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# QUANTIFICATION OF MUNICIPAL SOLID WASTE IN BENIN METROPOLIS AS FEEDSTOCK FOR BIOETHANOL PRODUCTION

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***Abstract***

***Solid waste can be defined as garbage, refuse and other discarded materials including waste resulting from industrial, commercial and agricultural operations and from community activities that are discarded as useless or unwanted. Challenges confronting waste management in developing countries like Nigeria are: low collection coverage and irregular collection services, inadequate funds to support waste management, inadequate equipment to support waste storage, open dumping and burning without air and water pollution control. In this paper waste generated by respondents were sorted and characterized by both research assistant and sanitation officers strictly supervised by coordinators. The research team determined the composition of the waste before weighing using a digital weighing balance to determine the mass of waste and records were taken accordingly on the sample notes generated for the purpose of the work before allowing proper disposal of the waste. For the purpose of this work which is to quantify the amount of waste for the commercial production of bioethanol with emphasis on organic waste (fruit and food) sorting was done in commercial areas, colour-coded bin bags were assigned for fruit/leaves waste, food waste and recyclables paper, plastic, metal, ceramics, glass and combustibles. The trend of waste generated in the commercial areas were as follows; food > plastics > paper > fruit > leaves > metals > glass > combustibles. The business area specifically the shopping complexes in the study area (University of Benin Community) generated the highest amount of municipal solid waste (MSW) generally, with 1,213.01 kg, followed by food courts, with 954.20 kg. The cooperate business area like the Banks generated the least waste, with 221.13 kg. However, the total waste stream generated from commercial areas was 2,388.34 kg. This result shows that, if wastes are properly sorted from source, the commercial areas within the University of Benin community is capable of generating organic waste large enough to be used as feedstock for Bioethanol production.***

***Keywords:*** Feedstock, Bioethanol, Solid waste, Community, Environment and Characterization.
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## INTRODUCTION

Solid waste can be defined as garbage, refuse and other discarded materials including waste resulting from industrial, commercial and agriculture operations and from community activities or waste that are normally solid and that are discarded as useless or unwanted [1]. The solid content is technically known as refuse while the liquid substances are called effluent [2]. According to Environmental Protection Department Air Management Group, [3], waste involves categories of household, municipal, commercial and industrial wastes, some hazardous and some toxic [3].

Municipal solid waste (MSW) is generated from residential, industrial, institutional and commercial sources. Municipal solid waste is generally made up of paper, vegetable matter, plastics, metals, textiles, rubber, and glass [4, 5]. Waste characterization

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is a fundamental component in any municipal waste management scheme (MWMS) of urban solid waste in a city but such data are not commonly compiled in cities across Africa [6]. Waste characterization data consists of information on the types and amounts of materials (paper, food waste, glass, yard waste, etc.) in the waste stream. It depends on a number of factors such as food habits, cultural tradition, socioeconomic and climatic conditions. It varies not only from city to city but even within the same city itself [7].

Characterization of municipal solid wastes is simply a descriptive means of identifying the various constituent of the waste stream in terms of quantity and quality generation taking into account location as well as seasons in which these wastes are generated. It is a means of finding out how much paper, glass, food waste, etc. is discarded in the municipal waste stream. Characterization is also important to determine its possible environmental impacts on nature as well as on society [8].

Some of the challenges facing solid waste management in developing countries includes: collection and disposal, low collection coverage and irregular collection services, inadequate funds to support waste management, inadequate equipment to support waste storage, crude open dumping and burning without air and water pollution control [9].

The problems posed by improper and ineffective management of Municipal Solid wastes (MSWs), including insufficient funding on the part of Government has become an issue of global concern over the past decades. [10, 11]. The magnitude of commercialization, industrialization and population expansion of most cities all over the world has also had its attendant adverse effects on the environment [12].

Municipal Solid Waste (MSW) data are sometimes measured both in volume ($m^3$/capita/day) and in weight (kg/capita/day). In Nigeria waste recycling has been encouraged by all stakeholders, but unfortunately it is yet to attain full recognition due to slow implementation and insufficient funding. As such the known and widely practiced method of disposal in Nigeria still remains open dump and landfill system and institute incineration [13], which play a great role in polluting our environment. This study was carried out to quantify municipal solid waste generated in the University of Benin community and to determine the feasibility/viability of the generated municipal solid waste which can be used as feedstock for bioethanol production.

