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Full Length Research Paper

Characterization of domestic and market solid wastes at source in Lagos metropolis, Lagos, Nigeria

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Waste management is an important element of environmental protection. Proper characterization of municipal solid waste is fundamental for the planning of municipal waste management services. The objectives of this study were to estimate the percentage of various components of household and market waste generated from source and also the seasonal composition of household waste. The domestic and market solid wastes generated during a period of 48 days by a sampling of 200 households and 40 market waste samples of different socio – economic characteristics were classified and weighed at source between March 2004 and April 2006. The household solid waste mainly consisted of putrescible waste (68.16%), paper (12.46%), nylon (7.68%), Plastic (3.64%), glass (1.78%), metal (2.08%), and garden waste/grit (4.20%). The market waste consisted of putrescible waste (68.98%); paper (23.57%), nylon (3.92%), Plastic (1.77%) and metal (1.77%). The seasonal composition shows a high generation of putrescible during the wet season and nylon during the dry season.

Key words: Household waste, market waste, waste composition, Lagos metropolis.

INTRODUCTION

Waste is defined by Oresanya (1998) as any unwanted material intentionally thrown away for disposal. However, certain wastes may eventually become resources valuable to others once they are removed from the waste stream (Wei et al., 1997). Waste products arise from our ways of life and they are generated at every stage of process of production and development. The knowledge of the sources and types of waste in an area is required in order to design and operate appropriate solid waste management systems (Tchobanoglous et al., 1993).

Solid waste is used to describe non-liquid waste material arising from domestic, trade, commercial and public services. There are eight major classifications of solid waste generators: residential, industrial, commercial, institutional, construction and demolition, municipal services, process, and agricultural (WHO, 1984). It comprises countless different materials: dust, food wastes, packaging in the form of paper, metal, plastic or glass, discarded clothing, garden wastes, pathological waste, hazardous waste and radioactive waste (WHO, 1984).

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Domestic waste consists of the organic (combustible) and inorganic (non combustible) household waste (Tchobanoglous et al., 1993). It has three characteristics: weight of waste generated, density and constituents which vary from country to country according to the level of industrial development (World Bank, 1999).

Municipal solid waste includes wastes generated from residential, commercial, industrial, institutional, construction, demolition, process, and municipal services. Residential Single and multifamily dwellings generate food wastes, paper, cardboard, plastics, textiles, leather, yard wastes, wood, glass, metals, ashes, special wastes (e.g., bulky items, consumer electronics, white goods, batteries, oil, tires), and household hazardous wastes.

Commercial Stores, hotels, restaurants, markets generate paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, etc (Tchobanoglous et al., 1993).

Waste composition is also influenced by external factors, such as geographical location standard of living, energy source, and weather (WHO,
1984). A detailed characterization or analysis is necessary for integrated solid waste management strategies to be successful, the amount and kind of solid waste that is produced and the behavior of the generator must also be

considered (Sakai et al., 1996).

Waste composition indicates the components of the waste stream given as a percentage of the mass or volume. The main constituents of solid wastes are similar throughout the world but the proportions vary widely from country to country and even within a city, because the variations are closely related to income level. Waste generated in developing countries contains a large percentage of organic materials, usually three times higher than that of industrialized countries. The waste is also more dense and humid, due to the prevalent consumption of fresh fruits and vegetables, as well as unpackaged food. First World residents consume more processed food and packaged in cans, bottles, jars and plastic containers than those in the developing world. As a result, waste generated in the former contains more packaging materials than in that of the latter. Higher volumes of wastes and a changing composition have a profound impact on waste management practices (Cointreau – Levin, 1997).

Municipal solid waste from Accra, Ibadan, Dakar, Abidjan, and Lusaka shows putrescible organic content ranging from 35 – 80% (generally toward the higher end of this range) (Onibokun et al., 2000). Plastic, glass, and metal are less than 10%; and paper in the low tens. According to WHO (1984), in South Asia, as personal income rises, paper increases, kitchen wastes decline and glass increases, total waste generation rises and the density of wastes declines. There are often local variations of wastes generation and constituent proportions over weekly and seasonal cycles, the former is related to the pattern of work and leisure and the latter to seasonal food products and sometimes to fuel residues arising from space heating in winter.

