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Characterization of Solid Wastes in the Non-Residential Areas of the University of Ibadan, Nigeria

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Abstract

Human activities create waste; the composition of solid waste varies from town to town and depends on food habits, cultural practices, occupations and the presence and types of industries and institutions. In Nigeria, only a little is known about the characteristics of solid wastes generated in institutions of higher learning. The study therefore characterized solid wastes generated in non-residential areas of the University of Ibadan. A cross-sectional study design was adopted. The non-residential areas of Student Union Building (SUB), Works Department (WD) and Faculty of the Social Sciences (FSS) were purposively selected. Wastes generated in the three locations were weighed and their physico-chemical characteristics determined using the Standard methods. Descriptive statistics were used to analyse data. The mean weekly recyclable wastes generated in the three locations were: 246.9±21.4Kg (food wastes), 111.7±10.6Kg (plastics) and 156.5±10.3Kg (paper).The mean values of the chemical constituents of the generated food wastes were: 2.7±0.59%, 2.1±0.77% and 3.4±0.72% (nitrogen) for SUB, WD and FSS respectively with no significant difference; 0.1±0.03%, 0.1±0.03% and 0.1± 0.04% (phosphorus) for SUB, WD and FSS respectively with no significant difference; and 0.3±0.04%, 0.2±0.05% and 0.2±0.03% (potassium) for SUB, WD and FSS respectively and no significant difference was observed. The solid wastes generated at the non residential areas have good recycling potentials with a large volume. Therefore, efforts should be made for the establishment of a solid wastes recycling facility in the institution.

Introduction

Human activities create waste; these wastes are generated from domestic, agricultural, commercial and industrial activities. These wastes may be gaseous, liquid or solid. The composition of solid waste varies from town to town, and from neighbourhood to neighbourhood within the same town or city. It depends on food habits, cultural practices, occupations and trades of inhabitants, the presence and types of industries and institutions.

Typically one to two thirds of the solid waste generated is not collected in developing countries. As a result, the uncollected waste, which is often also mixed with human and animal excreta, is dumped indiscriminately in the streets and in drains, so contributing to flooding, breeding of insect and rodent vectors and the spread of diseases. Furthermore, even collected waste is often disposed of in uncontrolled dumpsites and/or burnt, thereby polluting water resources and air.

In Ibadan, Nigeria, waste collection and disposal is frequently inadequate, with a large proportion of the refuse generated remaining in some parts of the city particularly the low income areas, receiving little or no attention. The onus is often on the local governments to provide a service for solid waste management. However, the fundamental deficiency of this system is the government's failure to assume basic responsibility in raising sufficient funds to provide acceptable levels of service (IDRC, 1999).

University of Ibadan is a large community with a population of about 22,176 people. It comprises of thirteen faculties and four institutes, students hostels, junior and senior staff quarters, markets, commercial, utility and recreational areas. The wastes generated on campus presently are enormous. The problems associated with the disposal are of a serious dimension. This is because the general method of disposal is open dumping which is mostly unplanned. Using this method to dispose solid waste has public health consequences such as the release of toxic fumes into the atmosphere. This leads to pollution of air, water and soil. Also when there is a delay by the waste disposal operators there is a tendency for the waste bins to overflow which in turn litter the surroundings. This usually attracts vectors to nearby apartments.

Furthermore, dangerous items such as broken glass, razor blades, aerosol cans and potentially explosive containers may pose risks of injury or poisoning, particularly to the itinerant scavengers who try to sort the various recyclable wastes for recycling purposes. Solid wastes have great potential for compromising people's health if not properly managed. This is because they are often highly infectious, toxic or hazardous. There are several infections associated with poor management of solid waste amongst which are; cholera, malaria, skin and body allergies, tetanus (Chavda, 1998). In Nigeria solid wastes are seldom well disposed and it is gradually becoming an issue of environmental concern as solid wastes are dumped indiscriminately into streams, drains and open dumps thus attracting vectors and pests. This can be attributed to poor waste management practices; therefore the introduction of the practice of waste-separation and segregation would go a long way in reducing the problem.

There is presently a dearth of information on the solid waste characteristics and recycling potentials in most institutions of higher learning. The study intends to make available the baseline data for the University of Ibadan which may be applicable to other communities in order to fashion out more effective and sustainable waste management strategies.

