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Analysis of Solid Waste for its better Management – a case study

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Abstract: *Rapid population growth and changes in consumption habits have caused a considerable increase in solid waste production, and the amounts of refuse destined for final disposal have rapidly consumed landfill capacity. Cities in developing countries face serious environmental pollution problems caused mainly by the inadequate and inefficient final disposal of their solid waste. The most poorly rendered services in the basket—the systems applied are unscientific, outdated and inefficient.This study is based on both primary and secondary sources of data; primary data was collected through field survey during the year 2015 – 16. In the present study an attempt has been made to analysis of the composition, characteristics and quantities of solid waste. An analysis of the composition, characteristics and quantities of waste is essential because it provides the basic data on which the management system is planned, designed and operated, the changes and trend in composition of waste over a period of time are known which helps in future planning and the forecast of trend assists designers and manufactures in the production of vehicles and equipments suitable for future needs.*
Key Words: *Analysis, composition, characteristic, disposal, Solid waste.*

I. Introduction

The information on the nature of wastes, its composition, physical and chemical characteristics and the quantities generated are basic needs for the planning of waste management. Characteristics refers to those physical and chemical properties, which are relevant to the storage, collection, treatment and disposal of waste such as density, moisture content, calorific value and chemical composition. An analysis of the composition, characteristics and quantities of waste is essential because it provides the basic data on which the management system is planned, designed and operated, the changes and trend in composition of waste over a period of time are known which helps in future planning and the forecast of trend assists designers and manufactures in the production of vehicles and equipments suitable for future needs. An examination of the composition and characteristics of wastes in different parts of the city underscores the profound influence of income, socio-economic conditions, social development and cultural practices and thereby focuses attention on the importance of obtaining the data locally.

The composition of solid wastes from all the urban centres is similar but its volume, weight and density varies from country to country, town to town and from place to place. It depends upon population concentration and various functional activities such as residential, commercial, industrial etc. Geographical factors like location of the city, climate and weather condition, socio-economic conditions including income, living condition and life style also play a significant role in it (Bhide A.D. and Sundaresan, B.B., 1987[1]). The quantity and nature of solid waste is changing from more biodegradable to non-biodegradable and hazardous waste (Boojh, R. 1996[2]). what we have observed that with changing life styles in modern pace, the quantity of ashes from domestic cooking have decreased by the use of L.P.G., kerosene oil and electric heating but the amount of polythene, plastic and paper waste is increasing with the growth in consumer packaging (Carvalan C.F., 1999[3]). In the present study an attempt has been made to analysis of the composition, characteristics and quantities of solid waste.

II. Database And Methodology

This study is based on both primary and secondary sources of data; primary data was collected through field survey during the year 2015-16. For selecting the sample, multistage stratified random sampling design was adopted. About 16 wards from the 60 wards of the city were selected on the basis of population and location (10 wards from old city zone and 6 wards from the civil lines zone). While collecting samples of households waste, major waste disposal sites were identified which covered a larger size of population, based on the type of area such as from residential areas of the old city zone and civil line zone, sampling sites were identified. The sampling sites were further classified on the basis of economic status of population such as high, medium and low income *mohallas.*

About 16 kg of municipal solid waste was collected from the 16 sampling sites from the sampled wards of Aligarh city (Usmanpara, Jaiganj, shahjamal, Jameerabad, Nagla Masani, Gambhirpura, Nagla Kalar, Nai Basti, Begambagh, Bhujpura, Jamalpur, Sudamapuri, Jiwangarh, Dori Nagar, Bhamola, Khai Dora). The solid waste samples were collected with the help of municipality workers. About 1 kg of solid waste was collected from each sampling sites from inside and outside of the solid waste dump. The total quantity of waste so collected was thoroughly mixed and then reduced by method of quartering till a sample of such a size was obtained which could be handled in the laboratory. The sample so obtained was subject to physical analysis, determination of moisture and then the sample was processed for further chemical analysis. The samples were tested by the lab technicians in the Laboratory, Department of Civil Engineering, Aligarh Muslim University, Aligarh.