Waste characterization consists of collecting waste at its source and directly sorting it out into types of materials (Brunner & Ernst, 1986; Martins et al, 1995). Weighing and sorting of household wastes at source makes the identification of waste materials easy and eliminate any uncertainty as to their origins (Bernache-Perez et al., 2001). This study aimed to characterize the composition of household and market waste at source of generation and the seasonal generation of the household waste in Lagos metropolis.

MATERIALS AND METHODS

Sample collection

Domestic waste for this study is defined as the waste generated by the activities of families at their homes.

The study area covers four (4) local government areas of the state. These settlements are classified according to the category of the inhabitants and their population densities. The settlements are: Ikoyi in Eti-Osa Local Government Area; this is a planned low density settlement which is predominantly inhabited by a mixture of the high income class and the middle class. Ebute-Metta in Lagos Mainland Local Government Area; this is a planned high density settlement, occupied mainly by a mixture of the middle income class and the low class.

Ifako-Gbagada in Kosofe Local Government Area this is an unplanned low density settlement, populated largely by the middle income class. The settlement developed rapid ‘80s.

Mushin in Mushin Local Government Area; this is one of the unplanned densely populated areas of Lagos. It is predominately inhabited by the low income class mixed with the middle class.

50 waste samples were taken randomly from each Local Government Area according to the number of residents indicated in the questionnaires administered to each household. 10 market samples each were taken from each settlement.

Market waste

Ten market waste samples were taken randomly from each Local Government Area as indicated below:

4 samples from wholesale/retail store (supermarket and store)
4 samples from catering services (Restaurant and Cafeteria) and
2 samples from business Centres

Method of waste characterization

Household waste

The method chosen for this study was that used by Bernache-Perez et al. (2001), which involves the direct sampling of solid waste from specific sources, a labour-intensive manual process of sorting, classifying and weighing all items in each sampling unit and a detailed recording of the data.

Each of the waste samples from the source of generation was emptied on a polythene sheet (1 meter square) laid on the bare floor for sorting, weighed (net weight) with Kwonnie balance (20 kg) model TN – 1741874 and sorted into categories, as recommended by the ASTM test method D5231 – 92 (1988). The total wet weight of each waste category was determined and expressed in gram. The whole process of sorting and weighing was carried out four times a week in every two months between March 2004 and February 2006.

Market waste

Apart from restaurants and cafeterias that use plastic bins, other business setup use cartons to store their waste. Wastes from cafeterias were sorted in a similar manner as the household waste which was described above, while the others were sorted directly into different cartons. Weighing was also done with balance (20 kilograms) model TN – 1741874. Taking of samples, sorting and weighing were done fortnightly between March 2004 and February 2006 for the purpose of determining the percentage composition of waste components.

RESULT AND DISCUSSION

The mean composition of household waste in the four LGAs of Lagos Metropolis is presented in Table 1. The total mean composition of waste per household per day are 1755.75, 321.02, 197.95, 93.65, 45.88, 53.51 and 108.20 g for putrescible, paper, nylon, plastic, glass, metal and garden waste/grit, respectively. The average weight of putrescible per household per day ranges from

Table 1. Mean Composition (g) of Household Waste and Market Waste from Lagos Metropolis (Values are expressed as mean ± standard deviation).

Waste Component	Household Waste			Market Waste		
	*Mean Composition	Minimum	Maximum	**Mean Composition	Minimum	Maximum
Putrescible	1755.75±212.47	1371.30	2367.50	6448.95±554.38	5004.50	7660.00
Paper	321.02±25.38	247.93	373.12	2352.22±206.01	1959.00	3081.30
Nylon	197.95±20.92	139.71	234.11	391.14±51.63	302.25	525.00
Plastic	93.65±15.79	64.54	146.30	176.52±22.61	131.25	223.75
Glass	45.88±6.13	31.43	62.09	None		
Metal	53.51±5.49	41.81	64.16	176.50±32.83	122.50	252.50
Garden Waste/Grit	108.20±20.07	76.61	169.50	None		

