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MUNICIPAL SOLID WASTE MANAGEMENT: A SURVEY AND PHYSICO-CHEMICAL ANALYSIS OF CONTAMINATED SOIL FROM SUKALI COMPOST AND LANDFILL DEPOT, BATKULI ROAD, AMRAVATI

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ABSTRACT
Solid waste management is a worldwide phenomenon. It is a big challenge all over the world for human beings. Therefore, the present study was undertaken to find out the problems and prospects of Municipal solid waste and to study various physicochemical parameters of soil which is collect from Sukali compost depot, Amravati. Amravati city has a population of 6, 78,192 in 2008 including 1, 28,682 rural and 5, 59,510 urban persons. As per the land use pattern of Amravati, nearly 41.50% of the area is in use of agricultural and garden land, which will reduce in the year 2011 by 54% of its existing land. Amravati is a city in the state of Maharashtra, India and seventh most populous metropolitan area in Maharashtra. Amravati Municipal Corporation, Amravati is responsible for the management of solid waste generated in the city. The medical officer of Health Department is the overall in charge of solid waste management in the city. According to Health Department report of 2009-2010, around 692.11 TPD solid wastes is generated every day (Personal Communication Dr. Jadhav). Quality of compost and landfill depot soil at summer season have been studied with respect to important physicochemical parameters such as pH, temperature, organic carbon, chlorides, Na, K, etc. In this paper revealed that the pH (7.76) of waste soil at temperature 32.4 ^{0}C. The colour of waste soil grayish dark brown and its texture sandy was determined. The moisture content (3.93 %) it much lower than control soil (6.62 %), organic carbon (43.17 %), Chloride (49.7 mg/kg), Conductivity (1.792 x10^{6} μmho/ m), sodium (26.5 mg/kg), potassium (89 mg/kg), $CaCO_3$ (79.1 %) respectively. The parameters examined values increases 30-60% folds more as compared to the control. Heavy metal analysis of waste soil, it contained Cu (1.001 mg/g), Zn (5.058 mg/g), Cr (0.536 mg/g), Ni (0.053 mg/g), Fe (21.65 mg/g), Mn (5.982 mg/g), Co (-100 mg/g) these all metal concentrations increases 4-7 times as compared to control soil. If this municipal solid waste landfill continues, it may create serious environmental problems. The present investigation study will revealed a data of analysis about the amount of toxicity level and analyzed various nutrients of soil which latter use as compost. This may bring the social awareness amongst the people.

KEY WORDS: Sukali compost and landfill depot, Toxicity, Pollutants, Heavy metals.

INTRODUCTION

Anthropogenic activities in society generate large quantities of wastes posing a problem for their disposal. Improper disposal leads to spreading of diseases and unhygienic condition besides spoiling the aesthetics. The municipal solid waste (MSW) is heterogeneous in nature and contains paper, plastic, rag, metal, glass piece, ash and compostable matter. In addition, other substances like scrap materials, waste papers, dead animals, discarded chemicals, paints, hazardous hospital waste and agricultural residue are also categorized under MSW (Lauber, 2005). Till date, the biomedical waste generated from clinics, hospitals waste and agricultural residue are also categorized under MSW. The average per capita solid waste generation in India (Status of Solid Waste Disposal, 1995) has increased from 0.32 kg/day in 1971–73 to 0.48 kg/day in 1994. Daily per capita generation of MSW in India ranges from about 100 g in small towns to 500 g in large towns (India States of the Environment, 2005). In 1995, EPRIT, Hyderabad showed that 23 big Indian cities generated 11 million tons (mt) of solid waste every year (Status of Solid Waste Disposal, 1995). But now urban centers of India produce 1, 20,000 t of solid waste each day (Yadav, 2007); this is expected to reach 300 mt per annum (CPCB, 2000) by the end of 2047. In 1996, NEERI, Nagpur carried out a study on the characterization of Indian MSW, demonstrating that it contains large organic fraction (30–40%), ash and fine earth (30–40%), paper (3–6%) along with plastic, glass and metal (each less than 1%). Amravati Municipal Corporation, Amravati is responsible for the management of solid waste generated in the city. The city administration has been decentralized in 4 zones. There are in all 81 wards in the city. This solid waste disposal cause serious environmental problem. The burning of solid waste creates heavy smoke and dust pollution. On inhalation this results in various respiratory problems among the habitats (The Indian Express, Pune 2006).

