wjpls, 2018, Vol. 4, Issue 11, 159-164 **Research Article** **ISSN 2454-2229**

World Journal of Pharmaceutical and Life Sciences
WJPLS
www.wjpls.org
SJIF Impact Factor: 5.088

INITIAL CHARACTERIZATION OF MUNICIPAL SOLID WASTE OF DIBRUGARH MUNICIPAL WASTE DUMPING SITE IN ASSAM, INDIA

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Article Received on 12/09/2018 **Article Revised on 03/10/2018** **Article Accepted on 24/10/2018**

ABSTRACT

Municipal Waste Management is one of the most challenging issues now a days due to lack of authentic data on different elements of Solid waste, namely, storage, collection, transportation, separation, processing and disposal. This study present an assessment of existing status of waste generation rate in conjunction with physical and chemical characterization. The collected MSW included biodegradables (organic fraction), paper, plastic, glass, ceramics, metals, inert materials, ash and debris. The data analysis indicated that the biodegradable components dominate the characterization at 39.56-41.95% followed by glass and ceramics (10.09%-11.40%). pH value of the waste was neutral 6.02-7.31 which coupled with high value of electrical conductivity. Organic waste, ash, plastic and paper are also the main heavy metal sources of MSW which accounted for 1128.60 mg/kg and 552.78 mg/kg contribution of the Fe and Cu. Much more attention should be paid on the MSW management to avoid heavy metal pollution.

KEYWORDS: Municipal Solid Waste (MSW), physical, chemical, heavy metals.

1. INTRODUCTION

Solid waste is referred as any garbage, refuse, sludge from a wastewater treatment plant, water supply treatment plant or air pollution control facility and other discarded materials including solid, liquid, semi-solid or contained gaseous material resulting from industrial, commercial, mining, agricultural and from community activities. Any discarded or abandoned materials which can be solid, liquid, semi-solid or containerized gaseous material is considered as solid waste. Increasing population, rapid urbanization, rise in community living standard and booming economy have greatly influenced Municipal solid waste (MSW) generation rate in developing countries like India (Minghua et al., 2009). India is an agriculturally based country with a present population of approximately 1.34 million (indiaonlinepages.com). Due to rapid industrial growth, the urban population is increasing rapidly. In the world, the MSW disposal has three primary ways such as landfilling, incineration, and composting.

The composition of municipal solid waste varies greatly from municipality to municipality (Kumar et al., 2016). Solid waste management is a multi-dimensional issue. Municipal solid waste provides services to the general public and private firms in regards to waste collection and disposal. The MSW amount is expected to increase significantly in the near future as the country strives to attain an industrialized nation status by the year 2020 (Sharma and Shah, 2005; CPCB, 2004). The composition and the quantity of MSW generated form the basis on which the management system needs to be planned, designed and operated. In India, MSW differs greatly with regard to the composition and hazardous nature when compared to MSW in the western countries (Gupta et al., 1998; Shannigrahi et al., 1997; Jalan and Srivastava, 1995). Solid waste management (SWM) is one of the most challenging issues owing to lack of authentic data on different elements of SWM, namely, storage, collection, transportation, separation, processing and disposal.

The daily waste generated in Dibrugarh is about 50 metric tons per day. The main generators of the solid waste are the five markets in the city. It accounts for almost 50% of the total solid waste generated. There is no leachate collection or protection system installed in the existing disposal site (Government of Assam for the Asian Development Bank, 2011).

Heavy metals are metallic elements that have relatively high density and toxic even at low concentration (Duribe, et al., 2007).They have a great ecological significance due to their toxicity accumulative behavior. Heavy metals in the MSW are a potential source of contamination of surrounding soil and ground water because of their leaching ability and mobility. The mobility of hazardous substance and contaminates should be reduced by stabilization of heavy metal. The accumulations of heavy metals in soil reach concentration since become a threat to vegetation and animals. Ultimately affect the quality of human life through food chain. Heavy metals are found in electrical wastes, municipal solid waste and from degradation of organic wastes (Esarru et al., 2003). Some metals are very essential to life but they are toxic at thigh level of dose (Ukpebor and Unigbe, 2003).