*Mean of 200 samples of each component, **Mean of 40 samples of each component

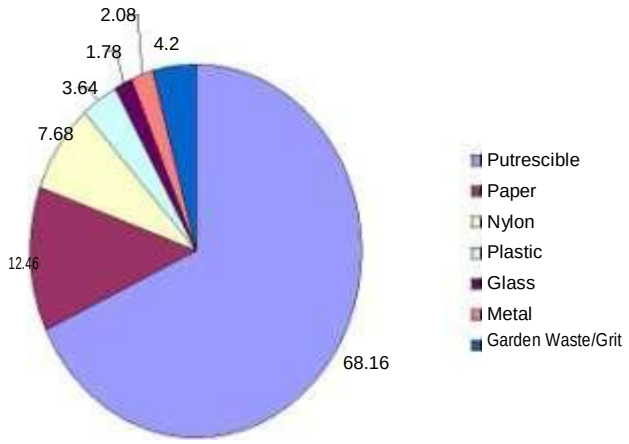

Figure 1. Percentage composition of domestic waste in Lagos metropolis.

1371.28 to 2367.51 g. The average weight of paper per household per day ranges from 247.93 to 373.12 g. The average weight of nylon per household per day ranges from 139.71 to 234.11 g. The average weight of plastic per household per day ranges from 64.54 to 146.30 g. The average weight of glass per household per day ranges from 31.43 to 62.09 g. The average weight of metal per household per day ranges from 41.81 to 64.16 g. The average weight of garden waste per household per day ranges from 76.61 to 169.50 g (Table 1).

Significant variations existed among the composition of household waste; this is confirmed with one way analysis of variance. The F value is significant for the average weight of the components of waste ($p < 0.01$). The Duncan Multiple Range Test categorized the composition of household waste into 2, 3, and 4 homogeneous groups. This indicates the variability in the composition of the different waste types.

The percentage composition of household waste in Lagos Metropolis is presented in Figure 1. The percentage composition ranges from 1.78% glass to 68.16% putrescible.

The major components of domestic waste from Lagos metropolis were food waste (68.16%), paper (12.46%), and nylon (7.68%) . The percentage composition of putrescible is similar to (68%) reported by Lavalin (1992) and UDBN (1997). This is however higher than those of Ibadan (55.8%) and Kano (50%) (Asomani-Boateng et al., 1996) although lower than some other African cities such as: Kumasi (84%), Accra (85.1%), and Kampala (75%) (Asomani-Boateng et al., 1996). The high percentage of putrescible in less developed countries may be attributed to the consumption of unprocessed food than the processed food consumed by high income countries. According to the World Bank (1999), generally, all low and middle income countries have a high percentage of compostable organic matter in the urban waste stream, ranging from 40 to 85% of the total. China and India diverge from this trend because they traditionally use coal as a household fuel source. The ash that is subsequently produced is very dense and tends to dominate the waste stream in terms of weight. Ash is incl category and makes up 45 and 54% of Indi waste composition, respectively.

The percentage composition of putrescible has not changed over the last decade while there are variations in the percentage composition of other components. Paper waste obtained in this study is higher than the corresponding result of the report by Lavalin (1992) and UDBN (1997). This is a little higher than the value for low income countries.

There was an increase in the percentage of plastics (nylon and plastic) (11.32%) compared to the corresponding result (7%) from previous report by Lavalin (1992) and UDBN (1997). This may have resulted from the recent explosion in packaged water business and the boom in polythene bag packaging and the manufacture of other disposable products in the country. This plastic value falls at the upper end of the range reported for high income countries (Cointreau-Levin, 1997). The percentage composition of metal and glass are lower than those values obtained from the previous reports. This may have resulted from the activities of scavengers in Lagos Metro-