The variables for physical characteristics of the solid wastes were vegetable matters/food/fruit, plastic, rubber and synthetic, glass pieces and broken crockery, papers, rags and jutes, construction debris, wooden materials and drain silt, while for the chemical analysis moisture, pH value, carbon, nitrogen, ash, organic matters, C/N ratio, phosphorus and N/P ratio have been taken as principal parameters. The physical analysis results are expressed on wet-weight basis whereas the chemical results have been obtained on dry- weight basis.

III. Discussion And Results

Aligarh city ($27^0$53' N latitude and 78^0 4' E longitudes) a medium sized city located in the fertile Gangetic plain of north India was chosen as the study area. The city is located along the Delhi – Kolkata railway line, about 130 km. away from New Delhi. This railway line divides the city in two parts, on east lies the congested old part of the city (city zone) while on the west side lies the new part or the civil lines (civil lines zone) developed by the Britishers. Now this part has also becoming congested. The city covers an area of nearly 37.82 sq. km. and has a population of about 1 million. The city spreads over 60 wards, 427 *mohallas* and has 102,004 households (Aligarh Nagar Nigam, 2016[4]). In Aligarh city, the residents have a mixed culture and are of different social groups i.e. servicemen, business class, politicians belonging to high, medium, and low income groups. They are settled either in business cum- residential or in residential areas generating varied nature of solid wastes which directly depends upon their living conditions. The refuse of Aligarh city mainly consists of vegetable waste, leftover food, fruit waste, paper waste, animal waste, carry bags, waste of pouches and sachets of different items, cans/bottles, plastic material, rubber, ash/cinders/dust and other wastes.

IV. Characteristics Of The Solid Waste

As the population grows by leaps and bounds so will be an increase in waste generation and the need for its disposal has also increased. Although the Aligarh Municipal Authority is trying to manage this waste (from collection, transportation to final disposal) but only 70-80 per cent of waste reaches the final disposal destination (Mohd., S., 2011[5]). Rest of the waste stagnates either in municipal waste bins, which are either not present or if at all they are there, have turned into mere pieces of rusted metal. These dustbins are not cleaned frequently as a result of which waste spills over and spreads everywhere on the streets. Garbage is dumped in open plots/ field or along roadside, in the residential colonies increasing the risk of diseases and several other problems like waterlogging, choking drains, garbage mounds on roads etc (Singh, A.L., and Rehman, A., 1998[6]).

Thus, the knowledge of physico-chemical characteristics of solid waste, i.e. its moisture content, pH value, carbon, nitrogen, ash, organic matter, C/N ration, phosphorus, and N/P ratio are important parameters in taking decision towards its proper management, evaluating alternative processes and energy recovery options. If the content of compostable materials is high, the refuse can be used for composting otherwise it should be used for sanitary landfilling. The value of the compostable material increases with higher ratio of carbon and nitrogen availability in it. Nitrogen provides nutrient to soil for plant growth. Apart from it, colorific value is also important determinant for installing incineration plant. For this purpose field investigations are necessary for providing basic data on the characteristics of solid waste. Samples of municipal solid waste from residential areas were collected.

While collecting samples of households waste, major waste disposal sites were identified which covered a larger size of population, based on the type of area such as from residential areas of the old city zone and civil line zone, sampling sites were identified. The sampling sites were further classified on the basis of economic status of population such as high, medium and low income *mohallas.*

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obtained which could be handled in the laboratory. The sample so obtained was subject to physical analysis, determination of moisture and then the sample was processed for further chemical analysis. The samples were tested by the lab technicians in the Laboratory, Department of Civil Engineering, Aligarh Muslim University, Aligarh.

The variables for physical characteristics of the solid wastes were vegetable matters/food/fruit, plastic, rubber and synthetic, glass pieces and broken crockery, papers, rags and jutes, construction debris, wooden materials and drain silt, while for the chemical analysis moisture, pH value, carbon, nitrogen, ash, organic matters, C/N ratio, phosphorus and N/P ratio have been taken as principal parameters. The physical analysis results are expressed on wet-weight basis whereas the chemical results have been obtained on dry- weight basis.