The major sources contributing to Municipal Solid Wastes generation in Dibrugarh city include the household, institutions, industries, markets, street sweeping, construction and demolition activities etc. Unscientific disposal of waste causes an adverse impact on all components of the environment including human health (Rathi, 2006; Sharholy et al., 2005; Ray et al., 2005; Jha et al., 2003; Kansal, 2002). The main objective of the present study is to assess the waste quantity and initial characterization of waste.

2. MATERIAL AND METHOD

2.1. Study Area

In the present study, Dibrugarh Municipal Waste dumping cities was selected. Dibrugarh is located along the Southern Bank of the Brahmaputra River lying between 27.26º N Latitude and 94.35º E Longitude. The town is situated at 104 m above the mean sea level. The physical characteristic of the district is constituted by a variety of elements such as flood plain, wetland and swamps, occasional highlands and foothills of the Barail Range. Dibrugarh experiences subtropical monsoon climate with mild winter, warm and humid summer.

The present dumping site is located at Maizan, Barsuikiya Gaon which is 6 km away from the city covering an area of 0.5 ha. The major activities included performing field investigations to assess the quantity of MSW generation per day and determining waste composition and characteristics. The activities included performing one-week field investigations and actual data measurement at MSW disposal sites, locations of which were selected in consultation with the local authorities. Initial planning and scheduling of the field investigations along with sampling were undertaken through field reconnaissance in each of the selected locations. This procedure was carried out daily during the six days of sampling. Samples were collected from the raw MSW input and analyzed for physico-chemical characteristics at the plant site and also a detailed chemical analysis was performed in the laboratory.

2.2. Solid Waste Sorting and Separation

Waste were sorted and segregated to assess the amount of ingredients present in the MSW. The ingredients were segregated and weighed. The ingredients identified in MSW could be broadly categorized as biodegradables, non-biodegradable, recyclables and inert wastes. In this study, MSW comprised biodegradable/compostable matters, leather, papers, plastics, glass and ceramics, metals, inerts, ash and debris. Density of the waste was done by mass per volume.

2.3. Physico-chemical Analysis

The samples were analysed in the department of Civil Engineering, Indian Institute of Technology Guwahati, India. Physico-chemical analysis were performed based on standard procedures prescribed by APHA, 2005 to determine pH, electrical conductivity, fixed carbon, volatile substance, ash content, moisture content. Heavy metals of the waste were measure by atomic absorption Spectrophotometric method (Varian, Spectra AA Duo). Sodium, potassium, calcium were estimated by flame photo meter (Systronics: 167).

