Characterization of household solid wastes generated in Sabon-gari area of Kano in Northern Nigeria

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Abstract

The paper presents a characterization study of the municipal solid waste generated in Sabon-gari area of Kano City in Northern Nigeria. The area was divided into three zones namely: Zone A-South (from France road to New road), Zone B- central (from New road to Ballat Hughes road) and. Zone C-north (from Ballat Hughes road to Nguru road). Twenty households were randomly selected from each zone making a total of 60 households that were studied. Solid waste was collected daily from each household for 14days using four trained collectors equipped with a wheel-barrow each and personnel protective equipment. The characteristics of household solid waste of was determined in terms of the components, average mass (kg) generated per household, solid waste per capita and bulk density. It was found that 57.5% of the solid waste generated in the area is made up of food/petruscible matter and vegetable matter; 17.6% plastics and 3.0% metals. Per capita waste generated was 0.31kg/capita/day and the average bulk density of waste generated was 259kg/m^3. It is recommended that a formal composting and recycling facilities be established within the community, and private firms be involved for efficient and effective solid waste management in the area.

Key Words: Characterization, Composting, Household, Solid waste, Sorting, Sustainable, Recycling

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1.0 Introduction

Municipal solid waste consists of domestic waste generated by urban residents (households) with addition of commercial wastes but typically excludes industrial hazardous waste and domestic sewage sludge (James, 1997). According to US EPA (2011), municipal solid waste includes durable goods, non-durable goods, containers and packaging wastes, food wastes and yard trimmings, and miscellaneous inorganic wastes. Thus municipal solid waste is an accumulation of rejects from households, market women, traders, shop owners and other commercial activities in the urban areas. The composition and characteristics of municipal solid waste is influenced by certain factors, which include the area (residential, commercial, etc), the economic level (differences between high and low-income areas), the season and weather (differences in the amount of population during the year, tourist places) and culture of people living or doing business in the area. High-income areas usually produce more inorganic materials such as plastics and paper, while low-income areas produce relatively more of organic waste. Uncontrolled or improperly sited open solid waste dumpsites constitute health hazards and damage the aesthetic beauty of many cities in Nigeria (Napoleon et al 2011.).It also encourages poor habits towards waste disposal.

The problem of municipal solid waste management in Nigeria cities has been attracting the attention of researchers (Nabegu, 2010; Ogweleka, 2009; Ogbonna et al, 2000; Agunwamba, 1998). Most of the research findings point to the need for a sustainable and an efficient solution to solid waste menace in Nigerian cities. Ogwueleka (2009) advocated for an alternative to the conventional approaches to municipal solid waste management used by development agencies and international donor agencies in developing countries. According to him the conventional approaches is bureaucratic and ignores informal sector. The conventional approach concentrates on the use of

advanced technology on collection and disposal. Its capital intensive nature can be a major reason why formal recycling or resource recovery programmes are not common in Nigeria (Ogwueleka 2009).

Importantly, it has been suggested that efficient recycling and composting could save 18.6% in waste management costs and 57.7% in landfill cost (Agunwamba, 1998). Agunwamba also recommended that Nigerians should accept recycling as a step towards adopting an integrated solid waste management approach..Recycling reduces the amount of waste needed to be collected, transported or disposed of, thereby saving money. The starting point of recycling is the collection and sorting of waste into different categories which can be reprocessed into new products. Composting on the other hand, involves a deliberate effort to convert organic waste into manure for agricultural purposes. According to Asomani-Boateng and Haight (2007), the practice of using *taki* (local name for compost from household waste, street sweepings and ash) as fertilizing materials by peri-urban farmers in Africa has gone on for centuries. Interestingly, composting is not new in Kano. The state is known to have a tradition for composting. However, improper collection and disposal discourages extraction of organic components of municipal solid waste for composting.

The six metropolitan local governments of Kano state (Fagge, Gwale, Kano Municipal, Kumbtso, Nasarawa and Tarauni) has a combined population of 1.8 million people (NBS, 2009) and they currently generate huge amounts of municipal solid waste than can be effectively disposed by the authorities. Anthony (2007) put the municipal solid waste generated daily in Kano metropolis at 2000 tonnes, out of which only 800 tonnes could be evacuated. The situation is yet to improve. Nabegu (2010) observed that in Kano metropolis, the solid waste is disposed “in a more or less uncontrolled manner.” In some cases dump sites develop all of a sudden at any empty space, including metropolitan roads.

According to Nabegu (2010) the management of municipal solid waste should involve a detailed study of the characteristics of waste. When different categories of waste are not considered during collection and disposal, effective management of solid waste becomes difficult (Danbuzu 2011). This study aims to characterize the household waste generated in the Sabon-gari area of Kano in Northern Nigeria with a view to prescribing the most effective and efficient method of its management.

