



Analysis of Solid Waste Composition and Management in Selected Markets and Residential Areas of Kaduna Metropolis, Kaduna

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Authors' contributions

This work was carried out in collaboration among all authors. Authors AAI and ASA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript.

Authors HCO and SA managed the analyses of the study. Authors OOA and EJZ alongside with authors FMR, OO and SO managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Samples of Municipal solid waste from dumps situated within four (4) markets located at Kawo, Monday, Sabo Tasha and Mando respectively, and two (2) residential areas located at Kabala Costain and Anguwan Sanusi in Kaduna metropolis were collected and segregated into various classifiable bulks; Organic, Inorganic and bacteria flora of the dumps were compared between the two categories of land users. The results obtained showed that there was a wide variation in the composition of waste in these two land use areas, organic waste made up of plant matters (Leaves, Grasses, Stumps food residues, Vegetables and ash) in this study has the highest percentage composition (65%) in market areas and 35.6% in residential areas, for inorganic waste consisting of glass, papers, metal and plastics account for 35% in market areas. Bacteria isolates from the

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dumps with their respective percentage prevalence were: *E. coli* (88.90%), *Staphylococcus aureus* (81.7%), *Salmonella* (47.3%), *Klebsiella* sp (44.1%), *Shigella* sp (46.6%) and *Proteus* Sp (35.2%) in market areas while in residential area the bacteria isolates 7prevalence showed: (57.5%), (44.2%),(28.1%),(25.2%),(17.8%) and (14.4%) respectively.

Keywords: Solid waste; organic; inorganic; bacteria flora; variation.

1. INTRODUCTION

In all Nigeria's urban centers solid waste consisting of millions of tons of bottles, cans, food scrap, plastics, abandoned broken down vehicles, dead animals etc are generated every year. When dumped into water drains they contribute to flooding. When dumped in improper landfills, they can contaminate, water, soil and air with disease spreading bacteria. A more serious risk is the release of toxic substances which arise from natural decomposition process and incomplete combustion of the incinerated waste. Uncontrolled waste encourages the breeding of flies, cockroach, rats and produce unsightly scenes while the putrefying organic matter produces nauseating odors that pollute the air [1-4]. At times waste contaminates water sources leading to cholera, dysentery, typhoid etc. [2]. Government efforts in dealing with waste management have led to the establishment of different agencies at state and local government levels [5-10]. Despite these efforts, mountainous heaps of solid wastes are still prominent features in most of the cities without effective and efficient municipal waste collection, transportation and disposal, with over 50% of the people in urban centers having improper or no facilities for solid waste disposal. As indicated by Nabegu, squander the executives in a few cities in Nigeria association is insufficient: a noteworthy segment of the populace 80% doesn't approach squander assortment administrations and just 20% of the waste produced is really gathered. The association for the exchange and transfer of waste is unsuitable from the natural, monetary, and budgetary perspectives. Most by far of clients of the administration 92% think about the administration as poor. The general issue of metropolitan strong waste is clearly multifaceted; numerous associations, including the United Nations (UN) and different non-administrative associations (NGOs) advocate an incorporated way to deal with squander the board by recognizing key partners, distinguishing explicit issues which involve significant "hindrances", and making proposals dependent on suitable advancements, nearby data, and squeezing human and ecological wellbeing

concerns (UNEP 1996, Senkoro 2003, Thomas-Hope 1998). The issue of waste administration is a primordial and present issue in creating nations in Africa, especially Nigeria. City squander the executives issues in Nigeria cut crosswise over worries for human wellbeing, air, water, and land contamination among others. The investigation of the key issue influencing the effective administration of civil waste is basic for developing a serviceable arrangement in a rising economy like Nigeria. The change of the current patterns in civil waste administration is essential for guaranteeing manageable situations (Abila and Kantola, 2013).