Therefore the purpose of this study was to characterize the solid wastes generated in the non-residential areas of the University of Ibadan.

Materials and Methods

The study area

The study was carried out in selected areas in the non-residential centres in University of Ibadan. The University of Ibadan is made up of 13 Faculties comprising both undergraduate and postgraduate programmes. The Faculties are: Arts, Social Science, Science, Education, Agric and Forestry, Technology, Basic Medical Sciences, Vet Medicine, Pharmacy, Public Health, Law, Clinical Sciences and Dentistry. The Faculties are housed in 205 Academic Blocks. Nine students Hostels; Senior and Junior Staff quarters, commercial centres such as the Students' Union Building and the Black market. Other sections in U.I are: The Central Administration which comprises the registry and bursary and consist of 15 Blocks, the Kenneth Dike Library, University Health Centre (Jaja Glinic), Administrative Blocks made up of 25 Blocks. Estate Development Department; Works Department, consisting of Waterworks, Workshops and Power house which were housed in 25 blocks. Others are the University Press, Black Market, Sports Complex, Students' Union building (SUB), Senior Staff Club, Abadina Community Centre, Trenchard Hall, Botanical Garden, Zoological Garden, shops, primary and secondary schools. The university has a total population of 23,303; out of which 18843 are students, 1197 are academic staff and 3263 are non-academic staff based on the 2007/2008 statistics (Planning Unit).

Study design

A cross-sectional design was adopted A cross-sectional study design was adopted. The non-residential areas of Student Union Building (SUB), Works Department (WD) and Faculty of Social Sciences (FSS) were purposively selected. The study involved field survey and laboratory analysis of food waste.

Characterization of generated solid waste

Determination of physical components
Weight determination

The determination of weight of the physical components was carried out daily for a period of four weeks. This was from Monday till Friday (five days) at the Faculty of the Social Sciences and the Works Department respectively (because they constitute defined occupational environments) and Mondays through Saturday (Six days) at the Students' Union Building (because days of operation extends due to commercial activities). Plates 1 and 2 show the source separation of wastes and determination of weight of the generated wastes.

At the Faculty of the Social Sciences, 11 women (University contracted cleaners) were given 3 bags with different colours each to sort the waste into. The sorted wastes were weighed using a 20kg capacity camry kitchen weighing scale. This was done daily for a period of 4 weeks. Other types of wastes were manually sorted and weighed using the same scale. At the Works and Maintenance Department, 4 women (University contracted cleaners) were given 3 bags with different colours each to sort the waste into. The sorted wastes were weighed using a 20kg capacity Camry Kitchen Weighing Scale. This was done daily for a period of 4 weeks. Other types of wastes were manually sorted and weighed using the same scale.

At the SUB, the building was categorized homogeneously into three sections based on the business activities in place. This was done after the mobilization and training of the business operators. The business operators were made to dispose and sort their waste into the given 3 bags with different colours. The weights of the sorted wastes were obtained using a 20kg capacity camry kitchen weighing scale. This was done daily for the duration of 4 weeks. Other types of wastes were manually sorted by the researcher and weighed using the same scale. The kitchen waste generated at the three locations was weighed from source due to the fact that hawking activities was discovered to be practiced.

Density

Density: This was obtained by taking 4 grab samples of paper, Nylon and plastics and Food wastes were taken from each location for each week. Each sample was put in a container of known volume and weighed using a 20 Kg Camry kitchen Weighing scale. The Density was then obtained and recorded.

$$\text{Density} = \frac{\text{Weight}}{\text{Volume}}$$

Determination of physico-chemical

components of generated food wastes

Two Grab samples of food wastes were collected from each location and combined into one composite sample for each month. The total number of eighteen samples obtained was made into nine composite samples and taken to the Agronomy Department. The physical parameters of the food waste measured were the moisture content, density and the pH while the chemical parameters of the food waste expressed in % were nitrogen, phosphorus, potassium, carbon, while zinc, copper, chromium, cadmium, lead, nickel, and cobalt were expressed in mg/Kg.

Figure 1: Source-Separation of Solid Wastes

Figure 2: Determination of Weight of Solid Wastes

All the parameters were analyzed using standard methods recommended by the modified standard method 2540-B American Public Health Association (APHA, 1992).