4.1. - PHYSICAL CHARACTERISTICS OF SOLID WASTE

The physical characteristics of solid waste collected from the 16 sampling sites (table 1) located in the residential areas of the different sampled wards shows that nearly 33 per cent of the waste comprises of vegetables, fruit and leftover food, another 33 per cent of drain silt, followed by nearly 10 per cent of plastic, rubber and synthetic, 5 per cent of rag and jute, 8 per cent of paper, 5 per cent of constructional debris, 8 per cent of wooden matter and 2 per cent of glass material and broken crockery materials.

Of the total sample of solid waste, nearly 33 per cent consists of vegetables /food/fruit waste. The proportion of this waste ranged from 50 to 27 per cent. The maximum proportion of this type of waste was at Begumbagh (50.15 per cent) followed by Sudamapuri (49.29 per cent), Jameerabad (40.95 per cent), Nagla Kalar (38.78 per cent), while minimum was at Shahjamal (27.47 per cent). About 50 per cent of solid waste was made up of vegetable, fruits and food leftover at Begumbagh and Sudamapuri was due to the high concentration of Hindu population in these areas. Almost all of them are vegetarians and consume vegetables both the time.

Of the total sample of solid waste, another 33 per cent consists of drain silt. This type of waste ranged between 44 to16 per cent. The maximum proportion was at Ghambhirpura (44.24 per cent), followed by Nagla Masani (42.40 per cent), Shahjamal (40.42 per cent), Begumbagh (40.11 per cent), Bhujpura (39.36 per cent), while it was minimum at Khai Dora (16.25 per cent). Proportion of drain silt is very high due to unsanitary condition and disposal of waste directly into the drain.

Of the total sample of solid waste, nearly 10 per cent consists of plastic, rubber and synthetic waste. The proportion of this type of waste ranged from 17 to 4 per cent. The maximum proportion of this type of waste was at Begumbagh (16.81 per cent) followed by Jiwangarh (14.2 per cent), Dori Nagar (12.60 per cent), Shahjamal (12.60 per cent), Nai Basti (12.25 per cent), while the minimum was at Nagla kalar (4.45 per cent). The maximum concentration of plastic, rubber and synthetic waste was at Begumbagh, Jiwangarh, Dori Nagar, Shahjamal, Nai Basti, due to the concentration of waste recycler or junk dealers in these wards.

Of the total sample, nearly 9 per cent of waste consists of rag and jute. The proportion of this type of waste ranged from 20 to 4 per cent. The maximum proportion of this type of waste was at Begumbagh (20.24 per cent) followed by Khai Dora (14.42 per cent), Dori Nagar (12.42 per cent), Jameerabad, (10.45 per cent), Bhamola (10.08 per cent), while minimum proportion of this type of waste was found from

Table: 1- Physical characteristics of the solid waste (in percentage) from the residential areas of Aligarh city, 2015 – 16

Ward No.	Name of the sampled ward	Vegetable/ food/fruit	Drain silt	Plastic, Rubber synthetic	Rag & Jute	Paper waste	Construction Debris	Wooden matter	Glass pieces broken crockery
02	Usman Para	28.98	18.25	5.95	4.49	5.41	5.05	3.45	1.54
06	Jaiganj	33.76	19.15	10.35	4.35	6.28	2.56	2.05	0.86
10	Shahjamal	27.47	40.42	12.60	6.30	7.42	9.10	4.86	1.24
14	Jameerabad	40.95	25.30	10.60	10.45	10.69	0.43	3.28	5.64
16	Nagla Masani	28.44	42.40	6.17	8.23	8.42	8.47	1.47	1.64
17	Gambhirpura	3.32	44.24	8.72	7.44	9.05	8.55	1.96	2.0
18	Nagla kalar	38.78	36.60	4.45	9.45	10.05	2.39	0.86	0.56
21	NaiBasti	31.36	38.40	12.25	9.50	9.42	8.79	4.34	0.78
22	Begum bagh	50.15	40.11	16.81	20.24	16.52	6.44	2.27	5.25
23	Bhujpura	32.44	39.36	10.12	5.44	7.85	8.20	0.81	1.08
30	Jamalpur	36.23	35.14	8.42	6.23	10.05	8.40	2.25	2.14
42	Sudamapari	49.29	25.26	6.17	8.47	10.72	2.89	1.55	3.44
47	Jeevengarh	40.42	36.34	14.12	9.22	12.42	3.80	2.05	3.11
48	Dori nagar	34.42	36.40	12.60	12.42	14.44	1.92	16.93	1.42
53	Bhamola	36.44	32.51	7.11	10.08	10.24	6.69	2.86	2.22
55	Khai Dora	32.90	16.25	7.29	14.42	12.22	3.14	2.44	3.45
	Average	32.96	32.88	9.61	9.17	8.24	5.43	3.34	2.27

Note: All values are given in percentages and calculated on wet-weight basis

Source: Laboratory, Department of Civil Engineering, Aligarh Muslim University, Aligarh (2015 – 2016).