RESULT AND DISCUSSION

The physical composition of MSW is shown in Fig. 1 which indicating that the fraction of individual composition in a 100% stacked pie diagram. MSW comprised biodegradable matters, papers, plastics, glass and ceramics, metals and debris. The composition of MSW at generation sources and collection points was determined on a wet weight basis and it consists mainly of a large organic fraction (39.56- 41.95%), Glass & Ceramics (10.09- 11.40%) followed by plastic and paper (6.99- 8.16 %) and (4.65- 5.91 %). Comparison of heavy metal contents of MSW of the study site with Indian Standards for compost (Table 1) shows that the concentration of Pb, Ni and Cd exceeds the specific limits but when United States Environmental protection Act (EPA) regulation limits are considered except lead, the concentrations of all other heavy metals studied are within the permissible limits. The physico- chemical characteristics of MSW in Dibrugarh Municipal Waste Dumping Site was presented in Table 2. From the result it was found that the average pH values ranged from (7.31±0.01-6.02±0.01). The neutral pH indicates that the Municipal Solid Waste received at the plants were fresh. Smith suggested that optimal pH value for growth of the majority of plants was between 6.5 and 7.0. According to Dios (2008) pH value between 5 and 7 are optimal for biological treatment. The basic pH value of solid waste indicates the possibility of waste to neutralize the organic acid that can generate from the anaerobic degradation of organic matter (Prechthai, et al., 2007). Electrical conductivity is a good indicator of the total salinity. Electrical conductivity was recorded more in morning (5.69±0.01mmho/cm) and less in the evening time (0.82±0.001mmho/cm). High value of electrical conductivity indicate the corrosive nature of the waste. The value of fixed carbon was found in the range of 13.98% -42.93%. Volatile solid was monitored high in the evening time 57.82 % as compared in the morning 11.55%. Ash content was recorded in the range of 42.18%-88.45%. Moisture content was found to be 41.2%- 59.4%. The presence of optimum moisture content in the waste has influenced the degradation rate generating organic acid. Ostman et al., (2006) mention that the moisture content are found to be important factors which influence the anaerobic condition of the dumpsite. Raymond and Zeiss (2004) also supported the fact that moisture content has an important effect on biodegradation rates in landfills. Heavy metals have greater density than water. The poisoning effects of heavy metals are due to their interference with the normal body bio chemistry in the normal metabolic processes. They are converted to their stable oxidation states combine with the body to form strong and stable chemical bonds **(**Asgele and Gebremedhin, 2015). Iron concentration was monitored to be 8453.76 mg/kg and 3949.44 mg/kg. Lead is the most significant toxic element of heavy metals and the organic forms of lead are absorb though ingression by food and water and by halation. Lead concentration was found 1128.60 mg/kg and 686.40 mg/kg. Copper was recorded more in the morning samples 552.78 mg/kg and less in the evening time (133.12 mg/kg). Highest concentration of Zinc was recorded in morning hours 676.66 mg/kg followed by 553.01 mg/kg. Long et al., (2010) reported that Cu and Zn contents in MSW are in greatly influenced by spatial variation. Chromium is released by combustion processes and from metal industries. In the present study Chromium was not detected in any one of the samples which is due to limited industries in the vicinity. Nickel was in the range of 115.83 mg/kg and 68.64 mg/kg. Cadmium was in the range of 19.60 mg/kg and 11.86 mg/kg. This finding was also supported by Kumar et al., 2016. High concentration of Sodium, Potassium and Calcium were monitored as 732.50 mg/kg, 9,639.70 mg/kg and 4470.20 mg/kg. The sources of these observed metals, Cd, Pb and Cr in the site are expected to be plastics, shoes, rubber, electronic waste and non-ferrous metal that were composed in the dumpsite. Based on the average concentrations, the heavy metal recorded in the present study followed the following trend- Pb>Zn>Cu>Mn>Ni>Cd. Garg and Prasad, 2003; CPCB, 2000; Bhide and Shekdar, (1998) mention that the physical and chemical characteristic of MSW change with population density. Jha et al., reported that in the metro cities of India, there is no much difference in the types of waste generated in the physical characterization data of MSW although there is an increase in the magnitude of generation over the years.