The unit generation rates

The unit generation rate was calculated from the formulated described by (Khan and Ahsan, 2003).

$$\text{Unit Generation Rates} = \frac{\text{Total Quantity of wastes}}{\text{No of houses x Residents per House x Days}}$$

Determination of heavy metals in food waste samples

The determination of lead, chromium, nickel, cadmium, zinc and copper in the organic waste was done by weighing 1g of the ground sample into a conical flask. About 5 ml of the digestion reagent (2:1 Conc. HNO_3 and Conc. H_2SO_4) were added and heated until brown peroxide and white perchloric acid evaporated. The resulting residue was totally dried. The procedure was repeated until a white precipitate remained in the flask. This was then filtered through a Whatman filter paper into a 100ml volumetric flask. The Filtrate was dilute with 0.1 N HNO_3 to 100 ml. The digested samples were then analysed for the heavy metals with a Bulk Scientific 210/211 VCP Atomic Absorption Spectrophotometer using the American Public Health Association (APHA, 1992) standard methods at the International Institute for Tropical Agriculture (IITA) Ibadan.

There was comparison of the results of the physical and chemical characteristics of the solid waste between the Student Union Building, Faculty of the Social Sciences and the Maintenance Department using the Analysis of Variance (ANOVA). All analyses were done at 5% level of significance.

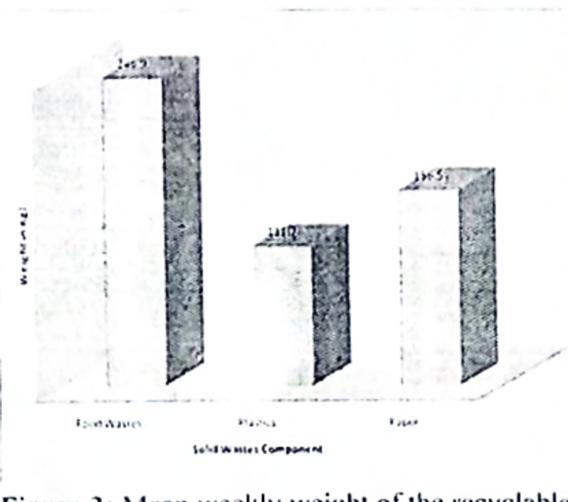

Figure 3: Mean weekly weight of the recyclable solid wastes components most highly generated at the three locations

Results and discussion

Survey of nature and quantity of generated solid waste

Physical assessment of components of solid waste generated in the three locations

The results of the survey showed that the major wastes generated in the three locations included paper, plastics, food waste and garden trimmings. Figure 2 illustrated the mean weekly weight of the recyclable solid wastes components most highly generated at the three locations while figure 3 reflects the percentage composition of the combined waste generated at the three locations. Paper, plastics, food waste and garden trimmings were the major components of the solid waste generated in the three locations. Percentage composition of the total waste generated at the three locations combined revealed that food waste was the most generated followed by garden trimmings, paper, plastics, wood, glass and hair. The percentage composition of the waste components was different from the observation of kundell (1996) composition of municipal solid waste as: paper and paperboard, yard waste, plastic, metals, wood, glass, food waste and miscellaneous in-organics. The waste generated depended to a large extent on the nature of activities in place, this was revealed by the results of the survey of the different locations. Garden trimming was the most generated component of solid wastes at the faculty of the social sciences, at the works

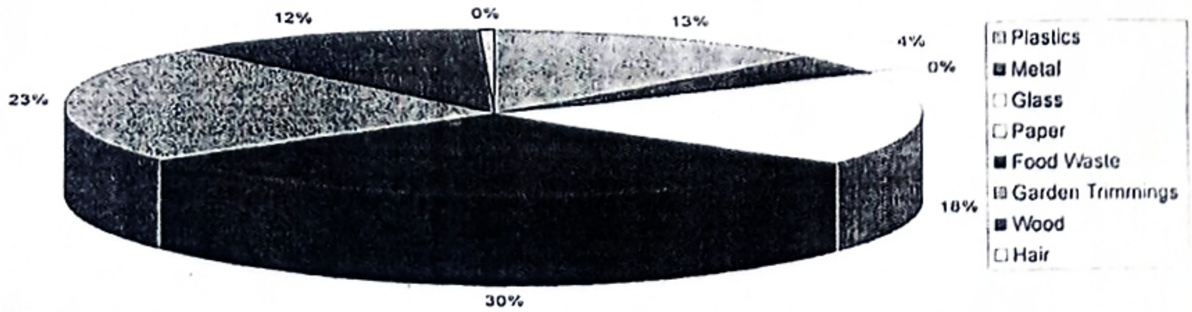

Figure 4: Percentage monthly total recyclable solid wastes components generated at the three locations

department wood while at the students' union building; food waste was the most generated. This shows that there is a significant difference in the percentage composition of the waste generated across the locations which is in agreement with Khan and Ahsan, (2003) who stated that the composition of wastes from commercial areas depends upon the nature of activities.

