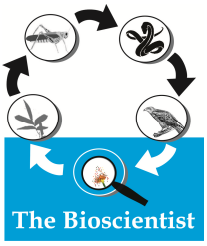
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Full Length Research Paper

THE CHARACTERIZATION OF SOLID WASTE IN NNAMDI AZIKIWE UNIVERSITY, AWKA

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ABSTRACT

Municipal Solid Waste (MSW) is produced through human activities and in the last two decades, management of MSW has become a major concern due to considerable increase in its production. Proper characterization of municipal solid waste is fundamental for the planning of municipal waste management services. This study reports the characterization of solid waste in Nnamdi Azikiwe University, it estimates the percentage of various components of solid wastes generated from source. Solid waste samples were collected, classified and weighed at source from four major sites in the university during the months of July, 2018- August, 2018. The results showed that Organics had the highest percentage (30.5%), Polyethylene (24.33%), Plastic (15.25%), Paper (14.73%), Metal (5.42%), Glass (3.79%) and others which include; ceramics, Styrofoam, textile and wood (5.98%). Data generated was analyzed using descriptive statistics and Analysis of Variance (ANOVA) at a significance level of 0.05 and there was a significant difference ($p \leq 0.05$) in the mean number of three of the seven waste categories classified in different sampling plots, they were plastic, paper and polyethylene. The study concludes that most of the waste generated in Nnamdi Azikiwe University could be composted. Suggestions for effective management strategies and efficient policies for waste reduction, disposal and recycling practices were offered in the sense of provision of colour coded waste bins at different locations so as to ensure easy sorting of waste for collection and proper use and also enlightening individuals of possibilities that exist in the complete utilization of a product.

Keywords: waste, composition, characterization

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. Solid waste is broadly composed of non-hazardous domestic, commercial and industrial refuse including household organic waste, hospital and institutional garbage, street sweepings and construction waste (Zerbock2003). Domestic solid waste includes all wastes generated in the community and generally includes food scraps, containers and packaging, discarded durable and non-durable goods, yard trimmings, miscellaneous inorganic debris and often construction and demolition debris. Municipal solid waste (MSW) consists of domestic waste generated by urban residents (household) with addition of commercial wastes but typically excludes industrial hazardous waste and domestic sewage sludge(Sakai *et al*., 1996). MSW includes durable goods, non-durable goods, containers and packaging wastes, food wastes and yard trimmings and miscellaneous inorganic wastes. Thus, MSW is an accumulation of rejects from household, market women, trades, shop owners and other commercial activities in the urban areas.

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). The composition and characteristics of MSW is influenced by certain factors which includes the area (residential, commercial etc) the economic level (differences between high and low incomes area) season and weather(difference 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 area produce relatively more of organic waste (Sakai *et al*., 1996). Uncontrolled or improperly sited open solid waste dumpsites constitute health hazards and damage the aesthetic beauty of many cities in Nigeria.

Waste characterization data consists of information on the types and amount of materials (which includes food waste, yard trimming, paper, glass, etc) in the waste stream. Characterization of municipal solid waste is a fundamental component in proper planning of solid waste management in any urban city. It helps in determining the quantity of waste generated in a particular location at a particular time of the year. Nigeria with a population of 140 million, as at 2006 census, generates about 25million tones of MSW per annum with generation ranging from 0.44kg/Capita/Day - 0.66kg/Capita/day. Solid waste management has emerged as one of the greatest challenges facing state and local government environmental protection agencies in Nigeria. Solid Waste Management in Nigeria is characterized by inefficient collection method, insufficient coverage of the collection system and improper disposal of the waste (Ogwueleka, 2009).

The purpose of this study is to identify and document the various waste categories generated in Nnamdi university since the knowledge of the types of waste in an area is required in order to design and operate appropriate solid waste management systems (Tchobanoglous *et al*., 1993).