2.0 Methodology

For the purpose of this study the residential area of Sabon-gari was divided into three zones namely: Zone A-South (from France road to New road), Zone B- central (from New road to Ballat Hughes road) and. Zone C-north (from Ballat Hughes road to Nguru road). Twenty households were randomly selected from each zone making a total of 60 households that were studied. The average number of persons per household was approximately five. Solid waste was collected daily from each household for 14days using four trained collectors equipped with a wheel-barrow each and personnel protective equipment. The leaders of selected household were consulted before commencement of the study and they voluntarily agreed to give their household solid waste to only the approved collectors during the period of the study. To discourage withholding of refuse, the collectors were not allowed to collect money from households. For each Zone, the solid waste collected daily was sorted into different categories, quantified and their bulk density determined.

2.1 Classification of Waste and Determination of Quantity of Components

For the classification of waste, ten waste components were considered. These were food/petruscible, vegetables, paper, plastic, glass/ceramic, fabrics, wood, metal, electronic waste and “others”. Others represent solid waste that are not identifiable or do not fall into the first nine categories. Sorting and weighing of collected waste were done at the dump site. The weight measurements were done using portable electronic scales - an EQB 50/100 Torrey scale (with a capacity of 50 kg , readability of 10g and plate dimension of 15” x 19”) and EK9150 5Kg/11lb x 1g Digital Kitchen Scale (with a capacity of 5kg , readability 1g and plate dimensions of 5” x 7.5”).

2.2 Determination of Bulk Density

For determination of bulk density of the un-compacted waste, a wooden container of capacity V_1= 0.1m^3 was used and its weight was determined as W_1. Waste collected from households was poured into the container until it was

overflowing. The contents of the container were settled by dropping it three times from a height of 10 cm; and again more waste was added to fill it (EPA, Ireland, 1996). The procedure was repeated until the container was completely full. When the waste was not enough to completely fill the container, the volume V_2 was calculated. No pressure was applied to the waste in the container to avoid altering the bulk density. The filed container and its contents were weighed to obtain a weight W_2. The bulk density (kg/m^3) was calculated as follows:

Bulk density (kg/m^3) $= (W_2-W_1) / V_1$ ---------- [1]
Or
Bulk density (kg/m^3) $= (W_2-W_1) / V_2$ ---------- [2]

The procedure was repeated daily, starting with confirmation of weight of the wooden container**.**

2.3 Determination of the Per Capita Generation

The per capita waste in the communities was calculated by dividing the weight (W_T) of the waste collected from each zone per day by the number of residents in the zone. This was computed on daily basis. Analysis of variance ANOVA was used to test for significant difference between mean figures of data from the three zones.

3.0 Results and Discussions

3.1 Results

Table 1 shows the categories of solid waste collected from the three zones (A, B and C). For the 20 households in each zone, there are 108 residents in Zone A, 106 residents in zone B and 96 residents in Zone C. This makes a total of 310 residents in the 60 households studied. Table 2 shows the per capita waste generated. Table 3 shows the bulk density (mass per unit volume) of the solid waste generated.

Table 1: Household Waste Categories and Quantities in Sabon-gari Kano

CATEGORY	ZONE A		ZONE B		ZONE C		ZONE A+B+C	
	Weight (Kg)	%	Weight (Kg)	%	Weight (Kg)	%	Weight (Kg)	%
Food.putresable	188.6	41.0	202.4	44.9	187	43.2	578	43.0
Vegetables	73.6	16.0	64.4	14.3	56.3	13.0	194.3	14.5
Paper	9.2	2.0	32.2	7.1	48	11.1	89.4	6.7
Plastics	82.8	18.0	78.2	17.3	75	17.3	236	17.6
Glass/ceamic	9.2	2.0	13.8	3.1	11	2.5	34	2.5
Fabrics	18.4	4.0	18.4	4.1	23	5.3	59.8	4.5
Wood	13.8	3.0	4.6	1.0	6	1.4	24.4	1.8
Metal	32.2	7.0	13.8	3.1	7	1.6	53	3.9
Electronic waste	4.6	1.0	9.2	2.0	4.6	1.1	18.4	1.4
Others	27.6	6.0	13.8	3.1	15	3.5	56.4	4.2
Total	460	100.0	450.8	100.0	433	100.0	1343.7	100.0
waste/household/day	1.64		1.61	0.4	1.5		1.6	

Source: Field survey (August, 2012)

Table 2: Per Capita Household Waste Generation in Sabon-gari Kano

	ZONE A			ZONE B			ZONE C		
Days	Total Waste (kg/day)	No. of Residents	Waste Generation (kg/cap/day)	Total waste (Kg)	No. of Residents	Waste Generation (Kg/cap/day)	Total waste (Kg)	No. of residents	Waste Generation (Kg/cap/day)
1	38	108	0.35	34	106	0.32	27	96	0.28
2	26	108	0.24	32	106	0.30	31	96	0.32
3	32	108	0.30	38	106	0.36	29	96	0.30
4	34	108	0.31	24	106	0.23	27	96	0.28
5	36	108	0.33	34	106	0.32	29	96	0.30
6	34	108	0.31	28	106	0.26	27	96	0.28
7	38	108	0.35	36	106	0.34	39	96	0.41
8	30	108	0.28	30	106	0.28	35	96	0.36
9	32	108	0.30	29	106	0.27	28	96	0.29
10	28	108	0.26	32	106	0.30	31	96	0.32
11	32	108	0.30	38	106	0.36	33	96	0.34
12	34	108	0.31	28	106	0.26	35	96	0.36
13	32	108	0.30	32	106	0.30	27	96	0.28
14	34	108	0.31	36	106	0.34	35	96	0.36
Total	460			451			433		
Mean	32.86	108	0.30		106	0.30	30.93	96	0.32

