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A Comprehensive Analysis of the Chemical Characteristics of Municipal Solid Waste in Agartala City

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Abstract*—*Solid waste management is a burning problem of the modern society. Solid waste characterization is an important activity to be performed before finalizing the management technique for solid waste. In the present study the results of solid waste characterization with respect to chemical characteristics has been presented for Agartala city for last three years. An effort is also made to investigate the variation of solid waste characteristics in the city over these years through statistical analysis. This particular study will surely help in further studies regarding the solid waste processing, treatment and management of Agartala city.

Keywords*—*Solid waste, characterization, box plot, management, Agartala city.

I. INTRODUCTION

Municipal Solid Waste (MSW) can be considered as a pathway for different tangible environmental problems. This statement can be validated by the fact that solid waste is created in every city, town and even in every village across the world. Inappropriate waste disposal practices have been a serious problem in many cities, especially in developing countries. These waste disposal problems can contribute to various sociological and economic problems. There are various factors which causes the inappropriate disposal of solid waste. Some of these factors include social norms, financial constrains, lackage of physical infrastructure etc (Barr, 2007; Steg and Vlek, 2009). A number of researches have been done in recent days regarding various approaches, systems and mathematical models of waste management (Beigl et al., 2008; Yau, 2010).

Maximum cities in both developed and developing countries generally do not spend more than 0.5 percent of their per capita gross national product on urban waste management services, which covers only about one-third of overall cost (World Bank, 1999). More than 80 percent of the total waste management costs in low-income countries are collection costs (World Bank, 1999). It implies that in such countries the fund allocation in waste management services is not adequate enough to cope up with the ever increasing load of solid wastes. As a result of such policies the municipal authorities find it difficult to provide sufficient infrastructure for the solid waste management.

The approach for effective solid waste management varies from place to place and should be compatible with the nature of a given society. Different studies on solid waste management in developing countries have revealed that the quantities and composition of solid waste varies from place to place depending upon the environmental, social and economic condition of the country, and thus the management policy should be adapted considering the surrounding conditions of the locality and society for which it is proposed.

In developing countries like India, the municipal solid waste is often disposed of in open dumps, which is not the proper way of disposal because such crude dumps pose serious environmental hazards (Kansal et al., 1998). Such practice imparts serious threats to the ecological balance and sustainability. Sanitary landfilling is one of the effective techniques of solid waste disposal in an environmentally sustainable manner especially in developing countries. Beside these techniques like incineration, pyrolysis, composting etc can also be used for solid waste treatment and disposal. For proper treatment and disposal of solid waste, the proper segregation of the solid waste is very essential. Segregation is the technique by which solid waste is divided into its components (mainly organic & inorganic) by manual or mechanical means. For proper segregation of solid waste as well as for selecting the suitable method for its treatment, the knowledge of quality of solid waste generated by a locality is very essential (Mor et al., 2006). In the present paper an effort is made to ascertain the chemical characteristics of the municipal solid waste generated in Agartala city based on the laboratory based results alongwith further statistical analysis.

II. STUDY AREA

Tripura is one of the North-Eastern State of India. Agartala is the capital city of Tripura. Geographical area and population of the city is about 62.02 sqkm and 3,99,688 respectively. The collected solid wastes from residential areas, commercial areas, institutes and streets were carried to the lone dumping ground of Hapania up to 2013 and now being disposed at Debendra Chandra Nagar dumping ground. Figure 1 shows the population growth of Agartala city from 1951 to 2011.

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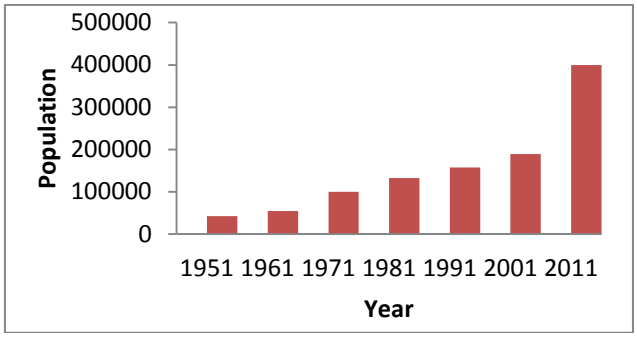