Civil Solid Waste Management (MSWM) is a comprehensively testing issue particularly in creating nations, because of its unfavorable ecological impacts [4]. Humankind normally relies upon the earth to continue their lives however strong waste is one of the three significant natural issues (other major ecological issue incorporate flooding and desertification) in Nigeria, numerous other creating and indeed, even the created nations are undermined by this. It assumes a critical job in the capacity of nature to continue life inside its ability. Most urban areas burn through 20-half of their yearly spending plan on strong waste administration and just 20-80% of the waste is gathered. The principles of waste administration is as yet poor and obsolete in many creating nations, with poor documentation of waste age rates and its structure, wasteful stockpiling and assortment frameworks, transfer of civil squanders with lethal and risky waste, unpredictable transfer or dumping of squanders and wasteful use of transfer site space. Inappropriate strong waste administration has contributed significantly to stream contamination, additionally adds to environmental change. Quick advancement, populace increment and changes in utilization design have straightforwardly (and by implication) brought about the age of gigantic measure of waste, running from biodegradable to engineered squander. It is against these backgrounds that this investigation means to address the accompanying exploration questions.

2. AIM AND OBJECTIVES OF THE STUDY

The aim of this study is to compare the characteristics of municipal solid waste in the residential and market areas of Kaduna metropolis, Kaduna state. the specific objectives for this study are to:

- i. characterize municipal solid waste by the type of waste produced in the study area;
- ii. determine the rate of generation in the two different land uses in Kaduna metropolis;
- iii. assess the variation of current solid waste management system for planning purpose in the study area;
- iv. compare the impacts of the variation observed in relation to environment and human health;

2.1 Study Area

The study was carried out in Kaduna Metropolis which lies within the Latitude $8^{\circ}55'N$ - $11^{\circ}27'N$ of Equator and Longitude $5^{\circ}55'E$ - $9^{\circ}45'E$ of Greenwich Meridian. The number of inhabitants in the state has been evaluated to be 6,066,562 It has a complete territory of about 45,789Km². It imparts basic outskirts to Abuja in the south-East and six different states, and Niger state in the North-West. Kaduna was at one time the local Capital of the North and assumed huge jobs in agrarian creation with Guinea Savannah vegetation. This investigation was completed in four neighborhood government territories in Kaduna city to be specific Chikun, Igabi, Kaduna South and Kaduna North. Kaduna Metropolis falls under the Tropical Continental atmosphere which is portrayed via occasional varieties with variation of soggy oceanic air mass and dry mainland air mass bringing about two unmistakable seasons. The region encounters the on-set of the blustery season in April which stops in October while the dry season (hamattan) keeps going from November to March. The length of precipitation differs from 150 days to 190 days with a yearly precipitation going somewhere in the range of 1500mm and 2000mm. The temperature is high during the time with the top in March and April (37oc), while the mean yearly temperature changes somewhere in the range of 24oC and 28oC. Humidity is constantly high (above 60%) at mid-day and close to 100% at night during the rainy season, relative humidity is low ranging between 20% and 40% in January and rising to between 60% and 80% in July

3. METHODOLOGY AND DATA GENERATION

The data for this study were generated through the collection of waste sample from dump sites located in six different areas- two in residential areas and four market areas in Kaduna metropolis. To determine sample collection dumps, a basic knowledge of the urban area of Kaduna was helpful guided by the assertion of that an urban area is usually defined to comprise of different land uses of which the major ones are residential and markets within which data will be collected, for residential areas are- Angwa Sanusi and Kabala Costain while in the Market areas represent the four local Government Areas are Kawo Market, Kaduna North Monday Market, Kakuri Kaduna South, Sabon Tasha Market, Chikun and Mando Market Igabi.

3.1 Sampling Sites

Locations of Market waste disposals in the four selected and designated dumpsites within Kaduna metropolis; namely Kawo Market in Kaduna North Local Government, Monday Market in Kaduna south Local Government, Sabon Tasha Market Chikun and Mando Market Igabi are constituted waste from market areas.

Locations of residential waste disposals in the two selected and designated dumpsites which are Kabala Costain in Kaduna North and Anguwa Sanusi in Kaduna South.