## STUDY AREA

The University of Benin Community is a Public Research University located in Ovia North East Local Government Area of Benin Metropolis, Edo State, Nigeria. It has a GPS Coordinate of $N6^0$ 20.022 $E5^0$ 36.009 and was established in 1970. The community currently has two campuses namely Ugbowo and Ekehuan campus respectively. For the purpose of this research, the commercial areas (Banks, Food court, Main gate, Fagcoop, SUG and June 12 shopping complexes) within the Ugbowo campus was selected.

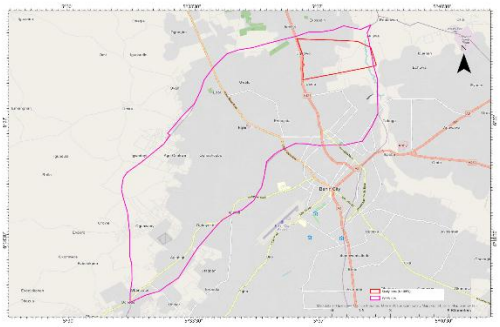

***Figure 1: Map of the Local Government Area.***

***Figure 2: Map of Study Area.***

## MATERIALS AND METHOD

The materials utilized for the work were wheelie bins (240 L), Wastebaskets, Hand Gloves, Coverall / Lab coat, Boots, Nose masks, Hand Sanitizers, Liquid Soap, Digital scale, Spring balance, Colour coded bin bags, Questionnaires, Sampling notes, Marker pens, Biro, Masking tape and Buckets.

Printing of questionnaires, sample notes, pamphlets, stickers, tagging of bin baskets and wheelie bins were also done. The questionnaires which were distributed to respondents were designed to obtain information on the status, lifestyle, class and level of awareness on waste management. The sample notes were designed to obtain data of various streams of waste generated. Pamphlets on sensitization and awareness on environmental management of waste were distributed during sensitization of respondents and sanitary officers. Wheelie bins and bin baskets were distributed to accommodate the sorted waste generated by respondents. Colour-coded bin bags of White, Green and Black were also distributed to respondents and sanitation officers.

Sorting and characterization of waste generated by respondents were done by sanitation officers. The research team determined the composition of waste before weighing using a digital weighing balance to determine the mass of the waste

generated and records were taken using the sample notes before allowing proper disposal of the waste. For the purpose of this work which is to quantify the amount of waste for the commercial production of bioethanol with emphasis on fruit waste, waste sorting was done in commercial areas. Colour-coded bin bags were assigned for fruit waste/ leaves, food waste, and recyclables paper, plastic, metal, ceramics, glass and combustibles.
For the safety of research officers and sanitation officers during the project, personal protective equipment (PPE) was worn at all times and also covid-19 guidelines were strictly observed. The systematic stratified sampling method was employed to obtain a good spectrum of respondents.

## RESULTS AND DISCUSSION

Below is the table showing the quantity of waste generated from the different locations (shopping complexes, banks and food court).

| SITE | FRUIT (KG) | FOOD (KG) | PLASTIC (KG) | PAPER (KG) | GLASS (KG) | METAL (KG) | COMBUSTIBLE (KG) | LEAVES (KG) |
|---|---|---|---|---|---|---|---|---|
| SHOPPING COMPLEXES | 118.82 | 172.13 | 457.87 | 281.74 | 19.18 | 27.11 | 0.05 | 136.11 |
| BANKS | 1.43 | 5.14 | 56.53 | 77.53 | 1.66 | 6.61 | 8.06 | 64.17 |
| FOOD COURTS | 46.30 | 638.90 | 251.09 | 5.39 | 3.65 | 0.99 | - | 7.88 |
| TOTAL | 166.55 | 816.90 | 765.49 | 364.66 | 24.49 | 34.71 | 8.11 | 208.16 |