Jaiganj (4.35 per cent). This type of waste (jute and rag) is high in these areas only due to concentration of markets in these areas. Of the total sample, nearly 8 per cent was paper waste. The proportion of this waste ranged, from 16 to 5 per cent. Proportion of paper waste was also high at Begumbagh (16.52 per cent), followed by Dori Nagar (14.44 per cent), Jiwangarh (12.42 per cent), Khai dora (12.22 per cent) and Sudamapuri (10.72 per cent), while the minimum paper waste was recorded at Usman para (5.41 per cent). Of the total sample of solid waste, nearly 5 per cent consists of construction debris. The proportion of this waste ranged between 9 to 1 per cent. Construction debris was recorded maximum at Shahjamal (9.10 per cent) followed by Nai Basti (8.9 per cent), Ghambhirpura (8.55 per cent) Nagla Masani (8.47 per cent), Jamalpur (8.40 per cent), while the minimum was recorded at Jameerabad (0.43 per cent). In these areas this type of waste was high due to constructional work. Of the total sample of solid waste, nearly 3.34 per cent consists of wooden matter. The proportion of this waste ranged between 17 to less than 1 per cent, Dori Nagar recorded maximum (16.93 per cent) followed by Shahjamal (4.86 per cent) Nai Basti (4.34 per cent), Usman para (3.45 per cent), Jameerabad (3.28 per cent), while was minimum at Bhujpura (0.81 per cent). This type of waste was high in these areas because of the presence of furniture market and wood wholesale market. Of the total sample of solid waste, nearly 2 per cent was glass pieces, broken crockery. The proportion of this waste ranged between 6 per cent to less than 1 per cent. It was recorded maximum at Jameerabad (5.64 per cent) followed by Begumbagh (5.25 per cent), Khai Dora (3.45 per cent), Sudamapuri (3.44 per cent), Jiwangarh (3.11 per cent), while minimum at Nagla Kalar (0.56 per cent). Proportion of this type of waste is high in these areas because of higher concentration of crockery shops in these areas.

4.2 – CHEMICAL CHARACTERISTICS OF SOLID WASTE

Knowledge of chemical characteristics of solid waste is essential in determining the efficiency of any treatment process. Chemical characteristics include chemical, bio-chemical and toxic. Chemical characteristics include pH, Nitrogen, phosphorus and potassium (N-P-K), total carbon, C/N ratio, calorific value. The bio-chemical characteristics include carbohydrates, proteins, natural fibre and biodegradable factor. Toxicity characteristics include heavy metals, pesticides, insecticides etc. the waste may include lipids as well.

The chemical characteristics of solid waste collected from the 16 sampling sites (table 2) located in the residential areas of the different sampled wards shows that nearly 47 per cent of the waste comprises of ash, 41 per cent organic matter, 31 per cent moisture content, 30 per cent carbon, 29 per cent C/N ratio, pH value 9, nitrogen 1.04 per cent, phosphorous 1.07 per cent and N/P ratio 1.07 per cent.

Table: 2- Chemical characteristics of the solid waste (in percentage) from the residential areas of the sampled wards of Aligarh city, 2015 – 16