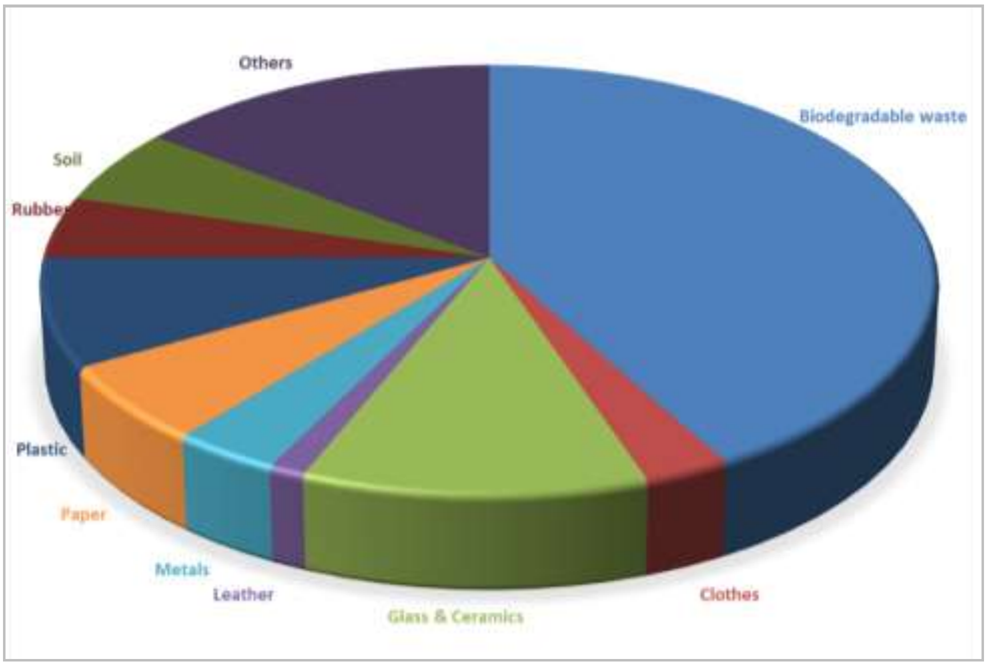
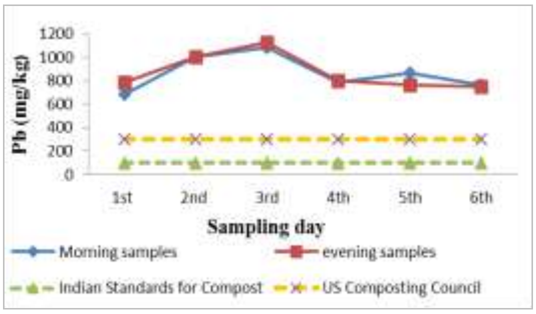
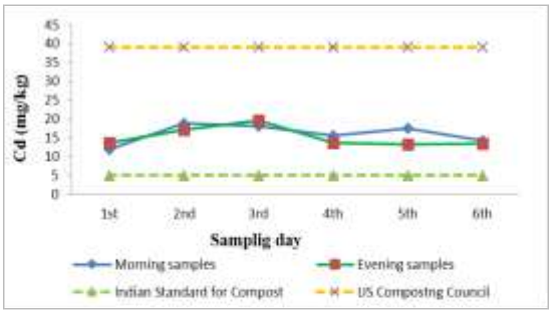
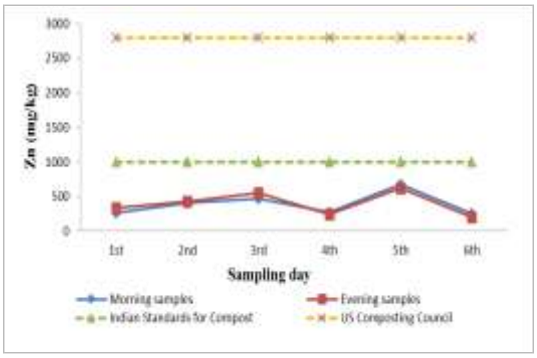
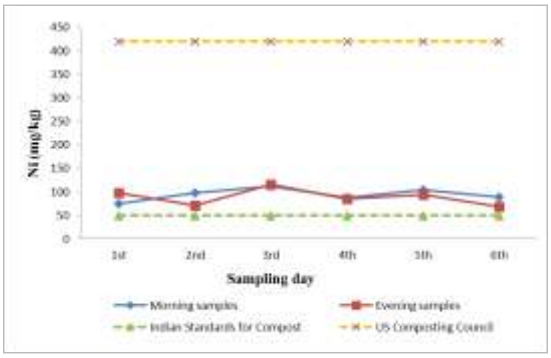


