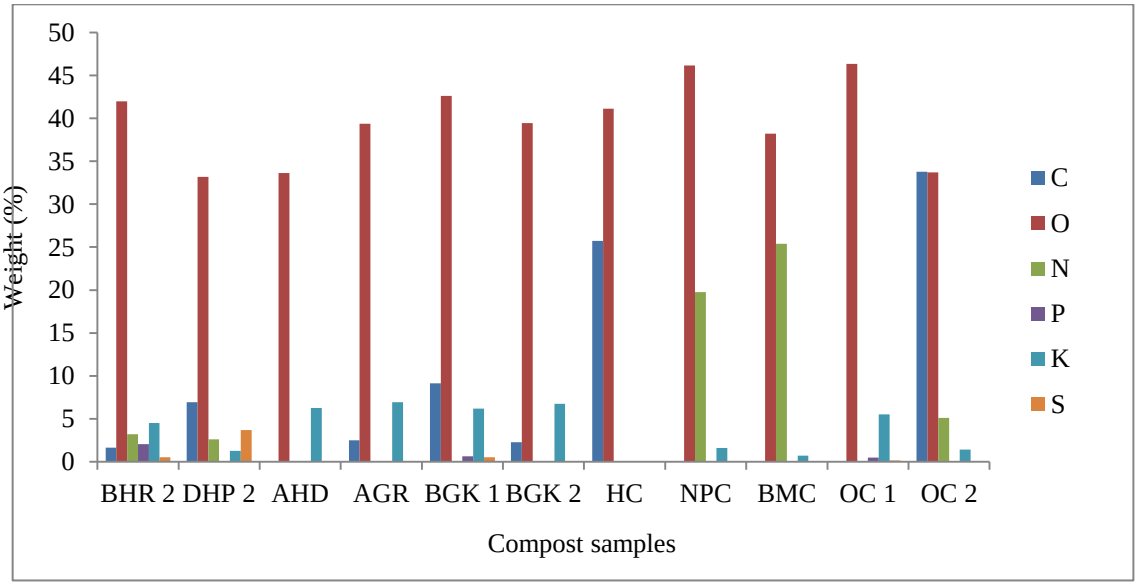

Fig. 3: Essential Elements present in compost samples

- All compost samples in the present study have abundant quantity of oxygen. Maximum quantity of oxygen was found in OC 1 (46.33 %), whereas lowest quantity of oxygen was observed in DHP 2 (33.16 %).
- Essential nutrients like C, N, P, and K are in low quantities in most of the compost samples **(Figure 3).**
- Some metals are also found in composts (Al, Mn, Fe, Mg, Cu, Zn, Ti, Pb, Hg, Cr) but in less quantities. Metals like Al, Si, Fe, K, Zn, and Ti were found to be more than 2% by total percentage weight of elements in compost samples **(Figure 4).** Sample AGR had the highest percentage (11%) of aluminium and BMC had the least (1%). Other metals like Fe and K were found in almost all samples whereas Zn and Ti were found in BHR 2, DHP 2, and AHD in small quantities.

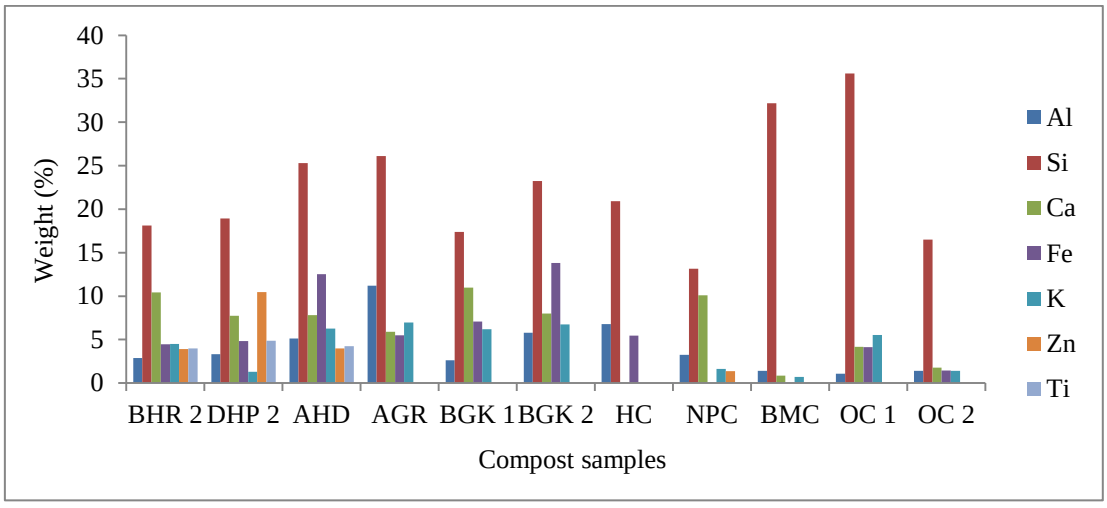

Fig. 4: Metals present in compost samples

- As all composts contain soil, large amounts of silicon are found in all composts (35.62% in OC 2 and 13.14% in NPC).

4. Conclusions

- Most composting numbers of companies use green waste and kitchen waste for composting.
- Compost companies produces different types of composts like, commercial compost, vermicompost, farm/ manure compost, mixed municipal compost, and forest/ woodchip compost
- The composts sampled in this study are not harmful for use in agriculture. However, these compost samples are of poor quality due to their low nutrient levels.
- Compost samples have some metals in their elemental composition in small quantity

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