MATERIALS AND METHODS

Study area

Nnamdi Azikiwe University is situated on the northern side of the Onitsha –Enugu Federal Highway, about 60km from Enugu and 35km East of Onitsha. Lying within Latitude 6°14′N to 6°14.5′N and Longitude 7°8.6′E to 7°9′E, UNIZIK is built on an area spanning over 502 hectares, with a vast expanse of land for development and expansion.

Sampling sites

Major sampling sites with dense population were selected namely; Administrative block and Banks Avenue, Engineering and Education section, Garuba Square section, Management Science section and Science Village section.

Admin and Banks Avenue constitute wastes from the first year students that converge at the multi-purpose hall (MPH), also students from the Faculty of Arts and staff in the Administration blocks and the surrounding banks and also workers at the fast food joints and cafés present there.

Engineering and Education section constitute the wastes from students of the aforementioned faculties and workers in the various fast food joints and cyber cafes there.

Garuba Square section holds the highest population of students because it houses the UNIZIK High school and Primary school and also students of Arts faculty not present in the Admin and Banks section.

Management and Science Village sections include wastes generated from students of Faculty of Management Sciences and Faculty of Biosciences and Physical Sciences.

Statistical Analysis

The means of the waste categories in the sites were analyzed with ANOVA using SPSS version 20 and significant means were separated using Duncan multiple range test. Percentages were presented in pie charts.

Data collection and Method of characterization

The method chosen for this study was that used by Bernache-Perez *et al*. (2001). Five (5) randomly collected samples of 2000g each, totaling 10000g of solid waste was collected in each of the three (3) sampling periods from each of the sites from 4pm to 6pm after the schools' daily activities. The weight of the sample was determined with a weighing scale. The samples were sieved to remove sand, followed by hand picking in order to remove stones which would not pass through the sieves, after which each of the waste samples from the source of generation was weighed with a weighing scale and emptied on a polythene sheet laid on the bare floor for sorting into seven (7) different categories namely: Organics, plastics, polyethylene, metal, glass, paper, and others (ceramics, styrofoam, textile, wood) After sorting, each category was placed inside a plastic basin and was weighed as recommended by the American Society for testing and materials (ASTM, 1988). The total net weight of each waste category was determined with Kwonnie balance (20 kg) and expressed in grams. This procedure was carried out for samples taken from each visit (three visits) for each of the four dumpsites for the duration of two months, July and August 2018. The dumpsites were labelled as follows: Site A (Admin and bank avenue), Site B (Faculty of Engineering and Education section), Site C (Garuba square section) and Site D (Faculty of Management Sciences and Science village sections).

RESULTS

The highest mean weight of plastic (403.33g) was collected in Site A, while the least (253.33g) was recorded in Site C. There was a significant difference (p = 0.01) in the mean weights of plastic generated between the sites. Polyethylene however had its highest mean weight recorded in Site D (586.67g) and its lowest in Site A (396.67g) with a significant difference (p = 0.00)between the sites. A significant difference (p = 0.01)was noted for paper having its highest mean weight in Site A (376.67g) and its lowest in Site D (218.67g). Glass, metal, organics and others had no significant differences (p > 0.05) for them individually, they had their highest mean weights in Site B (90g) , Site A (120g), Site B (676.67g), Site A (143.33g) and had their lowest recorded mean weights in Site C (60g), Site C (90g), Site A (483.33g) and Site D (84.67g) respectively (Table 1). The percentage composition of the waste categories is presented in a pie chart (Figure 1). The highest waste generated was organics (31%) (Figure 1) and it was also the highest in all the four sites while the lowest waste generated was glass (4%) in all the four sites at Nnamdi Azikiwe University.

Table 1: Mean composition (g) of solid waste from the four sites in UNIZIK (values are expressed as mean ± standard error).

