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## **Municipal Solid Waste Characterization and its Associated Vector-borne Diseases within the Vicinity of Dumpsite and Controlled Site**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. This work was part of author SAN thesis work. Author MJA was a major supervisor. Authors AHI, RHO and EB were co-supervisors. Author SAN did the study design, wrote the protocol, statistical analysis, literature searches, analyses of study, supervisors read and approved the final manuscript. All authors read and approved the final manuscript.*

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### **ABSTRACT**

This paper presents the composition of municipal solid waste in Uyo and vector-borne diseases associated with municipal solid waste within the vicinity of the dumping site (less than 1 km) and controlled site (above 1 km). The compositions of municipal solid waste were determined using samples obtained from Uyo village road waste dumping site. The dumpsite receives solid waste from all the communities in Uyo local government area. In order to assess the public perception of vector-borne diseases associated with municipal solid waste, sample survey method was adopted, which involved the administration of 500 questionnaires of which 250 were administered to the residents who lived less than 1 km from the boundary of the waste dumpsite and 250

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questionnaires were also administered to the communities living further away. The compositions and percentages constituent by mass revealed the following: Organic waste component constitute 53.86% and inorganic constituted a waste portion of 46.14%. For vector-borne diseases associated with municipal solid waste, the results indicated that 70.8% of the respondents attended tertiary education (OND/NCE and above), so the issues associated with municipal solid waste may not be strange to them. A significant number of respondents are aware that the origin of municipal solid waste is residential, commercial, industrial, market, street sweeping and industrial sectors. Respondents are more aware that rats, flies, mosquitoes, birds, pigs and cockroaches are vector-borne diseases associated with municipal solid waste. The findings in this study will be useful in a comprehensive solid waste management program which encompasses sweeping, storage, collection and disposal of solid waste. However, the waste can be best treated if any of these techniques are utilized composting, gasification and energy recovery in future for further reduction of waste.

*Keywords: Municipal solid waste; compositions; vector-borne diseases.*

## 1. INTRODUCTION

The issues posed by indiscriminate and non-successful management of municipal solid wastes has become an issue of worldwide responsibility in the last ten years. The immensity of the waste stream has received some abrupt dimensions [1-2], correlating with non-successful and insufficient management strategies [3], including insufficient funding on the part of Government [4-5]. The occurrence of poor waste handling has influence great environmental components like soil, water and air quality etc. Also, the immensity of development, modernization and inhabitants increase of most cities in the whole world has also had their accompanying unfavourable consequence on the environment [6].

Literature report indicated that Nigerian averaged municipal solid waste density span from 280-370 kgm<sup>-3</sup>, and daily waste production rate is approximately 0.44-0.66 kg/capital/day [7], with a yearly production of 25 million tons [8]. In addition, as recorded in literature, Nigerian municipality has registered an outstanding increase due to rural-to-urban migration [9], largely necessitated by the yearning of the populace to keep abreast of contemporary technological applications.

Unfortunately, high population density is implicated in poor handling of large waste streams generated, due to inadequate waste facilities and consequently results in environmental pollution. In major developing countries, human activities associated with insecure disposal of municipal solid wastes present death consequences to the ecosystem, in addition to being a threat to human health [10].

“Al Sabahi et al. [11] reported that toxic or contaminable leachates from municipal solid wastes dumpsites could be transformed physically, chemically or biologically, and transported via the air, or through runoffs which can contaminate the soil, surface or groundwater [12-13]”. Also, toxic fumes and greenhouse gases are also being produced by precarious or uncontrolled in-situ burning [14], which could have acute or chronic health and environmental consequences [15-17].

Illicit open dumping of municipal solid wastes may result in death consequences as dumpsites produce substances for growth and habitation of disease causal organisms and vectors of public health importance. “Oyekan and Sulyman [18], recorded that insects and vectors that transmit vital diseases affecting public health are normally seen in dumpsites”. These vectors include flies, mosquitos and rodents etc., [19]. The breeding of flies, for instance, is decomposing of organic waste, while mosquitoes are encouraged by piles of refuse like car tyres, empty cans etc. “Adamu et al. [10] reported that vectors found at the dumpsites play major roles in the transmission of disease of public health importance like plague, amoebic dysentery, rat-bite fever, Lassa fever etc. Similar reports have complained around Uyo village road waste dumping site. This lead to the subject of this study.