According to Anikwe and Nwobodo (2001), municipal wastes increase the nitrogen, pH, cation exchange capacity, percentage base saturation and organic matter. Organic waste can provide nutrients for increased plant growth, and such positive effect will likely encourage continued land application of these wastes (Anikwe and Nwobodo, 2001; Nyles and Ray 1999). However excessive waste in soil may increase heavy metal concentration in the soil and underground water. Heavy metals may have harmful effects on soils, crop and human health (Nyle and Ray 1999; Smith *et al.,* 1996).

MATERIALS AND METHODS

Selection of Site and collection of samples: Soil samples were collected, (2009-2011) in summer season from different points of Sukali landfill and compost depot which is situated outskirt of the Amravati city near village Sukali. An aerial photo and a zoomed sampling area are shown in **(fig.1).**This site is surrounded by a various forms. Three points on the location of the waste dump site was selected and three pits of 20-50 cm depth were dug for soil sampling on selected points.

FIGURE 1. Sukali landfill and compost depot

Physicochemical analysis

Moisture content (Dhyan *et al.,* 1999) and soil texture **(**Arora and Pathak, 1989) was analyzed. pH, Electrical conductivity, and temperature of the soil was measured in a 1:2 or 1:5 soil- water suspension or in saturates soil paste. Colour notations indicated by using Munsell`s soil colour chart.

Mineral and salt analysis

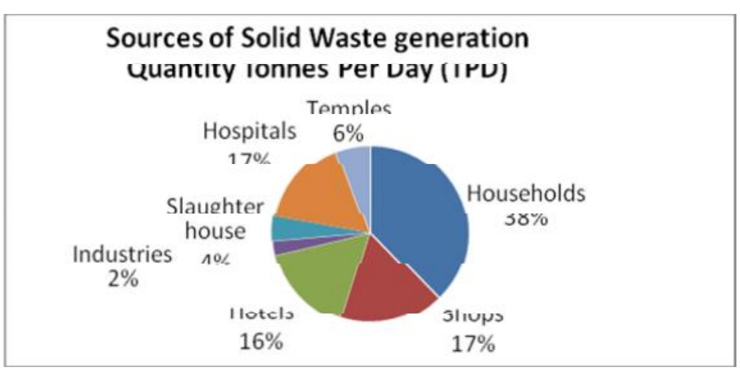
Na, K and Ca ions were determined by flame photometer (Hanway and Heidel, 1952). The organic carbon in the sample was oxidized with potassium dichromate and sulphuric acid (Walkely and Black 1934). Calcium carbonate by titrimetric method **(**Piper, 1966**).** The chloride content of the soil was directly measured by titrimetric method (Santra et al., 2006).

Metal analysis: Detection and analysis of metal ions such as Cu, Zn, Cr, Ni, Fe, Mn and Co from soil and sediments, wet oxidation of sample was carried out. Wet oxidation employs oxidizing acids like HNO_3 –$HClO_4$ di- acid mixture (Jackson, 1958).

RESULTS AND DISCUSSION:

Solid waste Management: Major sources of solid waste generation in household, shops, hotels, industries, slater house, hospitals, etc. **(fig. 2).** Presently in all the urban bodies in the region the entire Municipal solid waste is disposed improperly into Sukali and Navsari compost depot. The all the Municipal councils in Amravati region and Amravati Municipal corporation has obtained authorization. About 9.5 ha of land have been allocated for solid waste disposal, of which 7.5 ha area is already land filled. The present practice of solid waste disposal consists of biological decomposition of waste and land filling.