Sites	Waste Categories						
	Plastic	**Poly-ethylene**	**Glass**	**Paper**	**Organics**	**Metal**	**Others**
A (Admin and Banks Avenue)	403.33±29.87^{b}	396.67±36.99^{a}	76.67±19.44^{a}	376.67±23.84^{b}	483.33±52.70^{a}	120.00±21.16^{a}	143.33±34.80^{a}
B (Eng. and Education section)	276.67±35.81^{a}	416.67±30.73^{a}	90.00±29.36^{a}	293.33±29.63^{ab}	676.67±59.54^{a}	110.00±22.47^{a}	136.67±27.37^{a}
C (Garuba square section)	253.33±21.53^{a}	546.67±42.39^{b}	60.00±21.38^{a}	290.00±40.59^{ab}	646.67±61.62^{a}	90.00±18.38^{a}	113.33±29.87^{a}
D (Management and Science Village section)	286.67±39.48^{a}	586.67±47.43^{b}	76.67±20.63^{a}	218.67±25.74^{a}	633.33±56.62^{a}	113.33±16.52^{a}	84.67±16.24^{a}

*Means in columns with different superscripts are significantly different from each other ($p \leq 0.05$)

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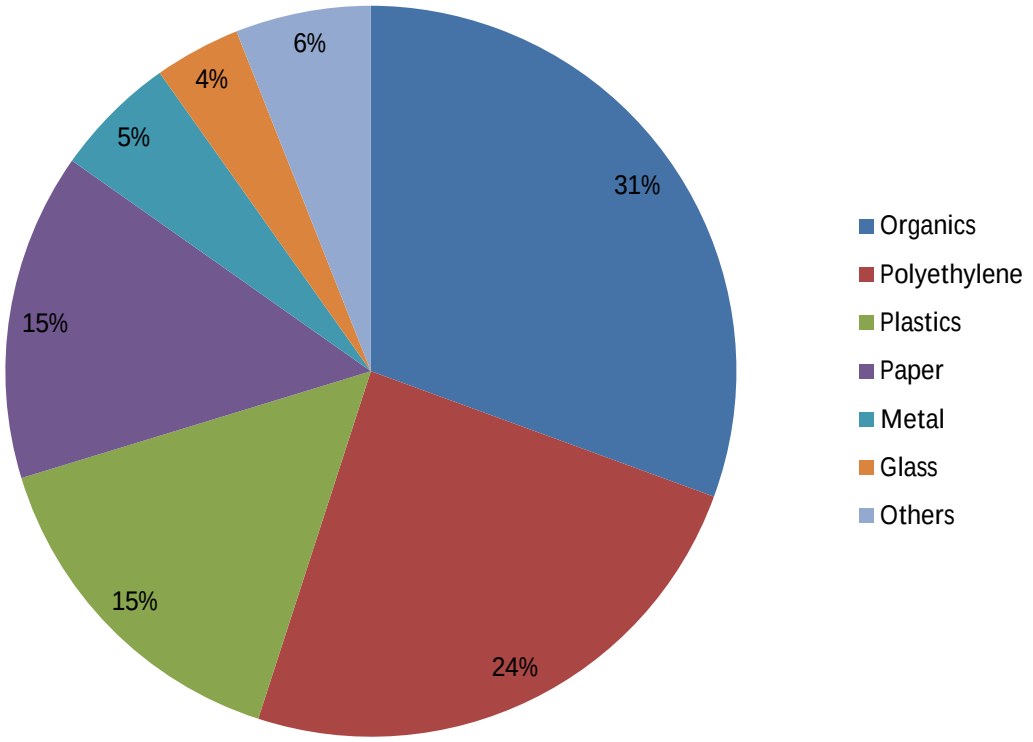