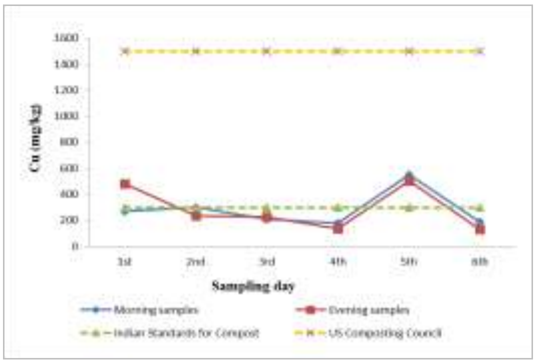
Fig. 1: Physical Composition of MSW in Dibrugarh Municipal Waste Dumping Site.

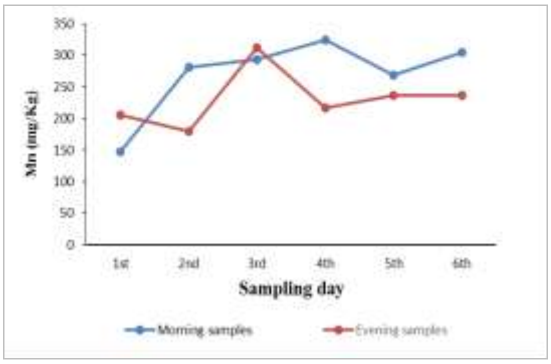


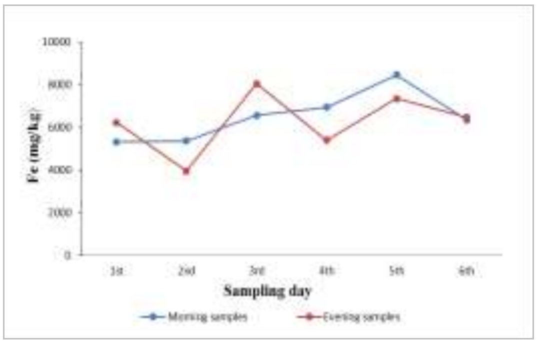


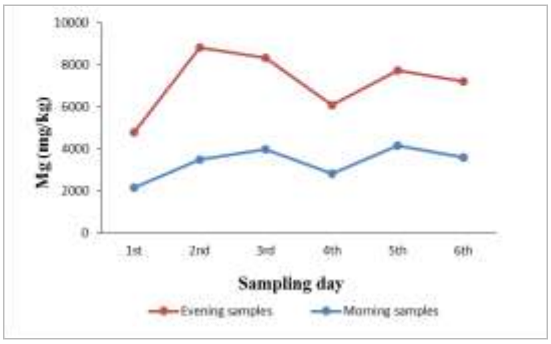

Zn (mg/kg)
Sampling day
Morning samples
Evening samples
Indian Standards for Compost
US Composting Council

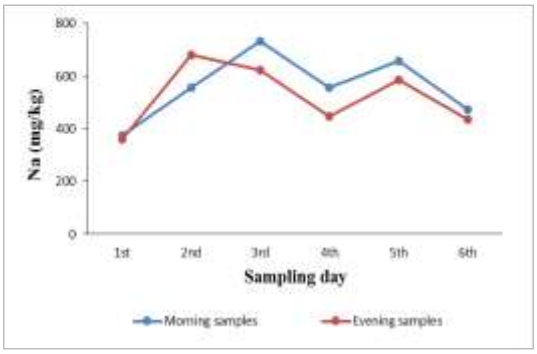

Ni (mg/kg)
Sampling day
Morning samples
Evening samples
Indian Standards for Compost
US Composting Council