FIGURE 2: Major sources of solid waste generation



Collection System

Solid waste is collected from different sources by various methods. Mostly waste collect into the containers. Total 81 wards in city out of which around 60 wards are managed on contract by 2 private contractor authorized by Amravati Municipal Corporation, Amravati. The contract involves sweeping of the wards, transfer of the waste to the containers and other collection point, collection of waste from this point and transporting them to the designated disposal point. The number of staff engaged in solid waste management in the city corporation (Table 1).

TABLE 1: Distribution of staff for management of solid waste

Sr.No.	Category Staff	Number
1.	Health Officer	1
2.	Deputy Health Officer	1
3.	Senior Health Inspector	2
4	Sanitary Inspector	16
5.	Senior Sanitary Inspector	2
6.	Sanitary Superintendent	1
7.	Drivers	18
6.	Field officer	2
7.	Other Worker	660

Transportation of waste

The waste collect in containers, total 538 containers distributed in 81 wards of Amravati city is directly transported through 16 open trucks and 8 dumper containers to the final dumping site. The refuse vehicles have to travel about 7 km distance through the city to carry waste up to dumping site. The containers carrying waste are not covered during the journey and waste tends to spill on the roads.

Plant species growing on Municipal solid waste dump soil

A large number of plants naturally grown on the solid waste dumping wastes. They have grown on solid waste in different seasons by quick absorbing waste decaying organic matters. Fixing the botanical identity and their uses for solid waste management and controlling environmental pollution may be taken into consideration. The most promising and dominated species are *Abutilon indicum, Amaranthus spinosa, Amarathus viridis, Argemone mexicana, Cassia occidentalis, Cassia tora ,Cleome viscosa, Croton banpandianum, Datura metal, Euphorbia hirta,* etc.

Characteristics of Solid Waste

Soil temperature varies in response to exchange processes that take place primarily through the soil surface. The active temperature for methanogenic microorganisms in the range 30-50 ºC. The change of temperature will have an impact on the growth of biomass and the activity of the micro-organisms (Naranjo *et al*., 2004). A rise in temperature of soil accelerates chemical reactions, reduces solubility of gases and decrease pH of soil. The soils are neutral to alkaline in reaction; pH of control soil was (7.76) slightly lower as compared to waste soil (8.37). The relative high pH of the soils might be due to the presence of high degree of base saturation. The organic carbon content in waste soil (43.17 %) than in control soil (34.35%). The very low organic content of these soils may be attributed to the poor vegetation and high rate of organic matter decomposition under hyper thermic temperature regime which leads to extremely high oxidizing condition (Kameriya, 1995). The results of the present investigation were found to be high organic contents due to this soil become more productive for vegetation. Colour of soil is useful indicator of some of the general properties of soil, such as the amount and state of organic matter and soil aeration, the colour of control soil dark reddish brown and waste soil grayish brown, due to waste soil had very poor drainage or suffer from waterlogged. Moisture content in waste soil was found to be very low (3.92 %) as compared to control soil (6.62 %). Wetness depends largely on the porosity of a soil, and for that reason clayey soil, which have a high porosity generally have larger water content than do sandy soils. (Williams, 2005) reported that the range of moisture content in a typical landfill is 15 to 40% with a typical average 30%. The water content in landfill sites assists to exchange of substrate, nutrients, buffer, and dilution of inhibitors and spreading of microorganisms (Cernuschi and Giugliano, 1996; and Tecle et al., 2008).The chlorides content in waste soil (49.7 mg/ kg) it was 20-30 % higher than control soil (42.6 mg/ kg). The conductivity of waste soil was much higher (1.792 $X10^6$) than control (0.128 $X10^6$). The overall mean exchangeable bases in waste soils were record as to be Na (26.5 mg/kg), K (89 mg/kg), Ca (400 mg/kg), $CaCo_3$ (79.1 %) respectively. In waste soil Na, K and $CaCo_3$ concentration 50-70 % higher than garden soil (control). This followed the pattern reported by Isirimah*et al.* (2003) for productive agricultural soil. The high base saturation of the dump soil may be as a result of increase release of Na, K, Ca and $CaCo_3$ by decomposing waste, is an indication of good yield.