Figure 1: Percentage composition of solid waste in Nnamdi Azikiwe university

DISCUSSION

Certain categories of trash had significantly greater mass than others, a finding consistent with similar studies (Bundela*et al*.,2010).The amount of organic waste generated in the university was at 31%, the highest of all waste categories classified. This was as a result of concentrated situation of food canteens, and vast grasslands within the school premises. Wastes from the Biology laboratories also contribute to the amount of organic wastes generated in the school, as specimens used for student's practical are carelessly discarded. Income and economic growth have impact on the composition of wastes. High-income earners consume more packaged products, which result in a higher percentage of inorganic materials metals, plastics, glass, and textile (Ogwueleka, 2009). In developing countries, waste stream is over 50% organic material (Hoornweg *et al*.,1999). Studies in Bandung, Indonesia and Colombia, Sri Lanka have found residential waste composed of 78% and 81% compostable material, and market waste 89% and 90% compostable, respectively (Cointreau, 1997). Most students have no source of income apart from allowances given to them by their parents/guardians, as a result most cash amounts they possess is spent on food and the left-overs contribute to the total organic waste generated. There was no significant difference ($p > 0.05$) in the amount of organic wastes generated from all the four sites, this was confirmed with one-way analysis of variance. There was a significant difference ($p \leq 0.05$) in the means of Polyethylene, Plastic and Paper generated across the study sites. Next to organics was polyethylene contributing 24% to the total amount of waste in the school largely due to

the presence of polyethylene bags used by traders, and sachets used in packaging low cost drinking water popularly referred to as "Pure Water" and sold everywhere .The generation of polyethylene waste was in line with a similar study carried out in Port Harcourt, Rivers State, which had organics as the highest and polyethylene as the second highest waste generated in the local government.

There were significant differences in generation of polyethylene waste in the sites; site A and B were statistically the same but significantly differed from site C and D which were also statistically similar. The amount of polyethylene waste in those sites were higher than those of Sites A and B, reason being that the sites with higher polyethylene waste are sites where the students settle down and spend most of their time at but in Sites A and B they are not usually settled, rather they are on the move, so items purchased here are consumed and disposed of mostly in Sites C and D which are Garuba square section and Management and Science Village sections. Plastic waste generated was at 15% and there was a significant difference in one of the four sites that were visited, the site with a significant difference was Site A which is the Admin and Banks Avenue, the reason for the increase in production of plastic waste in this site could be attributed to the fact that most of the items purchased here are with plastic packaging which is mostly plastic water bottles and plastic food packages.
There was an increase in the percentage of polyethylene and plastic wastes when compared to results from a state in Nigeria that had 11.32% of both plastic and polyethylene waste gotten from a research work carried out in the markets of Lagos State between the months of March 2004 and April 2006 this may have resulted from the recent explosion in packaged water business and the increase in polythene bag packaging and the manufacture of other disposable products in the country as a whole. Paper was also at approximately 15% of the waste generated within the school premises, this is in agreement with Palczynski (2002) who reported that paper waste was generated at a percentage of 10-15% in several African cities. Paper waste existing in a school area would be expected to be more than 15%, but for reasons being that paper could be resold, even after its use, to traders that use them as packaging for their goods. Also, paper when wet tends to dissolve, be broken down into smaller pieces and is washed away by the rain. These reasons caused the reduction in paper waste. There were significant differences in the contribution of paper wastes by the four different sites. Site A had the highest paper output of all sites while Site D had the lowest. Sites B and C were significantly equal to both Sites A and D. Site A which is the Admin and Banks Avenue had the highest paper output, reason being that most of the university's cybercafés are situated there and a lot of printing, photocopying and paperwork are done there so the resulting effect is an increase in the production of paper waste, while Site D had a lower output which could be attributed to the fact that Site D which is the Management and Science Village sections is highly concentrated with fast food places so in turn generating less paper waste than other sites.

Unlike the other waste categories, metals, glass and others (ceramics, styrofoam, textile, wood) were the lowest with percentages of 5%, 4% and 6% respectively and could be because students have the higher population of the schools capacity and do not mostly deal with the afore mentioned categories thereby leading to the reduction in producing wastes from them. These categories, especially the metal and

glass categories have been found to instead of being disposed of, reused or stored until they are being collected by people who later sell them to recyclers. Other wastes on the other hand, especially stryofoam is used to produce food packs called 'take-away' and this can't be recycled so heaps of them are created in the waste portions. There were no significant differences for these wastes in all four sites in the school.