It has been also been reported that characterization is a major parameter to measure the health impacts of municipal solid waste on nature as well as on society [20]. At this point, there is scanty information regarding the municipal solid waste compositions and it characterization in Uyo. Hence it's important to study the composition and its characteristics for

efficient management and to develop strategies of reducing its hazardous impact on the environment. Consequently, this research work is aimed at characterizing municipal solid waste compositions, origin and its associated vector-borne diseases within the vicinity of the dumping site and controlled site in Uyo metropolis.

**2. MATERIALS AND METHODS**

**2.1 Study Area**

The study was carried out at the main refuse dumpsite located on Uyo village road in Uyo local government area. It's situated at 5.03° North latitude, 7.93° East longitude and 196 meters elevation above the sea level. The average annual temperature in Uyo is 26.4°C. The rainfall here averages 2509 mm. Fig. 1 show the map of the study area, while Fig. 2 shows the general view of the municipal solid waste dumping site (Uyo village road).

**2.2 Data Collection**

**2.2.1 Characterization of municipal solid waste composition**

The spot sampling method presented by Ityona et al. [21] was used with slight modification. Ten kilograms (10 kg each) of the raw municipal solid

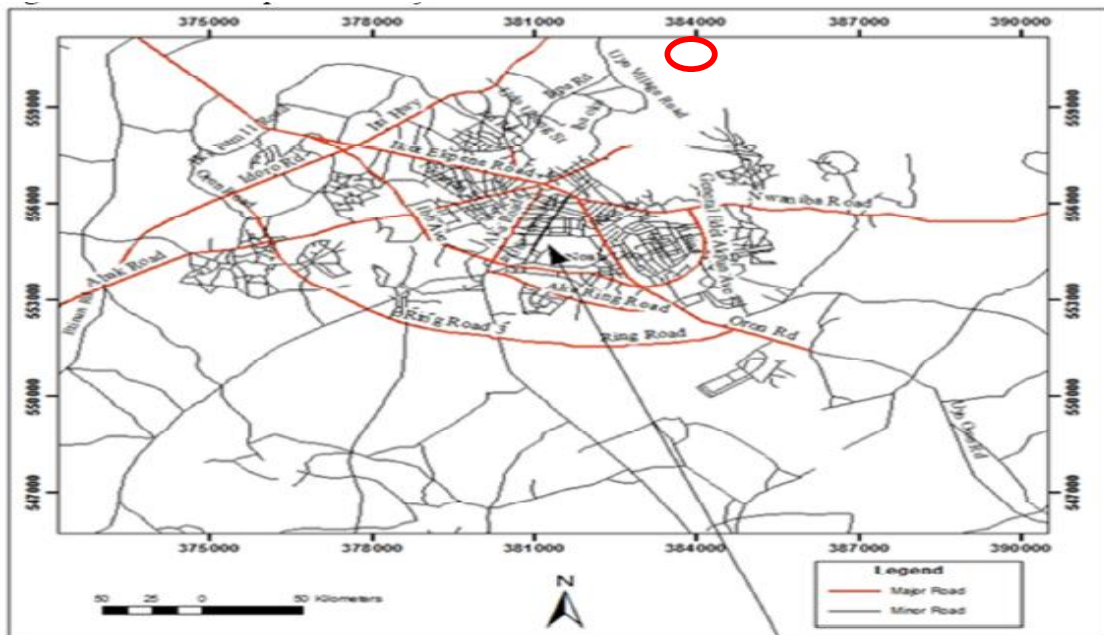
waste were collected at seven different sampling points within the dumpsite and put together to form a composite sample size of 70 Kg. The 70 Kg of the waste sample was sorted into various components and each component was measured with weighing scale and recorded. The data obtained in this study were expressed as percentage constituent by mass.

**2.2.2 Vector-borne diseases data**

The source population for this study was Uyo residents. Based on the standard sampling technique, the study populations for this study were those who live less than 1 km from the boundary of Uyo village road municipal solid waste dumping site and the same study population size above 1km away from dumping site [22].

The sample size of 500 was used since the population is small. In the opinion of Berinsky [23] a small population is appropriate. It will also help to improve the accuracy and quality of the data.

