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Solid Wastes Generation in Covenant University, Ota, Nigeria: Characterisation and Implication for Sustainable Waste Management

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Abstract
Adequate waste characterisation is a requirement for effective waste management and environmental benign waste disposal system. The objectives of this paper were to estimate the percentage of various components in characterised solid waste materials generated in selected sites in Covenant University, Ota, Nigeria. The study was undertaken for 10 weeks through the weighing of solid waste generated in the institution before their delivery to landfills. The study shows that of the average waste generated per day in the institution, food waste exhibited the highest percentage generation at 26.29%, followed by polythene bag at 19.37% then 13.64% plastic bottles, 11.59% metal cans, 10.52% paper, 7.24% plastic food pack, 5.69% other combustible wastes and 5.67% polystyrene food pack. The high composition of non biodegradable wastes from this results bears implication of the requirement of alternative waste management solutions for attaining sustainable and environmental friendly waste management system in the university community.
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Keywords: Solid wastes; waste characterisation; biodegradable waste; non biodegradable waste; environmental impact; sustainable waste management.

Introduction
Covenant University, Ota, is located in Ado-Odo Ota Local Government, Latitude 6° 41′N and Longitude 3° 41′E, Ogun State, Nigeria. The population distribution of the institution, as at March 2009, is over 7000 students, see Table 1, and above 1000 staffs (Table 2); and the university operate full residency of accommodation for all its students and for almost all the staffs.

Table 1 Covenant University Student Population as at March, 2009

Halls of residence	No of Students
Peter hall	706
John hall	685
Joseph hall	799
Paul hall	776
Daniel hall	357
Esther hall	771
Mary hall	379
Deborah hall	600
Dorcas hall	617
Lydia hall	647

Halls of residence	No of Students
Total female students in school	3014
Total male students in school	3323
Students on industrial training (IT) program	750
TOTAL	7087

Table 2 Covenant university staff population as at March, 2009

Designation of Staff	Population
Academic Staff	343
Non-academic Staff	510
Cafeteria/ SBS Staff	201
TOTAL	1054

Since all human produce wastes [1,2] waste generation is inevitable in Covenant University community. The university, apart from the population of its residents, also co-host along with Living Faith Church, its proprietor and sister community, congregations of three services, each in the order of the 50,000 capacity church edifice, every week and other biannual and annual spiritual gatherings with millions of human attendees. From these the natural tendencies of discarding unwanted or used materials abound into propensity of large scale domestic waste generation [1,3].

Covenant University manages its waste generation through its institutional self-owned waste disposal systems that use delivery trucks to deliver the wastes to municipal landfill sites, the known waste management employed for municipal solid wastes in developing nations [4]. However, that these wastes are never characterised portend improper waste management and planning which could present danger to health and environment [1]. For instance, human solid wastes could be made up of non conservative or biodegradable constituents and conservative or non biodegradable components [1,4,5,6]. Stabilisation of biodegradable components could produce greenhouse gases such as methane and carbon dioxide [5,7]. Leachate containing soluble components and degradation products contaminate surface water and groundwater resources [6,7,8,9,10]. These affect human health and environmental well-being [5,9,11].

However, a proper waste management is the requisite step towards curtailing negative environmental impact of wastes [12,13]. Beside this, benefits that could be derived from wastes, including material and energy recovery, are by-products of developments of sustainable waste management system [5,11,14,15,16,17,18]. A good waste management is usually initiated from data acquisition of waste constituents obtained from waste characterisation [3,11,16,18,19,20,21,22]. This is the reason the dearth of waste characteristic data of generated solid wastes is one of the factors militating against sustainable waste management practice in developing countries. While waste characterisation from households, markets and cities in some parts of Nigeria has been considered in recent studies [3,19,23], the characterisation of wastes in Covenant University has not been done. Therefore, the characterisation of solid wastes generated in Covenant University is investigated in this paper. It is hoped that results obtained from this work would help policy makers, both in the institution and in Nigeria, in the development of sustainable waste management and environmental friendly waste disposal system.

Materials and Methods

Waste characterisation method of Bernache-Perez et al [24] which was employed and described by Oyelola and Babatunde [3] was used in this study. Generated solid wastes samples were obtained from bins and waste disposal sites, Figure 1, before the delivering of the waste materials to landfills by the university operated trucks disposal systems, from the residential, commercial, colleges and departmental buildings of Covenant University. In the residential buildings, some samples were taken from individual households, Figure 2, to develop waste composition data for the specific types of buildings to achieve a system of source

generator-based study. Wastes materials were sorted into material types which include paper/cardboard, plastic food pack, plastic bottles, metal cans, food wastes, polythene bags, polystyrene food pack and other combustible miscellaneous waste materials. Each of these is then weighed to obtain the mass-based characterisations for the waste components. These monitoring was carried out over a period of 10 weeks (between January and March) and the average of wastes taken in kg per day, to even out encountered irregularities in the waste generations.