Generally, the amount of the biodegradable components and organic materials at all locations were above 60% which conforms with Sridhar (1999b) and Filani's (1999) findings that most of the solid wastes in Ibadan are putrescibles. This composition makes recycling; composting and sanitary landfills to be viable waste management options in the university community. This is in agreement with Dhussa and Varsney (2000) who stated that developing countries generally have high food and yard wastes as compared to developed countries with a large fraction of paper and plastic contents that can be recycled. The high volume of the garden trimmings generated at the three locations was as a result of the fact that the study was conducted during the dry season period of January, February and March, thus collaborating what Bhide and Sundaresan (1983) discovered that at the end of the growth season, leaves comprise a significant proportion

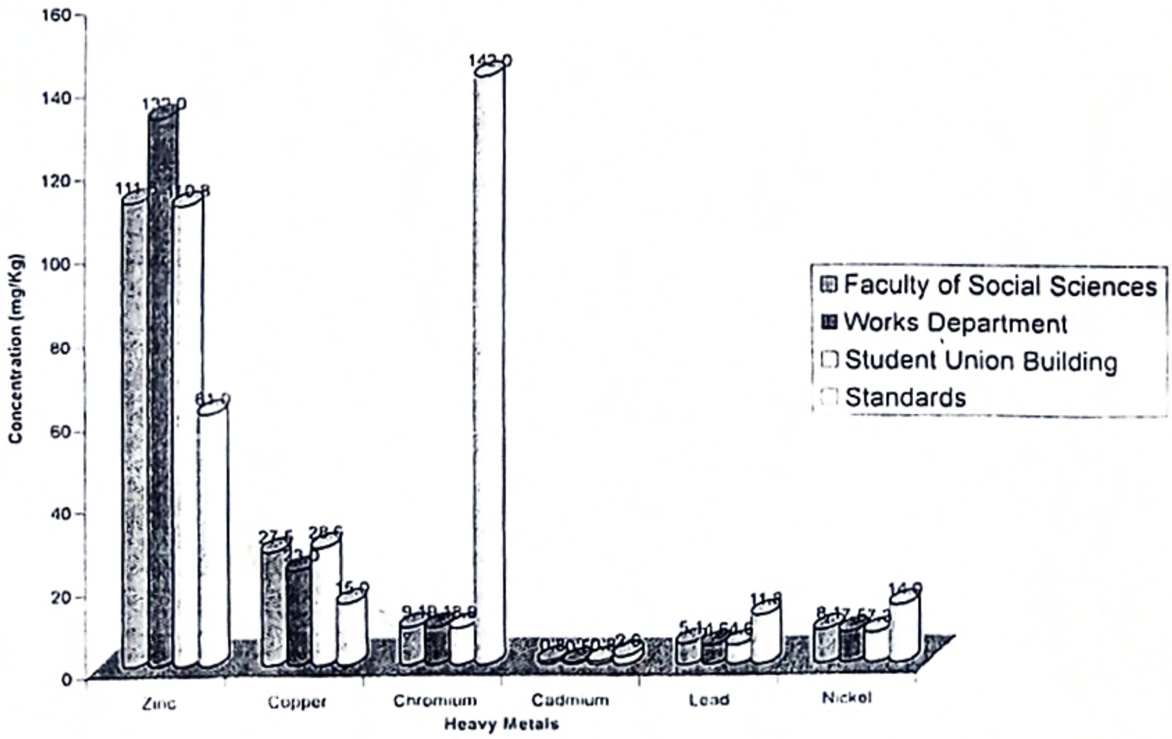

Figure 5: Mean concentrations of heavy metals in the three locations

Table 1: Comparison of Physico-chemical Characteristics of Food Waste in the Three Locations