***Table 1: Waste streams generated from commercial area.***

Table 1.0 above shows that respondents generated high volume of organic waste especially food waste, with food waste generating a mass of 816.90kg while respondents generated 374.71kg of fruits and leaves in the municipal solid waste (MSW) stream. Though, this waste may be harnessed in the production of Bioethanol, it's sourcing is still a serious challenge owing to the poor waste management system in developing countries like Nigeria. The recyclables materials like plastics and paper generated a mass of 765.49kg and 364.66kg respectively. The trend of waste generated in the commercial areas were as follows; food > plastics > paper > leaves > fruit > metal > glass > combustibles.
Comparing the results gotten from municipal solid waste (MSW) generated in University of Nigeria, Nsukka (UNN) campus, Organic waste formed the biggest component of the municipal solid waste (MSW) generated in which was about 34.29%. The trend was as follows; Organics > paper > plastics > glass > textile > metal >rubber > wood. It was observed that there was a slight difference in the trend, because paper waste generated was higher than plastic waste while vise-versa was the case in the University of Benin. This was probably due to the fact that only the commercial areas of the University of Benin was sampled unlike University of Nigeria, Nsukka UNN, both the commercial, residential and administrative/academic areas where sampled holistically [14].

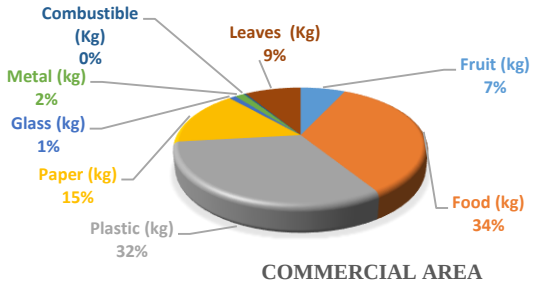


***Figure 3: Pie chart showing percentages of waste streams generated in commercial areas***

The percentages of the different waste streams generated from the study area are represented in the pie chart as shown in figure 3.0 above. They are; food 34%, plastics 32%, papers 15%, leaves 9%, fruits 7%, Metal 2% and Glass 1%. This also corroborates with the waste generated in the characterization of municipal solid waste (MSW) in Benin metropolis in general which resulted to a total of 2323.93kg of commercial waste collected and this gave an average of 44.96% of Garbage, 25.43% of plastic waste, 14.27% of paper waste, 3.21% of metal waste, 3.89% of glass and 8.24% of other waste (ceramics, foam, clothes etc.) [15].

***Table 2: Municipal solid waste generated in each sampling location***

| SITE | Total MSW in Kg. |
|---|---|
| **SHOPPING COMPLEXES** | 1,213.01 |
| **BANKS** | 221.13 |
| **FOOD COURTS** | 954.20 |
| TOTAL | 2,388.34 |

The shopping complexes in the University of Benin Community generated the highest amount of municipal solid waste (MSW) generally, with 1,213.01 kg, followed by food courts, with 954.20 kg. The Banks generated the least waste, with 221.13 kg, as shown in Table 2.0 above. However, the total waste stream generated from commercial areas was 2,388.34 kg.

## CONCLUSION

The potential of using municipal solid waste (MSW) as feedstock for bioethanol production is not in doubt, since the organic parts of the municipal solid waste (MSW) consists of materials from plant such as fruit, food, garden waste, leaves, etc. These waste does not compete with food and is readily available and sustainable since human daily activities always produce waste. The use of municipal solid waste for biofuel production is still in the developing stage due to the challenges of proper waste management and huge financial implications to solving this challenges. These challenges has made the concept of waste to energy unattractive for investors to venture into. Lack of Sensitization/awareness of respondents on waste sorting at source/management is another major challenge with municipal solid waste (MSW) as feedstock for bioethanol production. It was observed from our preliminary study that respondents in the commercial area were not interested in sorting their waste since they were used to dumping all the waste generated in a single bin basket. For the purpose of this work sanitation officers were given stipend to encourage them sort the waste generated by respondents into colour coded bin bags and the research team on the field also open the bin bags to ascertain the stream of waste before carrying out the characterization of the waste. For municipal solid waste to be an attractive feedstock for the production of bioethanol, proper waste management systems (from source to dumpsites) should be put in place by the relevant authorities to reduce the cost of waste sourcing. This result shows that, if wastes are properly sorted from source, the commercial areas in the University of Benin could be capable of generating organic waste large enough to be used as feedstock for the production of Bioethanol.

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