Ward No.	Name of the sampled ward	Ash	Organic matter	Moisture content	Carbon	C/N Ratio	pH	Nitrogen	Phosphorus	N/P Ratio
02	Usman Para	40.04	26.25	17.89	15.08	27.05	8.96	0.837	1.04	0.80
06	Jaiganj	42.24	27.44	19.42	16.23	18.45	8.23	0.985	1.09	0.92
10	Shahjamal	44.45	28.82	19.16	16.44	19.26	8.45	0.882	0.912	0.83
14	Jameerabad	56.02	40.44	43.15	45.24	30.44	8.66	1.242	0.936	0.65
16	Nagla Masani	56.0	32.42	13.95	22.62	30.23	9.75	0.870	1.087	1.32
17	Gambhirpura	66.0	27.44	18.47	42.92	26.44	9.32	0.990	1.045	0.80
18	Nagla kalar	48.24	26.04	38.47	30.16	32.44	8.54	1.040	1.240	0.93
21	Nai Basti	44.56	33.44	35.52	32.48	25.62	8.44	0.841	1.160	0.86
22	Begum bagh	50.52	45.0	52.34	27.15	38.38	8.52	0.948	1.240	0.88
23	Bhujpura	74.0	58.25	40.15	26.0	27.44	8.92	0.852	1.040	0.94
30	Jamalpur	44.24	56.23	38.55	44.08	26.69	8.22	0.952	1.096	0.97
42	Sudamapari	34.44	60.24	56.09	30.16	40.45	7.92	1.031	0.960	0.86
47	Jeevengarh	38.03	58.42	36.42	33.64	35.63	8.23	1.270	0.970	1.32
48	Dori nagar	33.55	60.40	22.45	44.24	24.37	8.60	1.280	1.040	1.42
53	Bhamola	29.0	59.63	26.87	30.73	33.42	8.74	1.520	1.251	1.96
55	Khai Dora	45.0	20.22	14.77	30.15	20.24	8.50	1.031	1.050	0.86
	Average	46.65	41.29	30.76	30.46	28.55	8.63	1.04	1.07	1.07

Note: All values are given in percentages and except pH, C/N- Ratio and calculated on dry-weight basis
Source: Laboratory, Department of Civil Engineering, Aligarh Muslim University, Aligarh. (2015 – 2016)

The chemical analysis of solid waste shows that of the total sample, the proportion of ash content ranges from 74 to 29 per cent. Ash content was found maximum at Bhujpura (74 per cent) followed by Ghambirpura (66 per cent), Jameerabad (56.02 per cent), Nagla Masani (56 per cent), Begumbagh (50.52 per cent), while the minimum concentration was at Bhamola (29 per cent). Proportion of organic matter ranged from 60 per cent to 20 per cent. It was maximum at Dori Nagar (60.40 per cent), followed by Sudamapuri (60.24 per

cent), Bhamola (59.63 per cent), Jiwangarh (58.42 per cent), Bhujpura (58.25 per cent) while minimum was at Khai Dora (20.22 per cent).

Proportion of moisture content ranged from 56 to 14 per cent. Proportion of moisture content was maximum at Sudamapuri (56.09 per cent) followed by Begumbagh (52.34 per cent), Jameerabad (43.15 per cent), Bhujpura (40.15 per cent), Jamalpur (38.55 per cent), while minimum was at Nagla Masani (13.95 per cent). Proportion of carbon content ranged from 45.15 per cent. It was recorded maximum at Jameerabad (45.24 per cent) followed by Dori Nagar (44.24 per cent), Jamalpur (44.08 per cent), Gambhirpura (42.92 per cent), Jiwangarh (33.64 per cent), while minimum was at Usman pura (15.08 per cent). Proportion of C/N ratio ranged between 40 to 18 per cent, was recorded maximum at Sudamapuri (40.45 per cent) followed by Begumbagh (38.38 per cent), Jiwangarh (35.63 per cent), Bhamola (33.42 per cent), Nagla Kalar (32.44 per cent), while minimum was at Jaiganj (18.45 per cent). pH value ranged from 10 per cent to 8 per cent. The pH value of waste was recorded maximum at Nagla Masani (9.75 per cent), followed by Gambhirpura (9.32 per cent), Usman para (8.96 per cent), Bhujpura (8.92 per cent), Bhamola (8.74 per cent), while the minimum was at Sudamapuri (7.92 per cent).

Proportion of Nitrogen ranged between 1.52 to 0.84 per cent. Maximum was recorded at Bhamola (1.52 per cent) followed by Dori Nagar (1.28 per cent), Jiwangarh (1.27 per cent), Jameerabad (1.24 per cent), Nagla Kalar (1.04 per cent), while minimum was at Usman para (0.84 per cent).