Parameter	Location	Mean	S.D	P- Value
Nitrogen (%)	FSS	3.39	0.73	
	WD	2.08	0.78	0.151
	SUB	2.66	0.59	
Phosphorus (%)	FSS	0.08	0.04	
	WD	0.13	0.14	0.576
	SUB	0.05	0.03	
Carbon (%)	FSS	53.09	1.49	
	WD	53.08	1.80	0.991
	SUB	53.24	1.37	
Potassium (%)	FSS	0.24	0.03	
	WD	0.24	0.05	0.094
	SUB	0.25	0.04	
Lead (mg/kg)	FSS	5.13	1.27	
	WD	4.61	1.58	0.907
	SUB	4.63	0.25	
Cadmium (mg/kg)	FSS	0.79	0.26	
	WD	0.54	0.11	0.367
	SUB	0.78	0.26	
Nickel (mg/kg)	FSS	8.09	3.56	
	WD	7.50	3.90	0.963
	SUB	7.31	2.07	
Copper (mg/kg)	FSS	27.49	3.87	0.530
	WD	22.99	4.41	
	SUB	28.62	8.88	
Zinc (mg/kg)	FSS	111.61	29.58	
	WD	131.96	46.23	0.708
	SUB	110.79	22.91	
Chromium (mg/kg)	FSS	9.08	2.56	
	WD	9.08	3.57	0.996
	SUB	8.91	1.05	
pH	FSS	4.77	0.47	
	WD	5.07	0.99	0.880
	SUB	4.87	0.64	
Moisture Content (%)	FSS	64.13	0.85	
	WD	71.73	5.88	0.501
	SUB	72.54	1.58	
Density (Kg/m^3)	FSS	229.33	13.8	
	WD	247.10	5.9	0.001
	SUB	248.47	4.9	

of the solid wastes. These garden trimmings are good sources of nitrogen needed for the purposes of composting which could be added to the food waste when the nitrogen concentrations are quite low. Therefore there are enough recyclable components of solid wastes in the three locations providing a good source of raw materials for a waste recycling plant at the University of Ibadan if established.

Heavy metal components of food waste generated at the three locations

Figure 4 revealed the mean values of the heavy metals concentrations in the food waste generated within three months at the three locations compared with the composting guideline limits (Sridhar and Bammeke, 1986). The results of the survey showed that there was no significant difference in the concentrations of the heavy metal components of the food waste generated at the three locations as reflected in Table1. The values of the concentration of zinc and copper were above the compost guideline limits given by Sridhar and Bammeke (1986) at the three locations. The concentration of the other heavy metals such as chromium, cadmium, nickel and lead were all within the guideline limits at the three locations. Although Agunwamba (1998) stated that heavy metals might find their way into animals and consequently pose a threat to human health; nothing is to be feared because the concentrations of the heavy metals of public health importance such as lead, cadmium, nickel and chromium were all within guideline limits in all the three locations.

According to Woodbury (1992) long-term studies of Municipal Solid Waste compost application to cropland have shown a decrease or little change in cadmium content but care should be taken not to apply such for crops like tobacco, spinach and mushroom. Plants only take up a small proportion of lead for most soils and studies suggest very little increase in the lead content of crops with substantial addition of Municipal Solid Waste Compost (MSWC). For chromium also studies have confirmed that most of the chromium in MSWC occurs in a form not readily taken up by plants. Although nickel is toxic to plants but according to Woodbury (1992), it is unlikely to decrease plant growth when MSWC is applied. For copper although, the concentrations observed were higher than the acceptable limits but according to Woodbury (1992) the organic material in the composts binds the copper and reduces its availability to plants. Also like copper, the level of zinc was also higher than the standards at all locations but according to Woodbury (1992), zinc in MSWC is unlikely to affect crops and may be beneficial in regions deficient in zinc.

