INNSPUB

International Journalof Microbiologyand Mycology| IJMM |
pISSN: 2309-4796
http://www.innspub.net
Vol. 13, No. 1, p. 1-8, 2021

Open Access RESEARCH PAPER

Occurrence and diversity of microorganisms isolated from selected solid waste dumpsites in parts of Ondo State, Nigeria

Oni, I. Olawale*, Onifade K. Anthony, Arutopin J. Daniel

Department of Microbiology, Federal University of Technology, Akure, Ondo State, Nigeria

Keywords: Microorganisms, Waste dumpsite, Assessment, Occurrence

Publication date: July 30, 2021

Abstract

This study was designed to assess the microbiological and physicochemical properties of soil samples from selected waste dumpsites in parts of Ondo State, Nigeria. The findings of the microbiological analysis carried out showed the mean values of the total heterotrophic bacterial counts ranged from $1.17 \times 10^6 \pm 0.08$ cfu/g - $7.67 \times 10^6 \pm 0.01$ cfu/gwhile the total fungal counts recorded ranged from $1.00 \times 10^4 \pm 0.02$ sfu/g to $6.33 \times 10^4 \pm 0.11$ sfu/g. The recorded physicochemical properties of the soil samples ranged from 5.4 to 7.9, 4.95 to 45.36%, 0.86 to 2.50% and 2.38 to 11.35% for pH, organic matter, organic nitrogen and organic carbon respectively. The soil particles of the selected dumpsites recorded a range of sand between 55 - 80%, silt 7 - 31% and clay 4 - 29%. The microbial isolates characterized and identified include *Bacillus, Alcaligenes, Staphylococcus, Proteus, Micrococcus, Pseudomonas, Serratia, Ochrobacterium, Escherichia and Aspergillus, Penicillium, Mucor, Rhizopus, Cladiosporium*and *Trichoderma*respectively. *Bacillus* and *Aspergillus* species were the most prevalent microorganisms isolated from the selected dumpsites and studies have revealed these organisms to be pathogenic in nature, which could pose serious health risk to residents in and around the dumpsites.

* **Corresponding Author:**Oni, I. Olawale ✉olawaleonih3@gmail.com

Introduction

Waste can be described as an unwanted material that is discarded by its owner. However, most discarded wastes can be reused or recycled. Ogban and Akuruju (2016) described waste has any solid or liquid substance which have been thrown away by its original owner, which may be or may not be found useful by any other person but constitute nuisance to people's health and the environment when left untreated. Waste is a complex mixture of different substances that are discarded by household, individual or organizations that are harmful to the environments and public health (Rushton, 2003). The wastes generated in Ondo-State, Nigeria are mainly municipal solid waste from household, markets, schools, hotels, etc., hazardous waste, construction/demolition waste, and agricultural residues. Over the years, unhealthy disposal of solid waste is one of the greatest challenges facing Nigeria as well as in most developing countries. These could be as a result of financial, institutional, technical, economic and social factors, which invariably affect the development of efficient and effective solid waste management systems. Ogwueleka (2009) observed that solid waste management in Nigeria is characterized by inefficient collection methods, insufficient coverage of the collection system and improper disposal while Babayemi and Dauda (2009), described the complete lack of efficient and modern technology for the management of waste. Refuse dumps constitute a habitat for vector and other organisms capable of transmitting or causing diseases such as typhoid, infantile diarrhoea and cholera in humans and animals (Siboe*et al*., 2006). Most refuse dumpsites are converted to urinal and defecation sites by destitutes and those who lack access to toilet facilities, which in turn gets invaded by scavengers and animals, and serve as breeding ground for disease vectors such as flies and rodents. Records have shown that man has suffered in no small way from diseases associated with solid wastes and contamination of the subsurface water by the leachate from solid wastes which are heavily laden with toxic chemicals and pathogenic organisms which contaminate the water and makes it not fit for human consumptions (Ye-Obongand Adedibu, 2008). Therefore, this study is focused on assessing the occurrence and diversity of microorganisms isolated from selected solid waste dumpsites in Ondo-State.