Fig. 1. Population Growth of Agartala City

III. METHODOLOGY

The two basic approaches for estimating the quality and quantities of municipal solid waste at the local, state, or national levels are the site-specific studies and materials flow studies. Site-specific study is the methodology in which the site-specific sampling, sorting, and weighing the individual components of the waste stream are done. This methodology is useful in defining a local waste stream, especially if large numbers of samples are taken over several seasons. The result of sampling by this method also increases the information about the fluctuations due to climatic and seasonal changes, population density, and regional differences and so on. The materials flow methodology is based on production data (by weight) for the materials and products in the waste stream. To estimate generation data, specific adjustments are made to the production data for each material and product category. Adjustments are made for imports and exports and for diversions from MSW and also for lifetime of the products. The problem associated with the materials flow methodology is that product residues associated with other items in MSW are not accounted for.

For the present study 10 sampling locations in the city of Agartala were selected on random distribution basis and from each station 5 kg of samples were collected for each analysis. All the tests were carried out on triplicate and the average results are presented. The total procedure of solid waste sampling of the city was done for the whole year from 2014 to 2016 to avoid any risk of biasing of the results due to seasonal variation. The collected samples were analyzed as per the standard procedure to determine quality parameters. Further these laboratory analysis data were statistically treated to generate box-whisker plot to ascertain the variation and distribution of the data.

IV. RESULT AND DISCUSSION

The samples were periodically collected from all the ten sampling stations throughout the year for the study period in each season and the average result of the whole year is depicted in Table 1, 2 and 3 respectively.

The statistical analysis of these data is also carried out as described in earlier section to investigate the variation of the parameters. The box-whisker graphs for the present set of data alongwith the graphical representation for segregation result are given in Figure 2 to Figure 5.

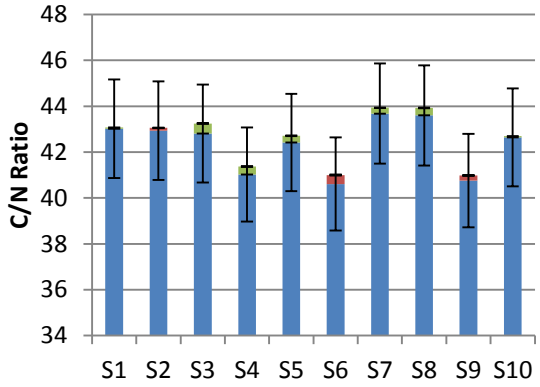

Fig. 2. Box Plot for C/N Ratio

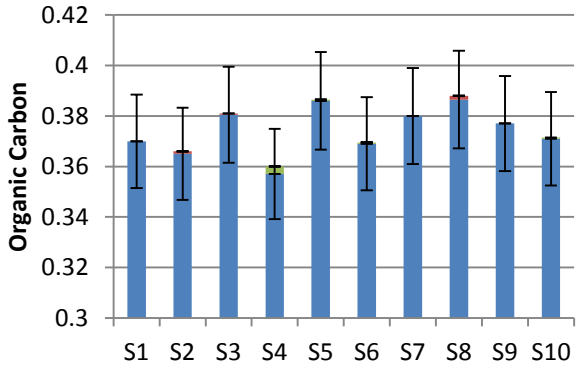

Fig. 3. Box Plot for Organic Carbon

TABLE I. Chemical composition of municipal solid waste in Agartala city (Sampling Year: 2014)

S. No.	Component	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	Average
1	Moisture Content	36%	35.70%	34.60%	38%	37.70%	35.60%	36.20%	37.80%	36.10%	35.50%	36.36%
2	Organic Carbon	37%	36.60%	38.10%	35.70%	38.60%	36.90%	38%	38.80%	37.70%	37.10%	37.50%
3	Total Nitrogen	0.86%	0.85%	0.89%	0.87%	0.91%	0.90%	0.87%	0.89%	0.92%	0.87%	0.89%
4	Potassium as K_2O	0.45%	0.46%	0.45%	0.44%	0.47%	0.46%	0.45%	0.48%	0.45%	0.46%	0.46%
5	C/N Ratio	43.02	43.06	42.81	41.03	42.42	41.00	43.68	43.60	40.98	42.64	42.36

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TABLE II. Chemical composition of municipal solid waste in Agartala city (Sampling Year: 2015)