Proportion of phosphorus content ranged between 1.25 to 0.96 per cent maximum at Bhamola (1.25 per cent), followed by Nagla Kalar (1.24 per cent), Jamalpur (1.0 per cent), Jaiganj (1.09 per cent), Nagla Masani (1.08 per cent), while minimum was at Sudamapuri (0.96 per cent).

N/P ratio ranged between 1.96 to 0.80 per cent. Proportion of N/P ratio recorded maximum at Bhamola (1.96 per cent), followed by Dori Nagar (1.42 per cent), Jiwangarh (1.32 per cent), Nagla Masani (1.32 per cent), Jamalpur (0.97 per cent), while minimum at Gambhirpura (0.80 per cent).

1.3. - COMPARISON OF PHYSICO-CHEMICAL CHARACTERISTICS OF SOLID WASTE WITH OTHER CITIES OF INDIA

In India authentic information regarding the composition of the urban wastes is not generally available as regular analysis of the refuse is not carried out by the municipalities. Table 3 is showing the physico-chemical characteristics of the solid waste in various cities of India. A perusal of the table 3 shows that there is a wide variation in the composition of solid waste with the other cities (Kanpur, New Delhi, Kolkata, Bangalore, Mumbai, and Lucknow) and Aligarh city. This may be due to varying socio-economic cultural circumstances and climatic conditions. The wastes generated in Indian cities contain mainly high compostable and low combustible matters (paper, plastic rubber, leather and wood). The percentages of compostable matters are 60 to 85 per cent of the total municipal solid wastes (Cook, D. & Kalberamatten, J. 1982[7]). The densities of solid wastes are very high because of the absence of paper, plastic glass, packing materials. The metal content is less than 1 per cent but fine earth particles and ash are high partly due to the presence of sewage sludge and silts. The average calorific value of the urban solid wastes generated in India is low (1500 Kilo calories/ kg). Since it contains a large amount of computable organic matters, these wastes are mainly disposed off by composting (aerobically) or biogas generation (anaerobically).

Table:3 - Physico-chemical characteristics of solid waste (in percentages by weight) in various cities of India

Type of solid waste	Kanpur	New Delhi	Kolkatta	Bangalore	Mumbai	Lucknow	Aligarh
Papers	1.35	5.88	0.14	1.5	3.20	8.89	8.24
Vegetable waste	53.34	57.71	47.25	75.2	59.37	38.78	32.96
Dust ash etc.	25.93	22.95	33.58	12.0	15.90	39.75	32.88
Metals	0.18	0.59	0.66	0.10	0.13	-	-
Glass	0.38	0.31	0.24	0.20	0.52	1.08	2.27
Textiles	1.57	3.56	0.28	3.1	3.26	5.79	3.57
Plastic rubber & synthetic	0.66	1.46	1.54	0.9	-	6.95	9.61
`Others	18.59	6.4	16.98	-	16.4	3.0	3.34
Density kg/m^2	500	-	540	578	-	-	-

Source: (i) Report of the Committee of Urban wastes, Government of India, Dec.2015 and management of solid wastes in developing countries, F. Flintoff, 1976
(ii) Based on field survey, 2015-16.

It is one of those components of the solid waste which is usually left over unclear and after decomposing not only emits bad odour but is also the cause of breeding and proliferation of undesirable and disease causing vectors (Smith. K.R., 1999[8]). The percentage of compostable matters i.e. vegetable matter is highest in Bangalore (75.2 per cent) followed by Mumbai (59.37 per cent), New Delhi (57.71 per cent), Kanpur (53.34 per cent), Kolkata (47.25 per cent) and Lucknow (38.78 per cent) where as the solid waste at Aligarh

City consists of 32.96 per cent of vegetable matters. The average density of refuse varies between 500 to 600 Kg /m^2. It is highest in Bangalore (578 Kg/m^2) and lowest in Kanpur (500 Kg/m^2).