Materials and Methods

Study Area and Sample Collection

Ondo State is located in south-west geopolitical zone of Nigeria with an estimated population of 3,441,024.Ondo is situated at 7.1° North latitude, 4.83° East longitude and 277 meters elevation above the sea level. Ondo State was created in 1976 out of the defunct Western State. Soil samples were collected using soil auger from ten selected waste dumpsites in Akure and Ondo. The soil samples were collected at two different points on a site. The depth of sample collection ranges from 0-5cm to 5-15cm respectively. The control samples were collected at short distance (>20m) away from the dumpsites based on the topographical assessment of each dumpsite location.

Isolation of Microbial Isolates

Nutrient agar (NA) medium was prepared according to manufacturer's instruction, sterilized and poured into Petri dishes. The serial dilution method was used for the enumeration and isolation of the microbial isolates. One gram (1g) each of the soil sample was dispensed in a beaker and mixed thoroughly with 10ml distilled water to make stock solution. The serial fold dilutions were made up to 10^{-7} and aliquots of each dilution was dispensed onto petri dishes using pour plate techniques. Nutrient agar and potato dextrose agar media were used for the growth of bacterial and fungal isolates respectively. The plates were incubated at 37^0C for 24hrs and at room temperature for 4days for the growth of bacterial and fungal isolates respectively.

Isolates were sub-cultured repeatedly to obtain pure cultures as described by Arotupin*et al*. (2013).

Total viable counts

The total viable count was carried out by counting the total number of colonies grown on the plates after incubation at 37^{o}C for 24hrs and 72hrs for bacterial and fungal respectively as described by Adejumo (2014).

Characterization and Identification of Bacterial Isolates

Pure cultures of the heterotrophic bacterial isolates were identified on the basis of their morphological and biochemical tests. The bacterial isolates were subjected to various morphological and biochemical characterization tests such as color, shape, elevation, consistency, margin, Catalase test, MRVP (methyl red-vogesproskauer test), fermentation of sugars, kovacs citrate, indole and hydrolysis of starch (Olutiola 1991). To determine the identity of bacteria isolates, results were compared with standard references of Bergey's Manual of Determinative Bacteriology 2nd edition (Buchanan and Gibbon, 1974; Sharma (2008).

Identification of fungi

The fungal isolates were characterized and identified through observation of their colonial morphology, microscopic examination of their respective spores and hyphal appendages. This involved picking fungi growth from an agar plate using a sterile dissecting needle. The hyphal was teased out on clean grease-free slide upon which a drop of lactophenol cotton blue was added. The smears were then covered with cover slide and viewed under the microscope using magnification of ×100. The characterization and identification to a certain level were carried out according to the methods of Barnett and Hunter (1975).

Physico chemical analysis

The soil PH, conductivity and particle size were assessed using procedures described by Osazee*et al.* (2013).

The organic carbon, organic nitrogen and organic matter content were determined using standard laboratory procedures and analytical methods (APHA 2005); Ogunmodede*et al.* (2013).

Results and Discussions

The dumpsites were characterized majorly by the presence of spoiled and degrading foods and its components, human and animal faeces, waste fabrics, dead and decaying plants, papers, nylons, plastics, leaves. As presented in Table 1 and 2, the microbial load recorded in this study from the control soils generally showed a low count compared to that recorded from the dump sites. This in agreement with reports by Osazee*et al.,* (2013) microbial counts on municipal waste dumpsites. The total microbial counts from the ten (10) selected waste dumpsites revealed bacterial counts ranging from $2.05 \times 10^6 \pm 0.07$ cfu/g - $7.59 \times 10^6 \pm 0.40$ cfu/g and $1.17 \times 10^6 \pm 0.08$ cfu/g - $7.67 \times 10^6 \pm 0.01$ cfu/g for Akure and Ondo respectively while the total fungal counts isolated from Akure dumpsites also ranged from $1.00 \times 10^4 \pm 0.02$ sfu/g - $3.33 \times 10^4 \pm 0.21$ cfu/g and the fungal counts in Ondo dumpsites ranged from $1.10 \times 10^4 \pm 0.01$ sfu/g – $6.33 \times 10^4 \pm 0.11$ sfu/g. Akure and Ondo are densely populated towns in Ondo State characterized by high wastes generation from both residential and industrial areas. It was observed that three out of the five dumpsites selected in Akure recorded a relatively low microbial count. This could be as a result of the indiscriminate burning practices in those dumpsites. The difference in the range of the bacterial isolates can be traced to the composition of the refuse collection points and the ability of the microorganisms to survive at these sites (Bowman *et al*., 1997). The pH recorded in this study for all the selected dumpsites ranged from 5.88 to 7.15. This is similar to Obire*et al.,* (2002), that reported a pH of 5.4 to 7.9.