S. No.	Component	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	Average
1	Moisture Content	36%	35.60%	34.70%	38%	37.70%	35.50%	36.00%	37.40%	36.20%	35.50%	36.30%
2	Organic Carbon	37%	36.40%	38.00%	36.30%	38.70%	37.00%	38%	38.50%	37.70%	37.20%	37.53%
3	Total Nitrogen	0.86%	0.85%	0.87%	0.87%	0.90%	0.92%	0.86%	0.87%	0.93%	0.87%	0.88%
4	Potassium as K_2O	0.44%	0.46%	0.46%	0.43%	0.47%	0.47%	0.45%	0.48%	0.46%	0.46%	0.46%
5	C/N Ratio	0.41%	0.43%	0.44%	0.43%	0.46%	0.45%	0.44%	0.45%	0.43%	0.45%	0.44%

TABLE III. Chemical composition of municipal solid waste in Agartala city (Sampling Year: 2016)

S. No.	Component	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	Average
1	Moisture Content	36%	35.70%	34.60%	38%	37.70%	35.60%	36.20%	37.80%	36.10%	35.50%	**36.36%**
2	Organic Carbon	37%	36.60%	38.10%	35.70%	38.60%	36.90%	38%	38.80%	37.70%	37.10%	**37.50%**
3	Total Nitrogen	0.86%	0.85%	0.89%	0.87%	0.91%	0.90%	0.87%	0.89%	0.92%	0.87%	**0.89%**
4	Potassium as K_2O	0.45%	0.46%	0.45%	0.44%	0.47%	0.46%	0.45%	0.48%	0.45%	0.46%	**0.46%**
5	C/N Ratio	0.42%	0.44%	0.43%	0.43%	0.45%	0.44%	0.43%	0.45%	0.42%	0.44%	**0.44%**

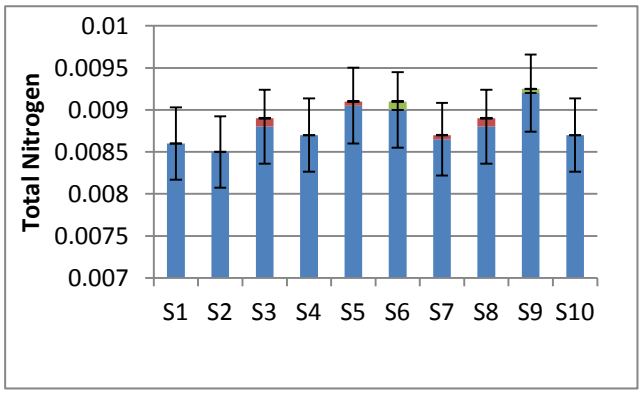

Fig. 4. Box Plot for Total Nitrogen

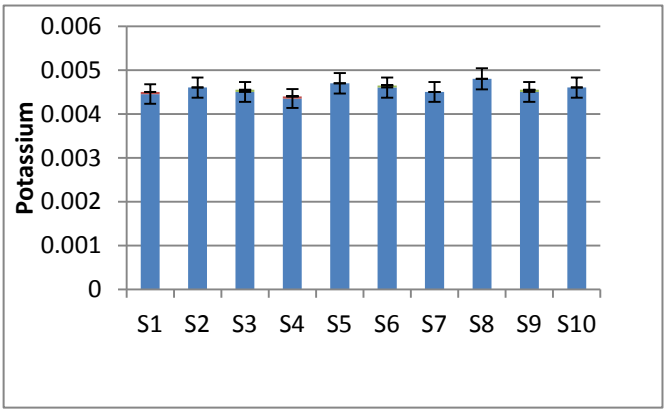

Fig. 5. Box plot for potassium

V. CONCLUSION

The chemical composition of solid waste in the study area indicates a consistent trend of solid waste quality. For chemical parameters like Potassium and Nitrogen uniform trend has been found for the study period. In case of Organic carbon content a very sharp increasing trend is encountered. It is probably due to the increase in population and corresponding increase in organic waste components. One of the important parameter with respect to solid waste management is C/N ratio, which shows a slight increasing trend. The present study provides a detailed overview regarding the solid waste quality of Agartala city. This study will surely help in developing effective solid waste management plan for the city in future. Moreover the correlation that has been derived from the present study among different solid waste components will serve as a basis for future study in the field of solid waste characterization and management.

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