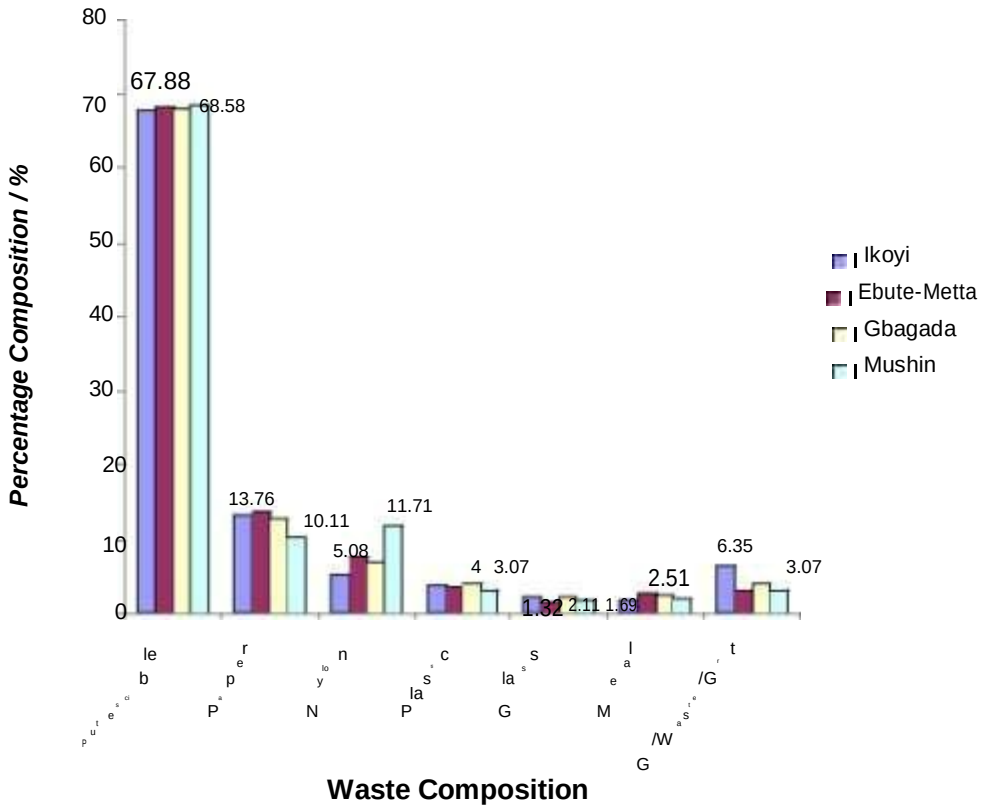

Figure 2. Percentage Composition of Household Waste in Four Local Government Areas of Lagos State

polis.

The comparative percentage composition of household waste for Ikoyi, Ebute- Metta, Gbagada and Mushin is presented in Figure 2. The percentage composition of waste is highest for putrescible in all the four Local Government areas. This ranges from 67.88% for Ikoyi to 68.58% for Mushin. Paper ranges from 10.11% for Mushin to 13.76% for Ebute-Metta. Nylon ranges from 5.08% for Ikoyi to 11.71% for Mushin. Plastic ranges from 3.07% for Mushin to 4.00% for Gbagada. Glass ranges from 1.32% for Ebute-Metta to 2.11% for Gbagada. Metal ranges from 1.69% for Ikoyi to 2.51% for Ebute-Metta while garden waste/grit ranges from 3.07% for Mushin to 6.35% for Ikoyi.

The percentage composition for each of the Local Government Areas shows that Ikoyi has the lowest value of putrescible. This can be explained according to Cointreau-Levin, (1997) that higher income and economic growth have an impact on the composition of wastes. Wealthier individuals consume more packaged products, which result in a higher percentage of inorganic materials in the waste stream. There is less food waste and other putrescible organics in the solid waste of high income countries. In the case of Ikoyi (Dolphin Estate) most residents depend on processed food while those from Ebute-Metta, Gbagada and Mushin rely more on unprocessed food for cooking at home, thus generating a significant amount of putrescible waste.

Bolaane and Ali (2004) reported that the packaging fractions of household waste have a direct relationship with household income. Likewise in this study, the packaging materials (paper, plastic, glass and metal) from Ikoyi, Ebute- Meta, and Gbagada are higher than those of Mushin. The low value of packaging materials from Ikoyi, when compared with Ebute-Metta and Gbagada may be due partly to the accessibility of scavengers to waste bins that are usually placed outside the gates of buildings. According to Beijing Environmental Sanitation Administration (1996), the wealthier households produce signifycantly higher percentages of paper, plastic, metal, and glass wastes, most likely from packaging materials. Compostable matter, such as food, horticultural, and ash waste, are predominant in single-story residential waste streams.

The average seasonal household waste composition in the four Local Government Areas of Lagos Metropolis is presented in Figure 3. The compositions of putrescible and garden waste are higher during the rainy season than the dry season while nylon is higher during the dry season than the rainy season.