Presence of metal content is almost negligible from all the cities and it is missing from Aligarh City. While the concentration of dust and ash content is second to Lucknow in Aligarh City and minimum in Bangalore (12 per cent). Waste of paper is also second to Lucknow. The proportion of glass pieces is maximum in Aligarh City (2.27 per cent), while minimum at Bangalore (0.20 per cent). The plastic, rubber and leather are in the highest proportion in Aligarh City (9.61 per cent) and the lowest in Kanpur (0.66 per cent). The proportion of textiles is highest in Lucknow (5.79 per cent), while minimum in Kolkata (0.28 per cent). The maximum proportions of stone, wooden matters etc have been found in Kanpur (18.59 per cent) and minimum in Lucknow (3.0 per cent).

V. Conclusion

Composition of waste is established to be changing in quality and quantity with increasing population, area and changes in life styles. The change is evident in city because it is progressing economically and commercially. Growing urbanization is pressuring the local governments on making the land available for Solid Waste Management. Thermal processing through combustion is an effective answer for restricting the quantity of residue to be disposed (Singh, O. and Srivastava, N., 2000[9]). Aligarh Municipal Authority does not have an effective and sustainable solid waste management system. The survey report also substantiates the same. The reasons can be attributed to:

- Lack of adequate and operational disposal site
- Lack of adequate technology for solid waste disposal
- Lack of adequate infrastructure.

The municipality produces approximately 400 mt/day of solid waste per day results on segregation indicated more diverse components in solid waste samples collected from different sites of the city. The physical characteristics of the residential solid waste reveals that nearly 33 per cent comprises of vegetables, fruits and leftover food, another 33 per cent of drain silt, 10 per cent plastic rubber and synthetic, 9 per cent of rag and jute, 8 per cent of paper, 5 per cent of constructional debris, 8 per cent wooden matter, and 2 per cent of glass and broken crockery material. The chemical characteristics shows that nearly 47 per cent comprises of ash, 41 per cent carbon, 29 per cent C/N ratio, 9 pH value, 1.04 nitrogen, 1.07 phosphorus and N/P ratio each.
The following plans need to be adopted for sustainable management.

- Organizing mass awareness programmes among students, business people and local inhabitants, targeting source reduction, reuse and recycling of waste.
- Enforcement of law against littering and dirtying of public places.
- Popularization of degradable consumables followed by restriction and / prohibition of non-degradable components like plastic, based on set standards.
- Controlling unsystematic dumping of solid waste by major industries and shops in public places and at other places.
- Encourage generators of solid waste to adopt composting and bio-machinations practices, wherever possible. Provide incentives / subsidies to those who adopt these technologies.
- Create awareness among generators of solid waste about segregation of waste into three categories viz. biodegradable, recyclable and non-recyclable.
- Implement a system of point to point collection of segregated waste by bell ringing vehicles at pre-fixed times.
- Encourage restaurants to continue with the present practice of supplying refused food items and other organic wastes to piggery / poultry.
- Earmarking areas for setting up of hazardous industries away from dwelling places and town areas.
- Monitor and upgrade waste collection and processing facilities periodically. Its possible impacts on the environment should also be assessed effectively. Land, water and air pollution during solid waste management should be made strictly within permissible levels.
- Maintain a corpus fund separately for the maintenance / repair of the vehicles / instruments as and when required. Financial constraints should not adversely affect the speed and efficiency of waste collection and disposal processes.
- Develop a green belt of appreciable thickness around waste processing / disposal sites. The species chosen for green belt development should have the capability to assimilate excessive nutrients, toxic gases etc. thereby reducing the net concentration of pollutants in the surrounding environments.
- Measures can also be taken with the help of NGOs and resident associations to streamline the activity of the informal sector for the betterment of the waste management system.

- Privatization of waste collection and disposal sectors can be considered as a viable option for ensuring infallible operation. Monitoring of the waste management system, in case of privatization, need to be carried out by the Government machinery.

No rational decisions on municipal solid wastes system are possible until data of composition and quantity of solid waste are available. The method and capacity of storage, the correct type of collection vehicle, the optimum size of crew and the frequency of collection depend mainly on volume and density of wastes. Climate also has some influence. The disposal method may be dependent on the type of material recycled, organic content of waste, which could be composted, and the combustible material, which could be a source of energy. The priority activities to be addressed appear to be identification of a location of a common dump site; construction of the dumpsite; organized collection and disposal of household garbage from houses to municipal dumpsites; collection and sale of recyclable material; promotion of composting of organic waste.

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