(a) (b) (c)

Figure 1: Sample waste bins and collection for characterisation

(a) (b) (c) (d)

Figure 2: Sample waste collections from individual households

Results and Discussion

The average mass-based distribution of the characterised wastes in the different sites studied in the university community is presented in Table 3 while the total average waste generated in each site in kg/day and the average generation, also in kg/day, of each characterised waste component are presented in Figure 3 and Figure 4, respectively.

Table 3: Average mass-based distribution of solid waste materials

Site	Paper/Cardboard (kg/day)	Plastic food pack (kg/day)	Plastic bottles (kg/day)	Metal cans (kg/day)	Food wastes (kg/day)	Polythene bag (kg/day)	Polystyrene food pack (kg/day)	Others (kg/day)
C. B. S	7.65	0	2	0.5	0	1.7	0.75	3.3
C. S. T	1.7	0.25	0.39	0.08	1.9	0.36	0.13	3
Cafeteria 1	0	0	7.92	6.24	50.4	4.2	0.5	0
Cafeteria 2	0	0	8	14.9	17.2	10.04	7.18	0
Chapel	1.5	1	1.2	1	1.2	2	1.2	1
Esther Hall	1.74	17.16	25.74	8.59	2.58	25.74	4.32	0
Guest House	2	0	1.5	1	5.2	2.2	0	0
Joseph hall	10.32	5.68	6.08	14.4	10.4	18.4	4.8	0

Site	Paper/Card board (kg/day)	Plastic food pack (kg/day)	Plastic bottles (kg/day)	Metal cans (kg/day)	Food wastes (kg/day)	Polythene bag (kg/day)	Polystyrene food pack (kg/day)	Others (kg/day)
Mech. Eng. Dept.	1.2	0.05	1.4	0.2	1.2	1.7	0.05	9.5
Paul Hall	18.7	11.9	13.09	9.97	0	22.1	7.48	2.55
PG Quarters	0.54	0	0.17	0.6	12	3	0.72	0
Professors quarters	0.56	0	0.24	0.4	15.69	0.37	0.49	0
Senior Staff's quarters	0.49	0.06	0.21	0.52	12.6	2.4	0.45	0
Suites	2	0	0	1	4.4	2.6	0	3.2
University Library	5.5	1	2	0	0	2.5	1	6.6