For the seasonal generation, more putrescible waste is generated during the rainy season due to the fact that

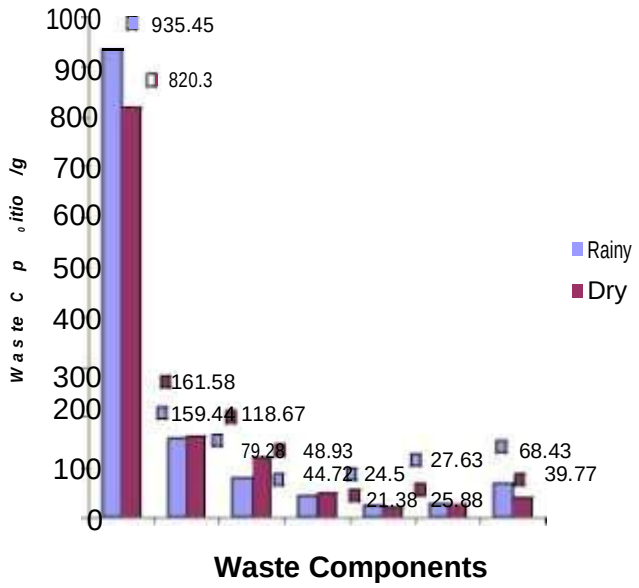

Figure 3. Average seasonal composition of domestic waste in the four local government areas.

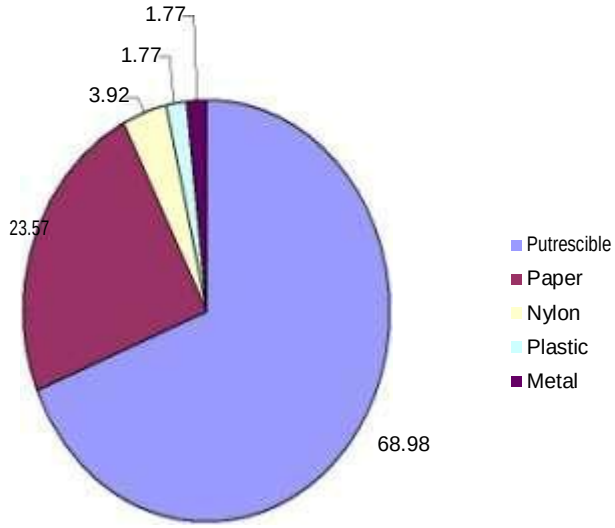

Figure 4. Percentage composition of commercial waste in Lagos metropolis

more fruits, vegetables and garden waste are produced during the rainy season. People tend to consume more because of the abundance and low price of fruits and vegetables. Also, garden waste trimming exercises are more during the rainy season. Dry season records high value for nylon due to more use of portable (sachet) water as a result of lack of public water supply in some of these settlements.

Composition of market waste

The composition of commercial waste per day from Ikoyi, Ebute-Metta, Gbagada and Mushin are presented in Table 1. The average composition (g) of commercial waste are 6884.45, 2352.22, 391.14, 176.52 and 176.50g of putrescible, paper, nylon, plastic and metal, respectively. The average weight of putrescible per day ranges from 5004.50 to 7660.00g. Paper ranges from 1959.00 to 3081.25g. Nylon ranges from 302.25 to 525.00g. Plastic ranges from 131.25 to 223.75g. Metal ranges from 122.50 to 252.50g.

The variability in the composition of commercial waste is confirmed with one way analysis of variance. The F value is significant ($p < 0.01$) for the composition of waste for all the 48 sampling days. The Duncan Multiple Range Test categorized the values into 2 or 3 homogeneous groups.

The percentage composition of commercial waste generated in Lagos Metropolis is presented in Figure 4. The highest percentage composition of waste is recorded by putrescible (68.98%) while the lowest is for plastic and metal (1.77%).

The comparative percentage composition of comer-cial waste for Ikoyi, Ebute-Metta, Gbagada and Mushin are presented in Figure 5. The percentage composition of putrescible ranges from 46.41% in Gbagada to 82.00% in Mushin. Paper ranges from 10.37% in Mushin to 46.93% in Gbagada. Nylon ranges from 3.13% in Gbagada to 4.42% in Mushin. Plastic ranges from 1.26% in Ebute-Metta to 2.50% in Ikoyi, while metal ranges from 1.51% in Gbagada to 2.18% in Ikoyi.