Table 1. The total heterotrophic bacterial counts from the waste dumpsites (cfu/g ± standard error)

		Akure	Ondo
Dumpsites	**Sample**	**x10^6 (cfu/mg)**	**x10^6 (cfu/mg)**
A	A_1	5.60±0.02	6.06±0.01
	A_2	7.59±0.40	6.00±0.01
	Average	6.56±0.23	6.03±0.01
	control	2.40±0.02	3.21±0.02
B	B_1	2.05±0.07	2.93±0.03
	B_2	2.55±0.17	2.20±0.01
	Average	2.30±0.12	2.57±0.02
	Control	6.20±0.08	4.33±0.02
C	C_1	2.35±0.01	7.67±0.01
	C_2	2.10±0.01	7.32±0.06
	Average	2.23±0.01	7.50±0.04
	control	5.15±0.01	2.31±0.02
D	D_1	7.15±0.35	3.07±0.01
	D_2	4.10±0.04	5.00±0.01
	Average	5.63±0.20	4.04±0.01
	Control	3.11±0.01	6.37±0.01
E	E_1	2.57±0.07	1.17±0.08
	E_2	2.51±0.01	2.67±0.01
	Average	2.54±0.04	1.92±0.05
	Control	5.50±0.02	1.20±0.04

Key: A_1, B_1, C_1, D_1 and E_1= Samples on dumpsites collected at 0-5cm while A_2, B_2, C_2, D_2 and E = Samples on dumpsites collected at 5-15cm.

Table 2. The total fungal counts from the waste dumpsites (sfu/g ± standard error)

		Akure	Ondo
Sites	**Samples**	**x10^4 (sfu/mg)**	**x10^4 (sfu/mg)**
A	A_1	1.00±0.02	4.33±0.01
	A_2	3.33±0.08	4.20±0.03
	Average	2.17±0.05	4.27±0.02
	control	2.00±0.01	1.99±0.09
B	B_1	3.00±0.02	4.00±0.01
	B_2	1.87±0.01	6.17±0.08
	Average	2.44±0.02	5.09±0.05
	control	3.15±0.02	1.05±0.02
C	C_1	3.33±0.21	5.60±0.03
	C_2	2.89±0.07	5.33±0.01
	Average	3.11±0.28	5.46±0.02
	control	4.11±0.05	1.37±0.03
D	D_1	1.30±0.01	6.33±0.11
	D2	2.00±0.01	1.10±0.01
	Average	2.65±0.01	3.72±0.06
	control	3.68±0.04	2.33±0.01
E	E1	1.23±0.01	3.58±0.04
	E2	1.67±0.07	3.51±0.02
	Average	2.90±0.04	3.55±0.03
	control	3.02±0.01	1.70±0.01

Key: A_1, B_1, C_1, D_1 and E_1 = Samples on dumpsites collected at 0-5cm while A_2, B_2, C_2, D_2 and E = Samples on dumpsites collected at 5-15cm

The pH is one of the soil factors which affect microbial community structure directly by providing a suitable habitat for specific microorganisms, by rendering them of a maximum or minimum efficiency in their functions (Girvan *et al.,* 2003). The findings from this study revealed a relative change in organic matter concentration and soil particles of the dumpsites compared to the control soils. The percentage organic matter ranges from 4.95 to 45.36%. High organic matter discovered around waste dump favors increased moisture content, water holding capacity and permeability (Akinbile 2012).

The highest values recorded from the dumpsites for percentage organic nitrogen and organic carbon was 2.50 and 11.35% respectively (Tables 3 and 4). Motsara and Roy (2008), stated that low organic carbon content may, in turn, affect the abundance of microorganisms due to low contents of substrates, and this may affect their functions and activity, including degradation of organic substrates. The range of sand is between 55 - 80%, silt 7 - 31% and clay 4 - 29%. Oyedele*et al.* (2008) reported that the textural class of a soil is mainly inherited from the soil forming materials.