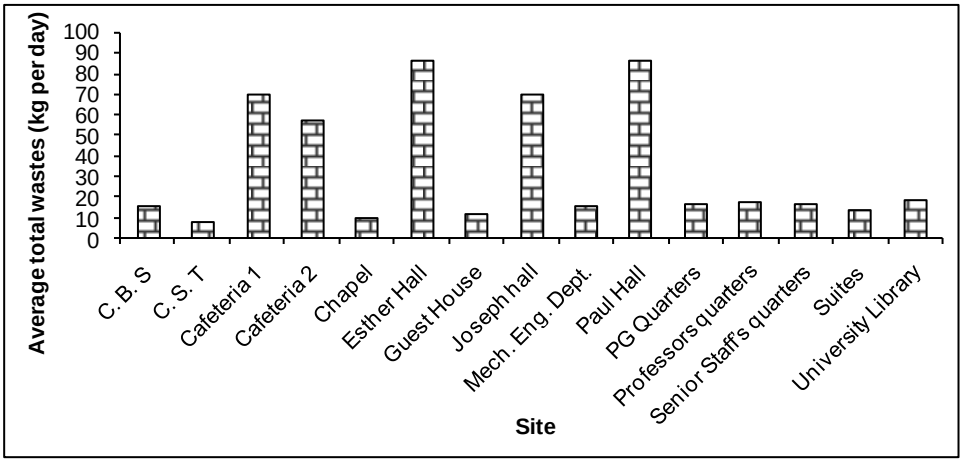

Figure 3: Average total wastes in kg per day generated at each site

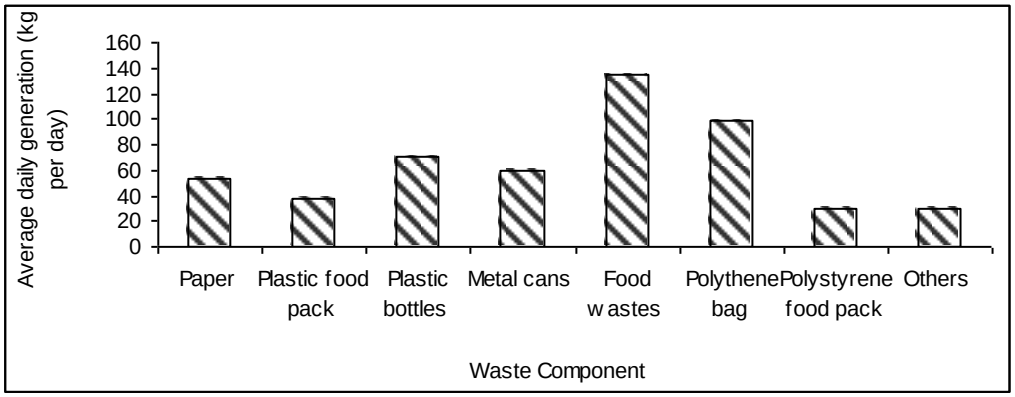

Figure 4: Average daily generation of waste components

From Table 2 and Figure 3, it could be observed that the students' hall of residence, Esther hall, Paul hall and Joseph hall, generated the highest mass of wastes in the sites of study chosen. This is due to the high population density of students resident in the hall compared to the other parts of the institution. Also, Figure 3 shows that food wastes constitutes the highest waste component generated in the institution followed by polythene bag and then by plastic bottles.

The high proportion of food waste component, 26.29% of the generated wastes (Figure 5) is suggestive that the current use of landfill system in the country is not an environmental friendly option of waste management system. Food waste is biodegradable and its disposal using landfill system exhibit potential hazards to the environment that could include emissions of potent greenhouse gases like methane and

leakages of leachate which could contaminate water streams. A more environmental friendly approach can be the inclusion of the development of bio-gasification scheme in the waste management system. Dual benefits accruable from this include generation of biogas as recoverable energy from waste and usage of the degraded residues from the digester as composts for agricultural land conditioning [5,11].

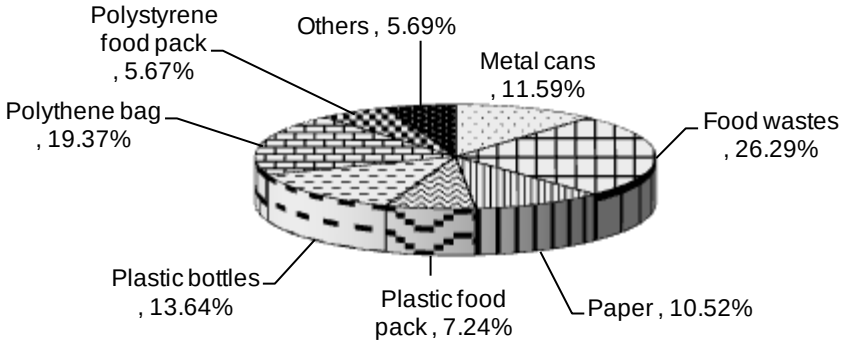

Figure 5: Comparative composition, in percentages, of characterised solid waste components

The results in Table 3 and Figure 4 also show that plastic related materials constitute sizeable portion of the solid wastes generated in Covenant University. These include non-biodegradable wastes such as polythene bag, plastic bottles, plastic food pack and polystyrene food pack. These materials are generated as wastes, respectively, at average values of 99.31 kg/day, 69.94 kg/day, 37.10 kg/day and 29.07 kg/day constituting 19.37%, 13.64%, 7.24% and 5.67% of all the generated solid wastes (Figure 5). All these add up to 232.42 kg/day of non biodegradable waste constituting 45.92% of all the generated wastes. This extent of non biodegradable component in the characterised waste constitution is substantiating the fact that waste disposal through landfill system alone is not a sustainable waste management choice for the generated wastes. A more suitable and sustainable waste disposal system should also include waste recycling to reutilise the plastics materials [14] or the employing of systems of co-incineration [25], or gasification [26] or pyrolysis [15,27] to grossly reduce the non biodegradable components of the waste stream.

Conclusion and Recommendations

Characterisation of solid wastes generated in Covenant University has been carried out in this work. The waste characterisation identified food wastes as having the highest average waste characterisation of 134.77 kg/day. Findings in the study also show that plastic related materials, in the form of polythene bag, plastic bottles, plastic food pack and polystyrene food pack are altogether generated at an average rate of 235.42 kg/day. It is opined that these results are suggestive of the requirement of a radical change in the current practice of waste disposal system. The generated wastes should not be managed using landfill system alone if a sustainable waste management system is to be achieved. Such sustainable waste management scheme should include the development of bio-gasification scheme for reducing the biodegradable waste components and any of recycling, co-incineration, pyrolysis and gasification system to be employed for reducing the non biodegradable waste components.