The percentage composition of waste from super-market and stores are presented in Figure 6. The percentage composition of paper is the highest in all the four Local Government areas; it ranges from 80.52 to 94.25%, while nylon ranges from 5.75 to 19.48%.

The relative percentage composition of market (Catering Services) waste from Ikoyi, Ebute-Metta, Gbagada and Mushin is presented in Figure 7. The percentage composition of waste is highest for putrescible in all the four LGAs, this ranges from 85.35 to 86.31%. Paper ranges from 1.03 to 3.35%, plastic ranges from 0.67 to 2.67%, nylon ranges from 5.98 to 9.96% and metal ranges from 1.83 to 2.80%.

The relative percentage composition of market (Business Centres) waste from Ikoyi, Ebute-Metta, Gbagada and Mushin is presented in Figure 8. The percentage composition of paper is the highest in all thefour Local Government Areas; it ranges from 77.17% to 92.89%. Nylon ranges from 7.11 to 22.83%.

As it is the case with domestic waste, the composition of commercial waste also records high mean for putrescible, decreasing through paper, nylon and least for plastic and metal due as well to the activities of scavengers on recyclable items from the waste stream. Catering services generate waste that is similar to household waste. Putrescible constitutes the highest composition in the waste stream. Mushin accounts for high rate of generation of putrescible mainly from Ojuwoye market,

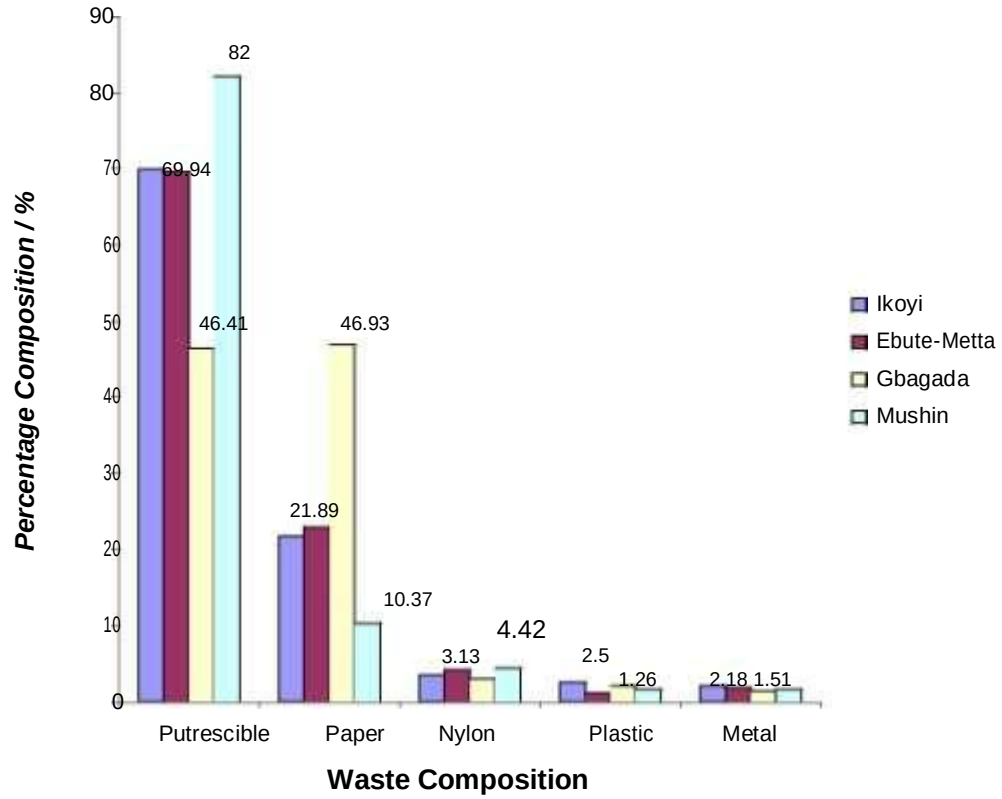

Figure 5. Percentage composition of commercial waste from Ikoyi, Ebute-Metta, Gbagada and Mushin