A total of 500 questionnaires of which 250 were administered to the residents who lived less than 1 km from the boundary of the waste dumpsite and 250 questionnaires were also administered to the communities living further away from the



**Fig. 1. Map of Uyo Urban showing the study area**  
○ Uyo Village Road Waste Dumping Site



**Fig. 2. Uyo village road municipal solid waste dumping site**

boundary of municipal solid waste dumping site by the researcher. The questionnaire was administered directly to either the male or female who is ready to respond to the questionnaire. This was done with the aid of two research assistants who were dullyinstructed on the techniques of questionnaire administration. The questions in the questionnaire were used to assess the perception of respondents on the vector-borne diseases associated with municipal solid waste, using the Likert scale (strongly agree, agree, disagree and strongly disagree). The social-demographic information of respondents was also obtained from the administered questionnaire.

The data for the study were analyzed using descriptive statistics (tables and percentages).

### **3. RESULTS AND DISCUSSION**

#### **3.1 Reconnaissance**

The observations made on the site are:

- i. The foul odour was strong and could be inhaled even at long distances from the landfill site.
- ii. Noise impact from the site.
- iii. A large number of rag pickers collect recyclable waste from the dumpsite.
- iv. There is a recycling dealer in the dump yard who buys the recyclable material from the rag pickers.
- v. Large number of flies, birds, rates, mosquitoes and cockroaches.
- vi. This dump site has no fence, no weigh bridge.

- vii. Truck movements of moving waste from communities to the dumpsite.
- viii. Complaints from the community in relation to odour.

#### **3.2 Municipal Solid Waste Composition**

Table 1 shows the constituent, mass and percentage constituent by mass of the municipal solid waste composition. In this study, 16 components were identified in the collected waste samples. Organic waste component constitutes the highest percentage of 53.86% by mass, while inorganic constituted a waste portion of 46.14% by mass.

From the result, food waste had the highest percentage of 33.71% by mass, thus making it predominant in the constituents. Vegetable waste recorded 5% constituent by mass which is agricultural waste. Textiles and papers recorded was 6.86%. Wood waste constitutes 1.43% constituent by mass.

Plastic and nylon bags recorded 15.43% by mass. The percentage of plastic waste increased with an increasing percentage of garbage waste. Plastics and rubbers recorded 5.71% constituent by mass. Bottles, leathers, construction waste and ceramics recorded 5.71, 1.57, 3.5 and 1.29% respectively. Electronic waste was 8.43% constituent by mass. Electronic waste thus even though the percentage by mass of this waste substance is small, toxicity potential can cause a very significant environmental problem. Metals, cans and battery waste were 0.49, 2.29 and 0.86% respectively. Finally, medical waste recorded 0.43% constituent by mass.

**Table 1. Municipal solid waste composition**

<b>Constituent</b>	<b>Mass (Kg)</b>	<b>% Constituent by mass</b>
<b>Organic waste</b>		
Garbage (food) waste	23.6	33.71
Vegetables	3.5	5.0
paper	4.8	6.86
Textiles	4.8	6.86
wood	1.0	1.43
Total	37.7	53.86
<b>Inorganic waste</b>		
Electronic waste	5.9	8.43
Cans	1.6	2.29
Plastic bags/Nylon bags	10.8	15.43
Plastics/rubbers	3.7	5.29
Bottles	4	5.71
Leathers	1.1	1.57
Ceramics	0.9	1.29
Construction material	3.5	5.0
Metals	0.3	0.49
Battery	0.2	0.86
Medical waste	0.3	0.43
Total	32.3	46.14
Net Total	70	100

Source: Author's fieldwork, 2018

Organic waste account for a large amount of waste generated in Uyo village road, this is in conformity with most of the waste generated in developing countries [24,25]. The organic fraction of municipal solid waste is an important component, not only because it constitutes a sizable fraction of the solid waste stream in a developing country, but also because of its potentially adverse impact upon public health and environmental quality. A major opposing influence that was observed around the waste dump site is its attraction of vectors such as flies, mosquitoes, rats, birds and cockroaches for which it provides food and shelter. Impact on environmental quality as was also observed in the dumping site takes the form of foul odours and unsightliness. These impacts were not only confined to the disposal site, but they pervade the area surrounding the waste dumping site.