Solid wastes generation

The results of the survey revealed that there was a significant difference in all the physical components of the solid waste generated daily at the three locations except glass which was uniformly generated at all locations as reflected in Table2. At the Works Department, wood and metal were highly generated; this is because of the presence of metal and wood workshops. There is also a food canteen which was responsible for the high volume of food waste. At the Students' Union Building there was a high volume of food waste and plastic waste, although most of the food waste do not get to the campus bin because of the hogging activities in place. The high volume could be attributed to the presence of food canteens and high volume of people that patronize the complex for commercial activities in place. The generation of paper was predominant at the Faculty of Social Sciences and the Student Union Building. This is also as a result of the nature of activities in place; the Faculty being an academic environment and The Students' Union Building a commercial environment. This agrees with Aluko (2001) that stated the variation in proportion of waste generated could be attributed to difference in population size, customs and culture, food habits, socio-economic and occupation of people in those locations. It is established that there were

Table 2: comparison of various components of solid wastes generated at the three locations

Parameter	Location	Mean (Kg)	S.D	P- Value
Paper	FSS	17.48	10.31	
	WD	2.40	1.39	0.00
	SUB	12.17	3.75	
Glass	FSS	0.17	0.22	
	WD	0.11	0.22	0.140
	SUB	0.54	0.11	
Metals	FSS	0.47	0.68	
	WD	5.96	1.11	0.000
	SUB	0.17	0.37	
Food Waste	FSS	7.79	3.14	
	WD	14.27	2.71	0.000
	SUB	27.03	8.31	
Plastics	FSS	5.83	1.27	
	WD	4.57	1.58	0.000
	SUB	11.83	3.54	
Wood	FSS	0.00	0.00	
	WD	20.41	5.44	0.000
	SUB	0.03	0.02	

Table 3: Mean Waste Generation kg/person/day in the Three Locations

Location	Week 1	Week 2	Week 3	Week 4	Mean	Standard
FSS	0.04	0.04	0.04	0.03	0.04	0.5
WD	0.11	0.12	0.13	0.10	0.12	0.5
SUB	0.09	0.08	0.13	0.10	0.09	0.5

*Population for FSS – 1000; WD – 335; SUB - 500

enough recyclables generated on the campus which is according to the activities in place, therefore in planning the logistics for sourcing raw materials for the recycling plant, it is readily established that the activities in place determine the kind of waste generated.

Unit waste generation rate at the three locations

Table 3 reflects the generation rates obtained from the survey. It was revealed that there was a significant difference of the generation rates across the three locations. The estimated mean daily domestic solid waste generation rate reported was low at the three locations although highest at Faculty of the Social Sciences. The high value obtained at the Faculty of the Social Sciences could be as a result of the high volume of paper waste and yard trimmings generated at the location. This contradicts the value of 0.4Kg/c/day to 0.6Kg/c/day given by Cointrean (1982) for developing countries. This could be attributed to the fact that the locations were not residential areas; therefore the duration of stay

Table 4: Comparison of Physico-chemical Conditions Required for Composting of Food Waste

Parameter	FSS	WD	SUB	Standard
C:N Ratio	15.1:1	25.5 : 1	20.1:1	25.1:1 - 30.1:1
Moisture Content (%)	64.1+0.9	71.73+5.9	72.5+1.6	50.0 – 60.0
pH	4.77±0.5	5.1±1.0	4.9±0.6	6.0 – 7.5

in those locations was not as long as in residential areas. Notwithstanding, because of the population of people involved in various activities in these areas, the rate of generation is adequate as a source of raw materials if a waste recycling plant is established on campus.

Physico-chemical conditions required for composting of food wastes

Table 4 reveals that the values of the physico-chemical parameters vary at the three locations. There was significant difference in the values of the C: N ratio at the Faculty of the Social Sciences (15.1:1), Works Department (25.5:1), and Students' Union Building (20.1:1) respectively. The values except that of the Works Department were below the acceptable standards. The low value associated with Faculty of the Social Sciences could be as a result of the absence of a canteen which is a good source of food waste. There is a high mean value of nitrogen but the source of organic carbon from other food sources is low, therefore there is need for increase in the food sources with high carbon content at Faculty of the Social Sciences. For moisture content: the values were all above the acceptable standards this might be associated with the fact that the food waste was obtained directly from the kitchen thus increasing the moisture content. There is therefore need to reduce the moisture content to the optimum value of 55% by drying the food waste. There was no significant difference also for the pH obtained at the three locations; the values were all below the acceptable standards. The pH would affect the rate of biological conversion during composting; there is therefore the need to increase the pH of the food waste at the three locations in order to have a good source of compost from the three locations. Therefore, although the food waste generated in these areas can be readily converted as sources of compost on campus, there is need for pretreatment of the food waste.