Table 3. The physicochemical parameters of the selected dumpsites in Akure town (± standard error)

Parameters	A	B	C	D	E
pH	6.00±0.01	6.20±0.10	6.87±0.01	7.15±0.03	6.54±0.10
Cs	4.11±0.01	5.00±0.01	5.42±0.30	4.99±0.02	5.31±0.10
Conductivity (ohms)	33.15±0.01	20.01±0.01	15.08±0.45	20.71±0.13	28.04±0.05
Cs	42.02±0.21	22.01±0.17	15.76±0.12	17.32±0.12	19.52±0.57
Organic Matter %	12.76±0.03	23.16±0.01	29.10±0.03	28.21±0.01	45.36±0.28
Cs	4.91±0.01	10.01±0.01	9.33±0.02	11.00±0.01	10.44±0.02
Organic Nitrogen (%)	0.97±0.01	0.91±0.00	0.91±0.43	0.86±0.58	1.00±0.76
Cs	1.11±0.05	0.90±0.03	1.39±0.01	1.71±0.04	0.73±0.02
Organic Carbon (%)	2.38±0.33	7.36±0.09	10.65±0.01	11.26±0.01	11.35±0.18
Cs	6.35±0.02	6.00±0.01	6.67±0.01	5.87±0.01	6.11±0.05
Sand (%)	67.68±0.33	60.68±1.66	67.90±0.11	58.12±0.03	62.36±1.76
Cs	75.81±0.17	63.20±0.22	77.48±0.07	60.45±0.14	73.51±0.01
Silt (%)	17.84±0.08	15.59±1.87	5.77±0.13	25.59±0.08	8.46±0.09
Cs	19.42±0.01	15.00±0.41	7.99±0.03	24.55±0.05	15.62±0.01
Clay (%)	14.48±0.41	23.73±0.03	18.23±0.05	16.29±1.65	29.18±1.65
Cs	4.77±0.11	21.80±0.26	14.53±0.51	15.00.±0.03	10.87±0.71

KEY: Cs = Control Soil. Each value represents a mean of two readings. A, B, C, D and E = Dumpsites

Table 4. The physicochemical parameters of selected dumpsites in Ondo town (± standard error)

Parameters	A	B	C	D	D
pH	5.875±0.00	6.325±0.07	6.921±0.03	6.108±0.19	6.773±0.01
Cs	4.398±0.01	3.12±0.03	4.01±0.15	4.58±0.11	3.81±0.01
Conductivity (ohms)	4.20±0.07	29.09±0.07	24.19±0.04	20.56±0.67	41.88±0.09
Cs	3.69±0.31	6.08±0.57	3.88±0.02	4.10±0.51	4.12±0.01
Organic Matter %	4.95±0.04	14.56±0.13	18.54±0.57	18.00±0.31	17.20±0.02
Cs	8.14±0.03	4.17±0.29	4.32±0.01	4.77±0.71	4.00±0.01
Organic Nitrogen (%)	1.01±0.00	1.38±0.04	2.50±0.03	2.02±0.01	1.11±0.04
Cs	1.00±0.76	1.50±0.10	0.96±0.01	1.09±0.08	0.970±0.02
Organic Carbon (%)	2.86±0.02	8.26±0.02	2.67±0.43	6.66±0.09	3.01±0.04
Cs	7.35±0.18	7.00±0.39	5.23±0.06	7.18±0.01	7.55±0.49
Sand (%)	65.68±0.01	79.68±0.44	80.41±1.20	55.09±1.55	60.26±0.88
Cs	67.68±0.06	65.11±0.01	65.29±0.04	67.00±0.01	55.37±0.03
Silt (%)	20.84±0.03	16.48±0.77	7.00±0.67	31.44±0.03	28.11±1.66
Cs	11.64±0.01	11.84±0.01	9.71±0.03	10.29±0.01	32.40±0.03
Clay (%)	13.48±1.38	3.84±1.57	12.59±1.52	13.47±0.08	11.63±1.11
Cs	20.68±0.06	23.05±0.54	18.89±0.02	22.71±0.06	12.23±0.06

KEY: Cs = Control Soil. Each value represents a mean of two readings.