### 3.3 Municipal Solid Waste

Out of the total questionnaires administered, 250 each were selected from the respondents who live within 1 km and above 1 km from the boundary of municipal solid waste dump site. The sex distribution of respondents comprises 136(54.47%) and 116(45.6%) male and female who live within the vicinity of the municipal solid waste dumpsite and 128(51.2%) and 122(48.8%) male and females live further away from the

waste dumpsite. The marital status shows that there are 128(51.27%) who are married, 105(42%) are single, and 10(4%) are divorced, while widow/widower constitutes 7(2.8%) live within 1 km from the boundary of municipal solid waste, whereas 115(46%) who are married, 122(48.8) are single, and 5(2%) are divorced, while widow/widower constitutes 8(3.2%) live further away as revealed in Tables 2 and 3, respectively. Table 4 shows that 43(17.2%) respondents have postgraduate degrees and 72(28.8%) have a first degree, while 62(24.8%) have NCE/OND, 53(21.2%) have secondary and 20(8%) have primary education live within the vicinity of the waste dump site. Also, 57(22.8%) respondents have postgraduate degrees and 69(27.6) have first degree, while 50(20%) have NCE/OND, 56(22.4%) have secondary and 18(7.2) have primary education respectively are the control group who live further away from the waste dumpsite. This response shows that the respondents are educated enough to provide answers to the questions on vector-borne diseases associated with municipal solid waste. A fact that needed to be stressed is that 70.8% of the respondents attended tertiary education (OND/NCE and above), so the issues associated with municipal solid waste may not be strange to them. In addition, 112(44.8%), 86(34.4%) and 52(20.8%) respondents who live within 1 km, 87(34.8%), 104(43.2%) and 59(23.6)

**Table 2. Sex distribution**

Responses	Communities living <1 km		Communities living >1 km	
	No. of respondents	Percentage	No. of respondents	Percentage
Male	136	54.4	128	51.2
Female	114	45.6	122	48.8
Total	250	100	250	100

Source: Author's fieldwork, 2018

**Table 3. Marital status**

Responses	Communities living <1 km		Communities living >1 km	
	No. of respondents	Percentage	No. of respondents	Percentage
Married	128	51.2	115	46.0
Single	105	42.0	122	48.8
Divorced	10	4.0	5	2.0
Widow/Widower	7	2.8	8	3.2
Total	250	100	250	100

Source: Author's fieldwork, 2018

**Table 4. Educational qualification**

Responses	Communities living <1 km		Communities living >1 km	
	No. of respondents	percentage	No. of respondents	percentage
Postgraduate	43	17.2	57	22.8
Degree	72	28.8	69	27.6
NCE/OND	62	24.8	50	20.0
Secondary	53	21.2	56	22.4
Primary	20	8.0	18	7.2
Total	250	100	250	100

Source: Author's fieldwork, 2018

**Table 5. Knowledge of municipal solid waste**

Responses	Communities living <1 km		Communities living >1 km	
	No. of respondents	percentage	No. of respondents	percentage
Dumpsites	112	44.8	87	34.8
Collection vehicles	86	34.4	104	43.2
Waste bins	52	20.8	59	23.6
Total	250	100	250	100

Source: Author's fieldwork, 2018

respondents, respectively, who also live 1 km away from waste dump site have adequate knowledge of municipal solid waste from the waste dumpsites, collection vehicles and waste bins as indicated in Table 5. Therefore, the issues related to solid waste are not new to them.

### 3.4 Municipal Solid Waste in Uyo Metropolis

Respondents are more aware of the origin of municipal solid waste as revealed in Table 6. For instance, 51% and 44% respondents who live within 1km, 47% and 49% respondents who live

above 1 km from the boundary of municipal solid waste dump site strongly agreed and agreed that residential sectors is one of major origin of municipal solid waste in Uyo metropolis, whereas 5% and 4% of respondents disagreed with this view. Similarly, 42% and 53% respondents who live within the vicinity of the waste dump site and the control group 39% and 57% respondents strongly believed and believed that commercial sector is the origin of municipal solid waste. In a similar vein, 35% and 52%; 64% and 34%; 27% and 53%; 60% and 33% respondents who live within the vicinity of the waste dump site and the control group 27% and 60%; 53% and 45%; 22% and 58%; 48% and 41% respondents

respectively, strongly agreed and agreed that industrial, market, street sweeping and institutions are also the major origin of municipal solid waste. Our observations are inconsistent with earlier report by Jorge [26] who documented that residential sectors, commercial sectors, industrial sectors, markets, street sweeping and institutions are the major origin of municipal solid waste. This awareness level would be beneficial in a comprehensive waste management program which encompasses of sweeping, storage, collection, and disposal of solid waste.