The distribution of metals concentration present in the soil is shown in (Table 2**)**. Iron (Fe) had the highest concentration in both the waste and garden (control) soil. High iron content was found due to the reason that iron is present in various forms of iron oxides in red soil giving the soil rusty red colure that’s why garden soil contain more amount of iron than waste soil. Zinc (Zn) and Manganese (Mn) second highest element in waste soil its concentration somewhat higher than garden (control) soil. The availability of Zn increased with increase in electrical conductivity (Vijayakumar and Martin, 2011). The results of the present investigation the electrical conductivity of waste soil much higher than control are close proximity with the above findings. Complexed Mn in the soil solution of a sandy loam increased from 10 to 55% as the amount of organic matter in the soil increased (McGrath et al., 1988). Cobalt was totally absent in control as well as waste soil. Higher concentration of Co it may prove toxic to plant and severely interfere with physiological and biochemical functions (El-Sheekh*et al*., 2003).

Cr concentration in waste soil had 30-35 % higher than control soil. Anthropogenic activities have led to the widespread contamination that Cr shows in the environment and have increased its bioavailability and biomobility. A detailed review on the critical assessment of Cr in the environment has been published by (Kimbrough *et al*., 1999). Chromium toxicity in plants is observed at multiple levels, from reduced yield, through effects on leaf and root growth, to inhibition on enzymatic activities and mutagenesis (Salt *et al*., 1994; Zavoda *et al.*, (2001). Cu concentration in waste soil had recorded 65-70 % higher than control. Giordani *et al.,* (2005), this is in keeping with the fact that Cu is an important constituent of several proteins and enzymes involved in photosynthesis and respiration, and only in excess can it cause chlorosis, inhibition of root growth and damage to plasma membrane permeability. Very low Concentration of Ni found in waste soil than control soil. It is well known that elements such as Cu, Mo, Ni, Cr, and Zn, among others, are essential for plant growth in low concentrations (Taiz and Zeiger, 1998). Nevertheless, beyond certain threshold concentrations, these same elements become toxic for most plant species (Blaylock and Huang, 2000). These toxic metals ultimately affect on human beings and animals also due to the consumption of plants.

TABLE 2: Physicochemical analyses of waste soil collect in summer from Municipal Corporation Sukali compost and landfill Depot, Amravati.

Sr.No.	Parameters	Garden (Control Soil)	Municipal corporation (Waste Soil)
1	Temperature(^{0}C)	35.5	32.4
2	pH	7.76	8.37
3	Colour	Dark reddish brown	Grayish dark brown
4	Moiture content (%)	6.62	3.93
5	Moisture correction factor (mcf)	1.06	0.13
6	Soil texture	Sandy loam	Sandy
7	Organic Carban (%)	34.35	43.17
8	Chlorides (mg/Kg)	42.6	49.7
9	Conductivity µmoho/m	$0.128 X10^6$	$1.792X10^6$
10	Na (mg/Kg)	4	26.5
11	K (mg/Kg)	13	89
12	Ca (mg/Kg)	890	400
13	$CaCO_3$ (%)	24.16	79.1
14	Heavy Metals		
I	Cu (mg/g)	0.699	1.001
II	Zn (mg/g)	1.684	5.058
III	Cr (mg/g)	0.168	0.536
IV	Ni (mg/g)	0.061	0.053
V	Fe (mg/g)	22.41	21.65
VI	Mn (mg/g)	4.695	5.982
VII	Co (mg/g)	-0.075	-0.100

CONCLUSION

All the recorded minerals and metals in waste soil samples were 30-80 folds higher than garden soil (control).The changes in temperature and pH affect the chemistry of soil often triggering chemical reaction resulting in the formation of unwanted products. Heavy metals may have harmful effects on soils, crop and human health. This Indicate serious environmental issue and in order to protect soil and environment, for this threat, mass public awareness is needed. Besides, pollution control authorities, Amravati Municipal Corporation, Amravati and local people should work hands in hands to combat against these dangerous environmental problems.

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