CONCLUSIONS AND RECOMMENDATIONS

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. Since the largest proportion of waste in Nnamdi Azikiwe University is organic (31%), it could 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, polyethylene can be recycled, so as to minimize the problem of indiscriminate disposal of polythene products in drainages. The study recommends the following;

- Efforts should be made by authorities to evolve policies for disposal, recycling and ultimately zero waste situation.
- Wastes shouldn't be burnt openly without energy recovery because this contributes to pollution of the environment.
- Bins with colour codes should be provided within the schools vicinity so as to separate the different wastes before it is collected stating those that can be recycled and those that should be composted.
- Awareness-building measures should therefore be coordinated with improvements in waste collection service.
- Programmes to disseminate knowledge and to improve behavior patterns and attitudes regarding waste management, are therefore critical.

REFERENCES

American Society for Testing and Materials. (1988).*Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste*. ASTM Standard D 5231-5292 (Reapproved 1998). American Society for Testing and Materials. Science and Education publishing, U.S. Pp 5292.

Bernache-Perez, G., Sanchez-Colon, S., Garmendia, A.M., Dávila-Villarreal A. and Sánchez-Salazar, M.E.A. (2001). Solid Waste Characterization Study in the Guadalajara Metropolitan Zone, Mexico. *Waste Management and Research*, 15: 573–583.

Bundela P. S., Gautam S. P., Pandey A. K., Awasthi M. K. and Sarsaiya S. (2010). Municipal Solid Waste Management in Indian Cities. A review. International Journal of Environmental Sciences. 1(4): 591-606

Cointreau-Levine, S. (1997). Occupational and Environmental Health Issues of Solid Waste Management. In: S Cointreau-Levine (Ed.*): International Occupational and Environmental Medicine*.Mes by, St.Louis, Pp198.

Hoornweg, B., Arnold, K., Smith, H.(1999). Landfill gases as pollutants: A preliminary report from Manilla.

MAB,Tech paper No. 14. Paris: UNESCO.

Ogwueleka, T.C. (2009). Municipal solid waste characteristics and management in Nigeria. *Iranian Journal of Environmental Health Science and Engineering*, 6(3): 173-180.

Oresanya, O. (1998). *Waste Control Measures and Responsibility of a Waste Manager within the Framework of Recent Management Methods and Development in Municipal and Industrial Wastes.* Paper presented at the Workshop on Effective Waste Management in Nigeria Organized by the Nigerian Society of Engineers, Lagos. April. *Journal of Waste Management*, 2014(193469): 7.

Palczynski, R.J. (2002). Study on solid waste management options for Africa, Abdijan, Côte d'Ivoire: African Development Bank. Sustainable Development & Poverty Reduction Unit.

Sakai, S., Sawell, S.E., Chandler, A.J., Eighmy, T.T., Kosson, D.S., Vehlow, J, van der Sloot, H.A, Hartlén, J. and Hjelmar, O. (1996). World Trends in Municipal Waste Management. *Waste Management*.16(5/6): 341-350.

Tchobanoglous, G., Theisen, H., Vigil, S. (1993). *Integrated Solid Waste Management: Engineering Principle and Management Issue. International* Ed. McGram - Hill Book Co., Singapore. Pp 978.

Wei, J.B., Herbell, J.D., Zhang, S. (1997). Solid Waste Disposal in China Situation, Problems and Suggestions. *Waste Management and Research*, 15: 573-583.

Zerbock, O. (2003). "Urban Solid Waste Management: Waste Reduction in Developing Nations". Unpublished MSc Thesis Michigan Technological University. *Management of Environmental Quality: An International Journal*, Vol. 28(1): 78-93.