References

1. Ogboi, E. & Kperegbeyi, J. I. *Bioscience Research Communications* 21 (2009) 229–236.
2. Shepherd, W. & Shepherd, D. W. (2003) *Energy Studies, 2nd Edition.* Imperial College Press.
3. Oyelola, O. T. & Babatunde, A. I. *African Journal of Environmental Science and Technology* 3 (2008) 430–437.
4. Longe, E. O. & Balogun, M. R. *Research Journal of Applied Sciences, Engineering and Technology* 2 (2010) 39–44.
5. Mendes, M. R., Aramakib, T. & Hanakic, K. *Waste Management* 23 (2003) 403–409.
6. Thorneloe, S. A., Weitz, K. A., Nishtala, S. R., Yarkosky, S. & Zannes, M. *Journal of the Air & Waste Management Association* 52 (2002) 1000–1011.
7. Al-Jarrah, O. & Abu-Qdais, H. *Waste Management* 26 (2006) 299–306.
8. Bahaa-eldin, E. A. R., Yusoff, I. Rahim, S. A., Zuhairi, W. Y. W. & Ghani, M. R. A. *Environmental Earth Sciences* 63 (2011) 1043.

9. Alkassasbeh, J. Y. M., Heng, L. Y. & Surif, S. *American Journal of Environmental Sciences,* 5 (2009) 209–217.
10. Armstrong, M. D. & Rowe, R. K. *Proceedings Sardinia 99, Seventh International Waste Management and Landfill Symposium,* Santa Margherita di Pula, Cagliari, Italy 2 (1999) 81–88.
11. Mor, S., Ravindra, K., De Visscher, A., Dahiya, R. P. & Chandra, A. *Science of the Total Environment,* 371 (2006) 1–10.
12. Lamport, C. Waste management in Austria / GHG mitigation effects of the landfill regulation. Workshop on Best Practices in Policies and Measures, 11 – 13 April 2000, Copenhagen, (2000) Accessed October 3, 2011 from
13. http://unfccc.int/files/meetings/workshops/other_meetings/application/pdf/aut.pdf.
14. Agunwamba, J. C. *Environmental Management,* 22 (1998) 849–856.
15. Post, V. & Haenen, I. Solid Waste Management in Sri Lanka: Plastic Recycling. CORDAID Tsunami Reconstruction 6 Project Report, *WASTE,* (2007) Accessed October 3, 2011 from WASTE Website: http://www.waste.nl
16. Ojolo, S. J. & Bamgboye, A. I. *Agricultural Engineering International: the CIGR Ejournal,* Vol. VII (2005).
17. Fobil, J. N., Carboo, D. & Armah, N. A. *Int. J. Environmental Technology and Management* 5 (2005) 76–86.
18. Klein, A. & Themelis, N. J. *Proceedings North American Waste to Energy Conference (NAWTEC 11),* ASME International, Tampa FL (2003) 241–252.
19. Themelis, N. J., Kim, Y. H. & Brady, M. H. *Waste Management and Research* 20 (2002) 223–233.
20. Nabegu, A. B. *J Hum Ecol,* 31 (2010) 111–119.
21. Igbinomwanhia, D. I. & Olanikpekun, J. *Advanced Materials Research,* 62-64 (2009) 763–768.
22. Ogedengbe, P. S. & Oyedele, J. B. *Journal of Land Use and Development Studies,* 2 (2006) 1–12.
23. Parizeau, K., Maclaren , V. & Chanthy, L. *Resources, Conservation and Recycling,* 49 (2006) 110–128.
24. Bamgboye, A. I. & Ojolo, S. J. *LAUTECH Journal of Engineering and Technology,* 2 (2004) 36–38.
25. Bernache-Perez, G., Sanchez-Colon, S., Garmendia, A. M., Dávila-Villarreal, A. & Sánchez-Salazar, M. E. A. *Waste Management & Research,* 5 (2001) 413–424.
26. Seemann, A. *Proceedings of the International Conference on Sustainable Solid Waste Management,* Chennai, India, (2007) 348–355.
27. Aznar, M. P., Caballero, M. A., Sancho, J. A. & Francés E. *Fuel Processing Technology,* 87 (2006) 409–420.
28. Nema, K. Thermal Disintegration of Plastic Waste and Energy Recovery Using Plasma Pyrolysis Technology. DST-SERC School On Plasma Diagnostics, Institute For Plasma Research, Gandhinagar 382 428, Gujarat, (2009). Accessed October 3, 2011 from http://serc-plasma09.pssi.in/documents/DT-13_plasma%20processing%202.pdf.