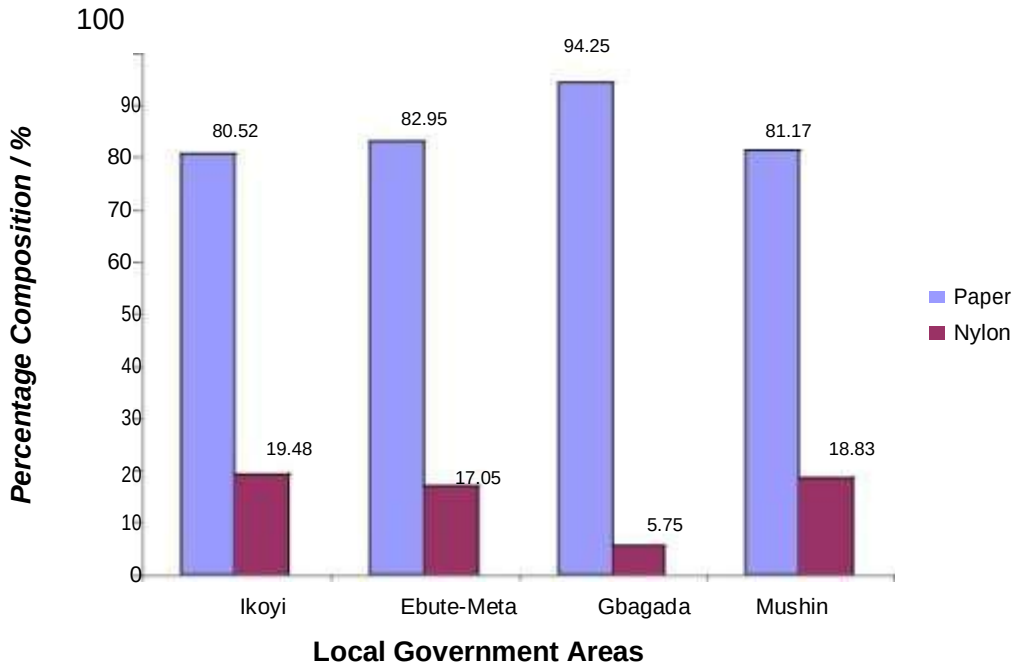

Figure 6. Percentage composition of supermarkets and stores waste in Lagos metropolis.

which is the largest of all the markets in the study area. Ebute-Metta is next, followed by Gbagada and Ikoyi, respectively. This is because Mushin market deals mainly in unprocessed food which attracts huge patronage. As regards the other components, Gbagada accounts for high concentration of packaging products (paper), while