Conclusions and recommendations

The study was carried out with the intent of identifying the nature and characteristics of solid waste generated in the non residential areas of the University of Ibadan in order to ascertain their recycling potentials. It was observed during the course of study that not much work had been done on the recycling potential of wastes generated in non-residential areas of institutions of higher learning. Most studies were on residential areas. At the end of the study, it was concluded that; the solid wastes generated at the non residential areas have good recycling potentials, a large volume of solid wastes generated in these areas provide a good source of raw materials for the establishment of a recycling plant, there were significant differences in the physical components of waste generated at the three locations, there were no significant differences in the chemical components of waste generated at the three locations, the concentrations of heavy metals of Public Health importance in the food waste are in quantities which do not exceed the guideline limits. Therefore it was recommended that; a solid waste recycling plant should be established on the campus, a Waste Management Committee should be inaugurated on campus to monitor recycling activities on campus, the University Authorities should establish Laws on sanitation and sanctions if violated and Environmental corps should be inaugurated to enforce sanitation rules and regulation on the campus.

References

Agunwamba JC (1998) Solid Waste Management in Nigeria: Problems and Issues. *The Journal of Environmental Management.* 22(6): 849-856.

Aluko OO (2001) Characterization and Treatment of Leachates from a Municipal Solid Waste Landfill Site in Ibadan. MPH Dissertation. Dept of EMSEH University of Ibadan, Ibadan, Nigeria. Pg 83-84.

APHA (1998) Standard Methods for Examination of Water and Wastewater. 19th Edition, American Public Health Association, Washington, DC Pg 458-497.

Bhide B, Sunderasan H (1983) Solid Waste Management in Developing Countries; Pg 21-25.

Chavda, D. (1998). Buried under Hospital Waste, Alimedabad faces Health Hazard. *The Indian Express.* 12:13.

Cointreau S J (1982) Environmental Management of Urban Solid Wastes in Developing Countries: A Project Guide. Urban Development Department, World Bank.
http://www.worldbank.org/html/fpd/urban//solid-wm/techpaper5.pdf. Assessed on 15th February 2008 Pg 26-32

Dhussa A K, Varshney AK (2000) Energy Recovery from Municipal Solid Waste – Potential and Possibility, *Bio Energy News*, UNDP, 4:23-25.

Fajehinsan A (1988) A preliminary assessment of the expanded Programme on Immunization (EPI) in Nigeria: The case of Oyo State, Report of NISER Sponsored Research. Pg 5-9.

Filani MO (1999) Socio-cultural dimension to Solid Waste Management. A paper presented at a one Day. Seminar organized by NINNAFEH, Ibadan.6. March 21st 1999 Pg12.

IDRC (1999) Managing the Monster. Solid Waste Management and Governance in Africa, Ontario Canada Pg 34.

Khan IH Ahsan N (2003) Textbook of solid Wastes Management First Edition CPS Publishers, Darya Ganj, New Delhi Pg 22.

Kundell J (1996) Solid Waste Management Goals: Recycling, Reduction and Diversion. Assessed on 26th June,2008 Pg 35.

Mabogunje AL (1968) Urbanization in Nigeria, African Publishing Corporation, New York, Pg 15-21.

Ogawa H (2007) Sustainable Solid Waste Management in Developing Countries.
http://www.gdrc.org/uem/waste/swm-fogawa1.htm (1 of 13) Assessed on 30th August, 2008 Pg 1-13.

Sridhar MKC (1999b) Waste Management for Lagos and Ibadan. The Report of a Workshop organized by Federal Government of Nigeria and UNICEF Water and Environmental Sanitation Programme, Zone B Pg 21.

Sridhar MKC, Bammeke AO (1986) Heavy Metal Contents of Some Solid Wastes in Ibadan.
Nigeria. *Water, Air and Soil Pollution* 29: 41-59.

Sridhar MKC, Ojediran JO (1983) The Problems and Prospects of Refuse Disposal in Ibadan city, Nigeria. *Journal of Environmental Health* 1:571-575.

Woodbury PB (1992) Potential Effects of Heavy Metals in Municipal Solid Waste Composts on Plants and Environment *Cornell Waste Management Institute, Center for the Environment* Pg 1-4.

World Health Organization (1983) Management of Waste from Hospitals *Euro Reports and Studies*, 97:11-12.