A poorly sorted nature of particle sizes may indicate soil not formed from natural process of weathering of the underlying parent material but rather, from the deposited wastes (Okoronkwo*et al.,* 2006).

Consequently, the frequency of occurrence of the microbial isolates can be influenced by the soil particle content which has been altered by the waste being disposed at the dumpsites.

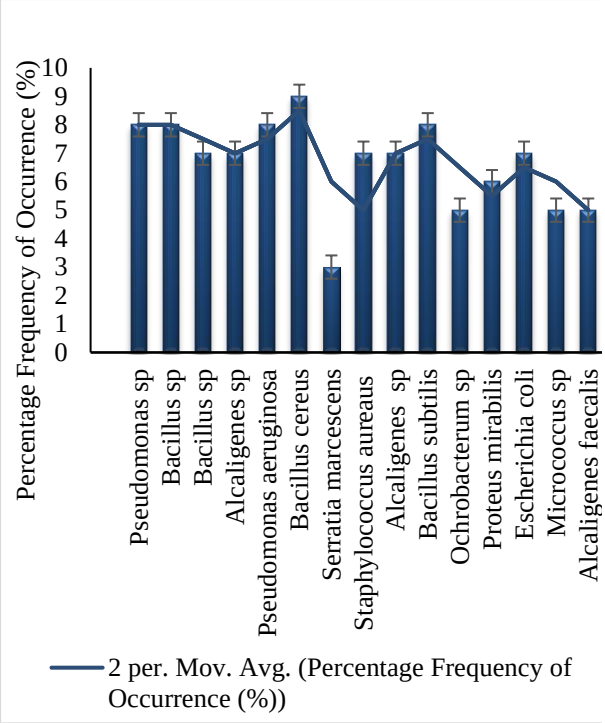

Figure 1. Frequency of occurrence of the bacterial isolates from Akure dumpsites

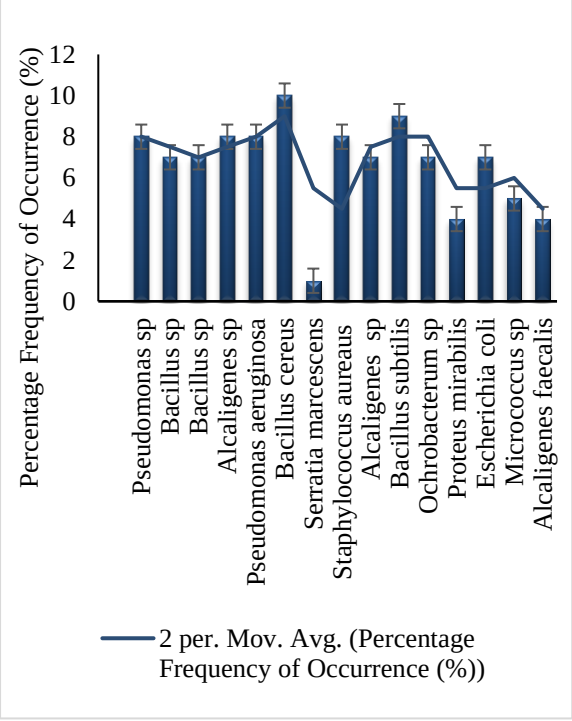

Figure 2. Frequency of occurrence of the bacterial isolates from Ondo dumpsites

Soils with high sand and low clay content have high pollutant leaching potentials. It could therefore be deduced that the underground water in this refuse collection points could suffer from pollution as reported by Nyles and Ray, (1999).