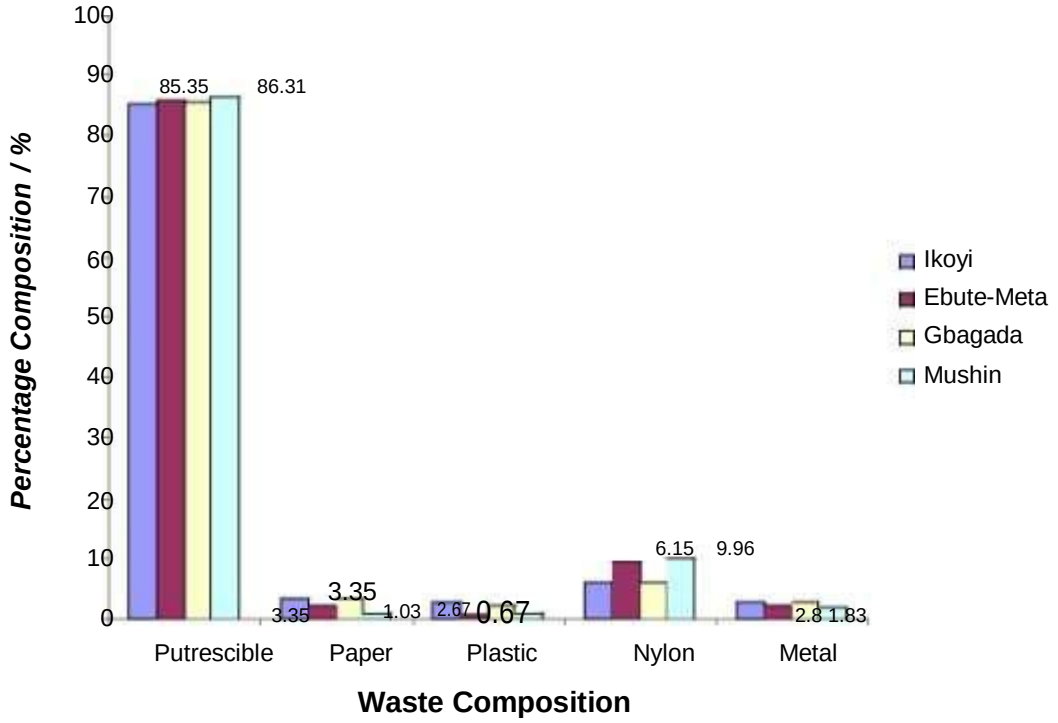

Figure 7. Composition of waste from catering services in Lagos metropolis.

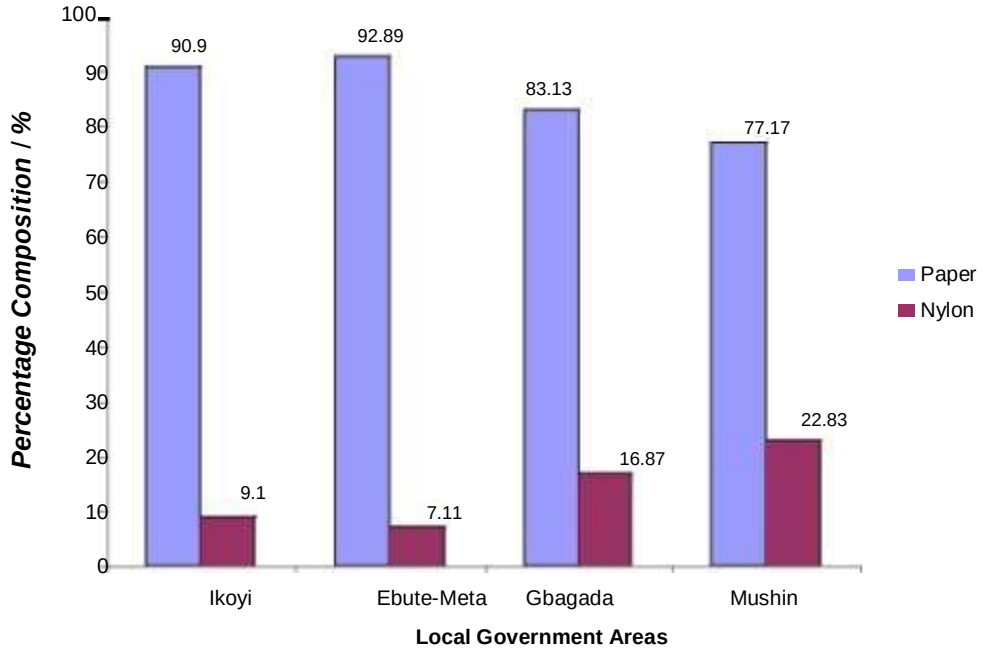

Figure 8. Percentage composition of business centres waste in Lagos Metropolis.

while Mushin has the lowest. The result may be due to the fact that Gbagada has supermarkets and stores with high turnover of retail/wholesale consumer good items. Surprisingly, Mushin, which also has a large retail/wholesale section in Ojuwoye market, has the lowest generation rate. It was discovered that traders reuse their empty container cartons (cardboard) or sell them out to other users, whereas in Gbagada almost all the stores

and supermarkets gather their empty cartons for disposal by the collection Agents.

There are more packaged materials (paper and plastic) in Ikoyi from catering services waste stream than in any other settlement. However, Mushin and Ebute-Metta record high value for nylon due to more use of portable (sachet) water as a result of lack of public water supply in most market areas in these settlements.

Generally, Business Centres generate mainly paper due to the number of schools and offices located in the study area.

Conclusion

The first step in waste management is to gain an understanding of the waste types being generated in order to design appropriate collection and disposal strategies. The largest proportion of waste in Lagos metropolis can be composted rather than disposed of. A heap of discarded papers that is meant to undergo some processing can be turned into toilet tissues. In the same manner old and broken glasses and bottles can be utilized in the manufacture of new glassware. Metals too can be recycled to scrap metals. Likewise nylon can be recycled, so as to minimize the problem of indiscriminate disposal of polythene products in drainages. Efforts should be made by stakeholders to evolve policies for disposal, recycling and ultimately zero waste situation.

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