3.2 Sample Collection and Analysis

Five hundred (500) grams of wastes was collected from each sampling point into a sterile can. These Wastes were weighed using the Tip-loading balance. Waste samples were being collected once a week for the period of one (1) months making a total of twenty-four samples from all the six dump sites. After collection, the wastes samples were immediately taken to the laboratory (KEPA LAB). At the laboratory the wastes were segregated into various categories manually and then weighed separately. Individual weight of each segregate was recorded. To determine the bulk weight in each dump site 1cubic meter of waste was weighed each time the samples were taken and recorded. Average bulk weight was calculated by obtaining simple average. Bacteriological examinations of the wastes were also carried out. Blood agar and Mac Conkey agar were used as culture media.

They were prepared as described by Morphological and Biochemical tests to identify the bacterial isolates were carried out in accordance with methods described by Corry et al., (1982).



Fig. 1. Kawo market dumpsite, Kaduna North LGA



Fig. 2. Monday market Kakuri dumpsite, Kaduna South LGA



Fig. 3. Sabo Tasha market dumpsite, Chikun LGA



Fig. 4. Mando market dumpsite, Igabi LGA



Fig. 5. Kabala Costain residential dumpsite, Kaduna North LGA



Fig. 6. Angwan Sanusi residential dumpsite, Kaduna South LGA

4. RESULTS AND DISCUSSION

4.1 Categories and Quantities of Solid Waste

Table 1 shows the various classes of waste saw in the landfill destinations in the four market zones of Kaduna city. From the examples of strong squanders gathered from the diverse dump locales, six distinct sorts of squanders were found. This incorporates, paper, glass, metal, natural, Nylon, Plastic material, and others which incorporate materials, elastic sack., etc. The arrangement of strong squanders and the weighted mean with rate structure is introduced in Table 1. Subsequent to taking the normal waste organization from the landfill destinations around four markets, Organic waste creation positioned the most noteworthy with 65% of the complete waste. This was trailed by Nylon, Paper, Others and Plastic with 12.6%, 11.9%, 3.7% and 3.3% individually. Metal and Glass had minimal synthesis of 2.3% and 1.2% individually. The high level of natural waste might be credited

to the showcasing of natural nourishment when contrasted with prepared nourishment promoted in progressively created nations [5]. This high level of natural substance in the waste stream of four neighborhood government regions of Kaduna city can be outfit for vitality age. It is assessed that 100 tons of metropolitan reject with 50-60% natural substance can create 1-1.5 Mega Watt of intensity relying upon the qualities of the waste. The most elevated natural waste organization was recorded at Sabon Tasha Market in Chikun Local government region, a huge suburb in the investigation region overwhelmed by low pay workers. Lower natural waste creation was recorded at Monday Market in Kaduna south neighborhood government zone Beside natural was Nylon, to a great extent because of the nearness of nylon sacks utilized by brokers, and sachets utilized in bundling minimal effort drinking water famously alluded to as "Unadulterated Water" and sold wherever particularly in the market territories. Nylon and the 'Others' class recorded the most elevated organization at Sabon Tasha advertise for

reasons likely of its low pay status. Paper was the following most unmistakable classification in the waste synthesis of four Local Government Areas in Kaduna city. Paper's noticeable quality in Kaduna city could be credited to the nearness of more workplaces and other paper using outlets. Paper squander is re-useable and recyclable and whenever clung to can lessen strong waste essentially in the region. As indicated by NEED (2011), one ton of paper reused from utilized papers rather than crisp strands from wood spares 7,000 gallons of water, 17-31 trees, 4,000 kW power and 60 lbs of air toxins. The low paper creation in Sabon Tasha could consequently be demonstrative of high paper reuse or reuse by administrators of the print machine ventures.

Paper recorded the most elevated synthesis in Monday Market territory, trailed by Kawo Market, and least in Sabon Tasha showcase. There are a bigger number of workplaces Kaduna South than Chikun, anyway there are a few little and medium scale business in Sabon Tasha, so one would have expected high paper creation in the surge of that zone. The low paper structure at Sabon Tasha could subsequently be characteristic of high paper reuse or reusing by administrators of the print machine ventures. Plastic, metal and glass recorded the most noteworthy synthesis at Kaduna South that is Monday Market, which was normal since there are available of two major ventures (NNPC and Indomie Noddles). Comparative waste piece and dispersion has been accounted for by different creators for Kaduna Metropolis and different urban areas in Nigeria.