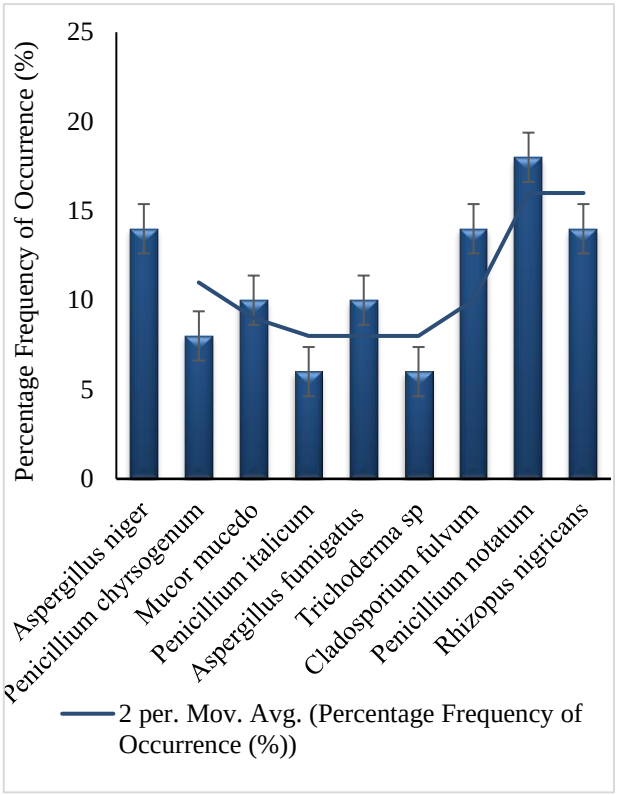

Figure 3. Frequency of occurrence of the fungal isolates from Akure dumpsites

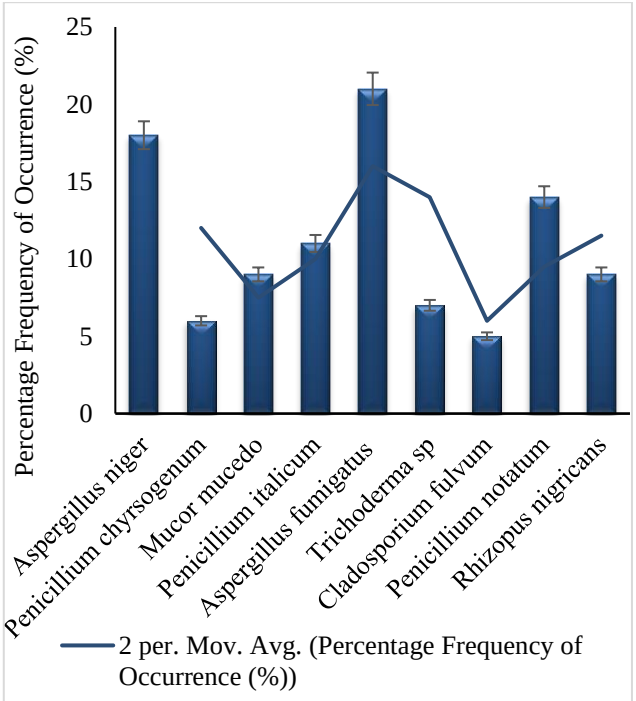

Figure 4. Frequency of occurrence of the fungal isolates from Ondo dumpsites

The microbes isolated and further characterized includes nine bacterial genera and six fungal genera among which were *Bacillus, Alcaligenes, Staphylococcus, Proteus, Micrococcus, Pseudomonas, Serratia, Ochrobacterium, Escherichia and Aspergillus, Penicillium, Mucor, Rhizopus, Cladiosporium*and *Trichoderma.* Antai*et al.* (2016) reported similar findings that the presence of pathogenic bacteria such Bacillus *spp, Proteus sp, Enterococcus sp, Micrococcous Pseudomonas sp, Staphylococcus sp* and *Coliforms* such as *E.coli*in *waste* dumpsite was not surprising. The most frequently occurring bacterial isolates recorded in Akure and Ondo were Bacillus *cereus*, *Bacillus* sp. and *Pseudomonas* sp. while the frequently occurring fungi for all the selected dumpsites were *Aspergillusniger*, *Penicilliumnotatum*and *Aspergillusfumigatus.*

Conclusion

This study showed the effect of waste on the microbiological and physicochemical qualities on the receiving environment and its potential impact on public health in the residential areas of the towns. As revealed in this study, *Bacillus* and *Aspergillus* species were the most prevalent microorganisms isolated from the dumpsites and studies have shown these organisms to be pathogenic in nature and could pose serious health risk to residents in and around the dumpsites.

Acknowledgement

The authors are grateful to the Department of Microbiology, Federal University of Technology, Akure (FUTA) for providing the laboratory facilities used in this study.

Conflict of Interest

The authors declared no conflict of interests

References

Adejumo TO. 2014. Microbial and physico-chemical analyses of five major dump sites and nearby water sources. Journal of Environment and Earth Science **4**, 165-179.