### 3.5 Perceived Vector-borne Diseases Associated with Municipal Solid Waste

Respondents are also more aware of the vector-borne diseases associated with municipal solid waste as presented in Table 7, so vector-borne diseases may not be strange to them. As expected, 64% and 33% respondents who live within 1 km, 51% and 45% respondents who live above 1km strongly believed and believed that rats are vector-borne diseases associated with municipal solid waste, whereas, only a small proportion i.e. 2% and 3% disagreed to this point, respectively. Respondents are strongly convinced and convinced that flies and mosquitoes are vector-borne diseases

associated with municipal solid waste. In fact, 69% and 31%; 75% and 25% who live within 1 km, 60% and 40%; 70% and 30% of the respondents who live above 1km, respectively, strongly agreed and agreed that flies and mosquitoes are vector-borne diseases associated with municipal solid waste. A major proportion of the respondents i.e, 44% and 54%; 19% and 38% respondents who live less than 1km, 47% and 50%; 11% and 21% respondents who live above 1 km from the boundary of municipal solid waste strongly agreed and agreed that cockroaches and pigs are vector-borne diseases associated with municipal solid waste. However, 77% and 23% respondents who live within 1 k, 78% and 22% respondents who live above 1 km strongly agreed and agreed that birds are also vector-borne diseases associated with municipal solid waste. The most important indirect risk of vector-borne diseases is the proliferation of animals that are carriers of microorganisms, and that transmit diseases to the whole population. These animals, known as vectors, include rates, flies, mosquitoes, cockroaches, pigs and birds. As well as feeding on the solid wastes, the vectors found in the garbage a favourable environment for reproduction and it becomes a breeding ground for the transmission of diseases, from simple diarrhea to severe cases of typhoid or other more serious illnesses [26].

**Table 6. Perceived municipal solid waste in Uyo metropolis**

Origin	Communities living <1 km				Communities living >1 km			
	%SA	%A	%D	%SD	%SA	%A	%D	%SD
Residential	51	44	5	0	47	49	4	0
Commercial	42	53	3	1	39	57	4	0
Industrial	35	52	11	2	27	60	9	4
Market	64	34	2	0	53	45	1	1
Street Sweeping	27	53	16	4	22	58	15	5
Institutional	60	33	4	2	48	41	3	4

SA = Strongly agreed, A = Agreed, D = Disagreed and SD = Strongly disagreed.

Source: Author's fieldwork, 2018

**Table 7. Perceived vector-borne diseases associated with municipal solid waste within the vicinity of dumping site and controlled site**

Vectors	Communities living <1 km				Communities living >1 km			
	%SA	%A	%D	%SD	%SA	%A	%D	%SD
Rats	64	33	2	0	51	45	3	0
Flies	69	31	0	0	60	40	0	0
Mosquitoes	75	25	0	0	70	30	0	0
Cockroaches	44	54	3	0	47	50	2	0
Pigs	19	38	33	11	21	33	30	16
Birds	77	23	0	0	78	22	0	0

SA = Strongly agreed, A = Agreed, D = Disagreed and SD = Strongly disagreed.

Source: Author's fieldwork, 2018

#### 4. CONCLUSION

The findings in this study indicated that organic waste account for a large percentage of the waste generated in Uyo. Organic components include (53.86% constituents by mass): garbage waste, vegetable, paper, textiles and wood and inorganic (46.14% constituent by mass) are: electronic, cans, plastic bags/nylon, plastics/rubbers, construction material, metals, medical waste and others. This is in conformity with most of the waste generated in developing countries. Results also revealed that 44.8%, 34.4% and 20.8% respondents who live within 1 km, 34.8%, 43.2% and 23.6% who live above 1 km have knowledge of municipal solid waste from the dumpsite, collection vehicles and waste bins. 46% and 44% respondents who live within 1 km, 39% and 51% respondents who live above 1 km from the waste dump site strongly agreed and agreed that the origin of municipal solid waste is a residential, commercial, industrial, market, street sweeping and industrial sectors. 58% and 34% respondents who live within 1 km, 55% and 37% who live above 1 km from the waste dump site strongly agreed and agreed that vector-borne diseases associated with municipal solid waste are rats, flies, mosquitoes, birds, pigs and cockroaches. It is therefore recommended that a compressive solid waste management program be put in place such that impact on soil, surface and groundwater qualities, and indeed the health of the nearby communities will be as low as reasonably possible.

#### 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 knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

#### CONSENT

It is not applicable.

#### ETHICAL APPROVAL

It is not applicable.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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