Table 2 shows the rate mass load of the various things of waste in the two zones. Natural squanders represents 35.6% of the normal load of the whole waste examples, while the non-biodegradable like Nylon, glass, metal, plastic and others had 64.4%, indicating plainly the transcendent waste in the local locations of Kaduna city is biodegradable. This is noteworthy since biodegradable waste can be reused into manure for treating the dirt in addition to other things. Moreover, the high substance of biodegradable material would require expedient departure of waste to landfill in perspective on its powerlessness to decay in a domain that is always hot. Anyway checked varieties exist between the two private zones. In this manner in the Anguwa Sanusi a sum of 63.5% of the waste comprises of inorganic, while the Kabala Costain

has 65.4%. Contrasts in the sort of waste between the two local locations mirror the distinctions in way of life and utilization design between the two neighborhoods. Nearness of a sizeable measure of inorganic waste has been a significant fascination in foragers who scout all the waste assortment focuses to pick these things for resulting deal for re-use and reusing. Reusing particularly of plastic materials regardless of whether casually sorted out has become a noticeable business and wellspring of employment for thousands in Kaduna city.

4.2 Variation of Solid Waste for Management and Planning Purposes

Table 3 shows the rate mass load of the various things of waste in the two land employments. In the business land use in all the four dump destinations in the market, natural squanders represents 65% of the absolute normal load of the whole waste examples, while the inorganic had 35%, indicating plainly the dominating waste in business zones of Kaduna city is natural. This is noteworthy since natural waste can be reused into manure for treating the dirt in addition to other things. Besides, the high substance of natural material would require rapid clearing of waste to landfill in perspective on its weakness to deterioration in a situation that is continually hot. In this way in Sabon Tasha showcase a sum of 69% of the waste comprises of natural waste while 31% of the waste is inorganic, though natural waste speaks to 60% and inorganic is 40% in Monday advertise. Anyway checked varieties exist between the two land utilizes, in the local locations natural waste speaks to 35.6% while inorganic is 64.4% of the all out normal load of the whole waste examples in the neighborhoods. Contrasts in the kind of waste between the two territories mirror the distinctions in what are the predominant things in the business sectors, way of life and utilization design between the two land utilizes under the examination. Nearness of a sizeable measure of inorganic waste has been a significant appreciation for foragers who scout all the waste assortment focuses to pick these things for consequent deal for re-use and reusing might be answerable for low inorganic waste around the business focus than in the local locations. Reusing particularly of plastic materials regardless of whether casually sorted out has become a noticeable business and wellspring of work for thousands in Kaduna city.

4.3 Impacts of the Variation Observed to Environment and Human Health

Table 4 shows the combined rate event of the bacterial vegetation disconnected from 24 examples of the losses as examination appeared from Kaduna State Environmental Protection Agency (KEPA) Laboratory of the six bacterial confines recuperated from the waste example, three were coliform bacterial (E. coli, Klebsiella sp and Shigella sp.). Rate event of Shigella sp, and Klebsiella sp didn't likewise contrast fundamentally ($p < 0.05$). Shigella sp and Proteus sp had a similar rate event. All the bacterial

confines recuperated from the waste examples in the four dump destinations of Market regions and two dump locales of neighborhood have direct connect to nourishment borne diseases, for example, typhoid, looseness of the bowels and gastroenteritis. These ailments happen sparingly in all the two land employments. Nearness of coliforms, for example, E.coli, Klebsiella sp plainly shows that the loss in the market territories, particularly the Sabon Tasha, Mando and Kawo regions is tainted with fecal issue. While those coli structure are of lower rate in the two local locations.