Source: field survey (August, 2012)

Table 3: Bulk density of Household solid waste in Sabon-gari Kano

	ZONE A	ZONE B	ZONE C
Days	Density (Kg)/m^3	Density (Kg)/m^3	Density (Kg)/m^3
1	250	242	240
2	213	295	267
3	274	200	299
4	238	235	213
5	289	213	255
6	287	270	288
7	226	245	298
8	290	298	234
9	290	223	277
10	247	225	235
11	289	230	279
12	270	264	278
13	223	283	289
14	274	284	251
Mean	261	251	265

Source: Field survey (August, 2012)

Tables 4 and 5 show summary of Analysis of variance (ANOVA) used to determine if there exists a statistically significance difference in the means of per capita waste generation and bulk density among the zones.

Table 4: Results of the Analysis of Variance (ANOVA) of per capita solid waste generation

Source of Variation	df	SS	MSS	F-ratio	F-tab. (5%)
Sample Treatment(between)	2	SST =0.0031	MST= 0.00153	1.11	3.24
Error(within)	39	SSE=0.0538	MSE=0.00138		
Total	41	TSS =0.0569			

Table 5: Results of the Analysis of Variance (ANOVA) of bulk density of solid waste.

Source of Variation	df	SS	MSS	F-ratio	F-tab. (5%)
Sample Treatment (between)	2	1516.05	758.02	0.91	3.24
Error (within)	39	32610.43	836.16		
Total	41	34126.48			

4.2 Discussion

The Analysis of solid waste composition shown in Table 1 indicates that 57.5 % of the solid waste is made up of food/petruscible and vegetables materials. This agrees closely with the result of a similar study done for the whole of Kano Municipal by Nabegu (2012), obtaining a total biodegradable waste of 66%. This indicates that composting/biodegradation can be used for the disposal of this 57.5% of the waste and the product can be sold as fertilizer.

Plastic materials are as much as 17.6% of the total solid waste being generated at Sabon-gari. The plastic materials are mostly made of food-related packaging materials (cellophane bags, sachet water bags, rice bags, etc.). This is a pointer to the fact that the traditional packaging materials for food items that used to be of biodegradable material such as green leaves have been replaced by plastic materials which are not easily biodegradable. Paper materials, glass/ceramics, and metals were 6.7%, 2.5%, and 3.0% respectively. Recycling has been a very useful method of managing these types of waste. The electronic wastes (1.4%) although quantitatively small, could have significant negative environmental impact considering its potential toxic character.

Table 2 indicates that the average per capita waste being is generated in the area is 0.31.kg/capita/day. Dauda and Osita (2003) obtained 0.25Kg/capita/day for Maiduguri, Igbinomwanhia and Olanikpekun (2007) found 0.56kg/capita/day for Mushi, Lagos and Solomon (2009) quoted 0.49Kg/capita/day for average Nigerian communities with household and commercial centres. With the average number of individuals per household being five, this shows that a household in the area generates an average of 1.6Kg of solid waste per day. The result presented in table 3 shows that solid waste being generated at Sabon-gari area of Kano metropolis has an average bulk density of 259kg/m^3. This bulk density of 259kg/m^3 agrees with the national average obtained by Diaz and Golueke (1985). Bulk density is important for the selection of waste collection equipment. For example, compactor trucks are most effective if the waste has a low bulk density (UN-Habitat, 2011).

The summary of analyses of variance (ANOVA) in tables 4 and 5 ($p<0.05$) show that there is no significant difference in the means of per capita waste generation among the three zone in which Sabon-gari was divided. Same goes for the bulk density of the waste.

5.0 Conclusion and Recommendations

The characteristics of household solid waste generated by Sabon-gari residents in Kano urban area have been determined. The solid waste being generated is made of nine major components (food/petruscible, vegetables, paper, plastic, glass/ceramic, fabrics, wood, metal and electronic waste). During the study period, 57.5% of the total solid waste being generated in Sabon-gari was made of biodegradable matter and 17.6% plastics. The per capita waste generation in the area was 0.31kg/capita/day and the average bulk density of waste generated was 259kg/m^3.
There is the need to establish a formal composting (for 57.5% of the waste) and recycling facilities (for almost 25% of the waste) within Sabon-gari area using the result of this characterization study as a guide. The participation of private firms in the collection, processing and disposal of the municipal solid waste is also recommended. This has been found to work well in Singapore (Bai and Sutanto, 2002). The Plastics (17.5%), glass/ceramics (2.5%) and metals (3.0%) are recyclable and this should be encouraged.

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