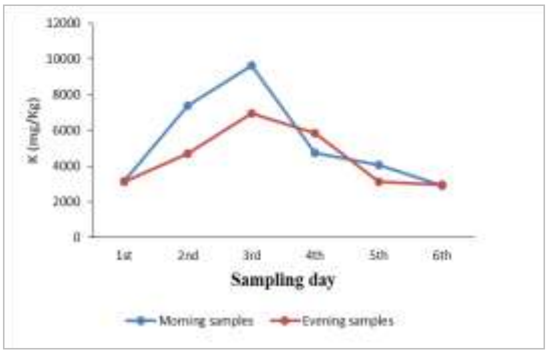

Cu (mg/kg)
Sampling day
Morning samples
Evening samples
Indian Standards for Compost
US Composting Council


Mn (mg/Kg)
Sampling day
Morning samples
Evening samples


Fe (mg/kg)
Sampling day
Morning samples
Evening samples


Mg (mg/kg)
Sampling day
Evening samples
Morning samples


Na (mg/kg)
Sampling day
Morning samples
Evening samples


K (mg/Kg)
Sampling day
Morning samples
Evening samples

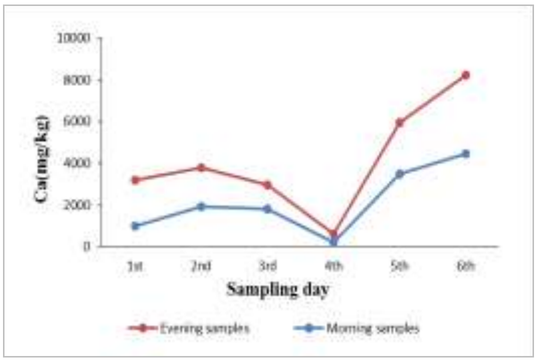

Ca(mg/kg)
Sampling day
Evening samples
Morning samples

Table 1: Heavy metal contents in MSW fine fractions (all values are in mg/kg).

Particulars	Pb	Zn	Mn	Cu	Ni	Cd	Cr
Average values	868 ±147	395 ± 159	251±56	285 ± 146	91 ± 15	16 ± 2	ND
Indian Compost Standards[a]	100	1000	--	300	50	5	50
US EPA Compost Standards[b]	300	2800	--	1500	420	39	1200

[a]Municipal solid Waste (Management and Handling Rules 2000)
[b]US Composting Council (1997)

Table 2: Physicochemical Characteristic of MSW.

Sl. No.	Parameters	1st Day		2nd Day		3rd Day		4th Day		5th Day		6th Day	
		Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening
1	pH	6.91±0.01	7.31±0.01	6.49±0.01	6.09±0.01	6.52±0.01	6.37±0.01	6.02±0.01	6.18±0.01	6.41±0.01	6.21±0.01	6.50±0.01	6.99±0.01
2	EC (mmho/cm)	2.25±0.01	0.82±0.001	2.96±0.01	3.02±0.01	3.56±0.01	2.75±0.01	2.11±0.01	3.76±0.01	5.69±0.01	3.56±0.01	1.85±0.01	0.89±0.001
3	Fixed Carbon	33.47	13.98	35.39	36.82	32.86	41.31	22.91	42.88	37.76	42.93	21.42	21.89
4	Volatile Solids (%)	11.55	13.53	35.26	57.82	40.10	30.56	21.53	42.07	36.69	41.86	21.22	20.89
5	Ash Content(%)	88.45	86.47	64.74	42.18	59.90	69.44	78.47	57.93	63.31	58.14	78.78	79.11
6	Moisture Content(%)	41.6	42.4	55.6	54.4	58.6	59.4	46.4	47.0	44.4	43.8	41.2	41.6
7	Density (Kg/m^3)	282.41		247.98		233.54		236.95		181.48		209.22	

CONCLUSION

The study will be helpful to the decision-makers in identifying appropriate processing and disposal options. The determination of the physical and chemical characteristics of MSW should be considered because their importance in the biochemical transformation and final treatments such as incineration or energy recovery.

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