Table 1. Weighted (g) Waste categories collected in Four Sampled Markets in the Study Area

Types	Kawo Mkt		Monday Mkt		S/Tasha Mkt		Mando Mkt		Total	
	Weight	%	Weight	%	Weight	%	Weight	%	Weight	%
Organic	325	65	300	60	345	69	330	66	325	65
Paper	70	14	75	15	28	5.6	65	13	59.5	11.9
Glass	5.5	1.1	12.5	2.5	1	0.2	5	1.0	6	1.2
Metal	8	1.6	20	4.0	7.5	1.5	10	2.0	11.5	2.3
Nylon	65	13	53.5	10.7	73.5	14.7	60	12	63	12.6
Plastic	16.5	3.3	24	4.8	11	2.2	15	3.0	16.5	3.3
Others	10	2	15	3.0	34	6.8	15	3.0	18.5	3.7
Total	500	100	500	100	500	100	500	100	500	100

Sources: Field Survey, 2019.

Table 2. Composition of waste in the two residential areas

Tayypues	Kabala Costain		Anguwa Sanusi		Total	
	Weight	%	Weight	%	Weight	%
Organic	173	34.6	182.5	36.5	178	35.6
Paper	53.5	10.7	61	12.2	57.5	11.5
Glass	29.5	5.9	27	5.4	28.5	5.7
Metal	16.5	3.3	40.5	8.1	28.5	5.7
Nylon	99	19.8	40.5	8.1	70	14
Plastic	29.5	5.9	40.5	8.1	35	7
Others	99	19.8	108	21.6	103.5	20.7
Total	500	100	500	100	500	100

Sources: Field Survey, 2019

Table 3. Percentage waste bulks collected in the Two Land Uses

Land Uses	Location	Organic (%)	Inorganic (%)	Total (%)
Market Areas	Kawo Mkts	65	35	100
	Monday Mkts	60	40	100
	Sabon Tasha Mkts	69	31	100
	Mando Mkts	66	34	100
	Total Average	65	35	100
Residential Areas	Kabala Costain	34.6	65.4	100
	Angua Sanusi	36.5	63.5	100
	Total Average	35.6	64.4	100

Sources: Field Survey, 2019.

Table 4. Percentage frequency occurrence of bacterial isolate from waste dump sites

Bacteria isolate	% Occurrence of bacterial isolate					
	Market Areas			Residential Areas		
	Kawo	Monday	S/Tasha	Mando	Kabala C.	A/Sanusi
<i>Samonella sp</i>	46.4	41.6	37.6	47.3	15.1	17.8
<i>Klebsiella sp</i>	42.8	37.8	40.5	44.1	23.8	25.2
<i>Proteus sp</i>	33.9	28.7	33.7	35.2	12.2	14.4
<i>Escherichia coli</i>	83.1	77.8	86.8	84.8	54.3	57.5
<i>Staphylococcus aureus</i>	75.8	69.1	81.7	77.6	42.7	44.2
<i>Shigella</i>	40.8	37.9	44.6	42.7	26.7	28.1

Source: KEPA Laboratory Analysis 2019

5. CONCLUSION

The significance of understanding the waste creation of the two land utilizes in Kaduna city can't be over-accentuated as it is the initial move towards a practical strong waste administration. This data is vital for arranging, structuring and building up fitting and progressively economical assortment, transportation and last transfer procedures of the waste. Squander the board here if not appropriately oversaw will wind up in the boulevards and will thusly present genuine wellbeing and natural issues to these territories. Data on the attribute of strong waste is significant in assessing elective hardware needs, frameworks, the board projects and plans particularly regarding the usage of transfer, asset and vitality recuperation alternatives. Moreover, the variety in the arrangement of waste saw between the two significant land utilizes in Kaduna city reflects neighborhood variety in way of life and this shows to make progress in squander the executives, waste ought to be overseen at the nearby level rather than the present acts of having a huge brought together organization with the goal that neighborhood variety can be considered. It is seen plainly that the arrangement of waste in advertise zones is more than that of the local location consequently the assortment time frames in these zones ought not be the equivalent. Refuse management must be decentralized according to different land uses so that local knowledge will be used to solve an issue that is essential local.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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