Akinbile OC. 2012.Environmental impact of landfill on groundwater quality and agricultural soils in Nigeria.Soil and Water Research 7, 18–26.

Antai, SP, Asitok AD, Tiku DR, Louis OI. 2016. Microbiological analysis and solid waste biodegradation potential among some selected isolates from municipal dumpsite in Calabar municipality, Cross River State. International Journal of Innovative Science, Engineering & Technology 2, 1463-1478.

APHA. 2005. Standard Methods for the Examination of Water and Waste Water. American Public Health Association, Washington, DC. 21, 1020-3500.

Arotupin DJ, Olalemi AS, Ijabamido DM. 2013.Evaluation of bacteria and physicochemical qualities of tar sand soil from gbelejuloda, Ondo-State, Nigeria. Federal University of Technology, Akure, Journal of Research in Sciences 9, 118-122.

Babayemi JO, Dauda KT. 2009. Evaluation of solid waste generation categories and disposal.Journal of Applied Sciences and Environmental Management 13, 83–88.

Barnett HL, Hunter BB. 1975. Illustrated Genera of Imperfect Fungi. 3rd Edn. Burgess Publishing Co. New York. 225.

Bowmen JP, McCammon SA, Brown MV, Nicholas DS, McMeekin TA. 1997. Diversity and Association of Bacteria in Antarctic Soil. Applied Environmental.Microbiology 63, 3068-3078.

Buchanan RE, Gibbons NE. 1974.Bergey's Manual of Determinative Bacteriology 8th edition. TheWilliams and Wilkins company, Baltimore. 1246.

Girvan, MS, Bullimore J, Pretty JN, Osborn AM, Ball AS. 2003. Soil type is the primary determinant of the composition of the total and active bacterial communities in arable soils. Applied and Environmental Microbiology 69, 1800-1809.

Motsara MR, Roy RN. 2008. Guide to laboratory establishment for plant analysis. Food and Agriculture Organization of the United Nations, Rome. 204.

Nyle CB, Ray RN. 1999. The Nature and Properties of Soils. 12th Ed. United States of America. 835.

Obire O, Nwabueta O, Adue B.2002. Microbial community of a waste dump site. Journal of Applied Science and Environmental Management 6, 78 – 83.

Ogban ME, Akuruju VA. 2016. The stigmatization of residential properties due to proximity to waste dump. International Journal of Research in Business Management 4, 37-46.

Ogunmodede OT, Ajayi OO, Amoo A, Adewole E. 2013. Characterization of Dumpsite Soil: Case Study of Ado-Ekiti and Ijero-Ekiti, Nigeria. Journal of Environmental Science, Toxicology and Food Technology 3, 43-50.

Ogwueleka TC.2009. Municipal solid waste characteristics and management in Nigeria. Iranian Journal Environmental Health Sciences Engineering 6, 173-180.

Okoronkwo NE, Odemelam SA, Ano OA. 2006. Levels of toxic elements in soils of abandoned waste dump site. African Journal of Biotechnology 5, 1241-1244.

Olutiola PO, Famurewa O, Sontag HE. 1991. An introduction to General Microbiology, a practical Approach HeidebergerVerlagsanstalt and Druckerei GmbH HeldelbergGmbh, Germany.

Osazee OJ, Obayagbona ON, Daniel EO. 2013. Microbiological and physicochemical analyses of top soils obtained from four municipal waste dumpsites in Benin City, Nigeria. International Journal of Microbiology and Mycology 1, 23-30.

Oyedele DJ, Gasu MB, Awotoye OO.2008. Changes in soil properties and plant uptake of heavy metals on selected municipal solid waste dump sites in Ile-Ife, Nigeria. African Journal of Environmental Science and Technology 3, 107-115.

Rushton L. 2003. Health hazards and waste management. British Medical Bulletin 68, 183-197.

Sharma K. 2008. Manual of Microbiology.Ane Books. Pvt. Limited. New Delhi, 405.

Siboe HA, Lewis DL, Gattie DK. 2002. Pathogen risks from applying sewage sludge to land. Environmental Science Technology Journal 36, 286-293.

Ye-Obong U, Adedibu AA. 2008. Environmental problems associated with urbanisation of rural areas in Nigeria. Environmental Issues 15, 229 – 235.