

Assessment of Microbial Contamination of Groundwater Near Solid Waste Dumpsites in Basement Complex Formation, using Total Plate Count Method

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Abstract: Microbial analysis of water samples collected from two selected dumpsites within Ibadan metropolis were carried out in order to ascertain the effects of leachates generated by dumpsite on groundwater quality. Water samples were collected from surrounding wells and stream near Aba-Eku and Ajakanga solid waste landfill sites in Southwestern part of Nigeria. The samples were analysed for coliform count and Escherichia Coli through total plate count method. The result of the microbial analysis reveals high presence of coliform in all the water samples while two wells around Aba Eku dumpsite have E. Coli presence and none is detected in wells and stream around Ajakanga landfill. High values of microbial counts are principal indicators of suitability of water for domestic purpose and also sign of groundwater contamination in the surrounding wells. The sign of groundwater contamination was noticed in many surrounding wells around the two dumpsites resulting in high number of coliform bacteria. The presence of E. coli in wells 2 and 7 in Aba Eku requires control measures before consumption.

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Introduction

Solid wastes are produced everyday in urban societies as a result of human activities and in an attempt to dispose off these materials; man has carelessly polluted the environment. Classical unlined sanitary landfills and open dumps are well known to release large amount of hazardous and otherwise deleterious chemicals to nearby groundwater, surface water, soil and air through leachate and landfill gases respectively. Leachate generated as a result of solid waste anaerobic decomposition may seep from the landfill site into underground aquifers thereby polluting water resources (Bhuiya et al., 2002, Tesfaye, 2007). Besides the effect of leachate on groundwater, solid wastes dumped on landfill causes various aesthetic and public health problems by attracting insects, rodents and various disease vectors (Egunjobi, 1986, Olayinka and Olayiwola, 2001). This is especially the case in developing countries.

Solid waste disposal in Ibadan city located in southwestern part of Nigeria has become a growing problem in the area of groundwater resources and this requires environmental impact assessment of the area.

Ibadan city currently generate about 1,618,293kg of solid waste daily with high probability of increase in the volume of these wastes as years come by (CPE, 2010). Waste management in Ibadan is characterized by inefficient collection, insufficient coverage of the collection system and improper disposal of solid waste. Ibadan however, suffers serious water supply problems, because of inadequate supply of pipe borne water and cases of dry taps are common virtually in every part of the city (Ifabiyi, 2008). Hence, many homes have hand-dug wells as alternative source of potable water. Siting of dumpsite near the residential area have high chances of polluting the surrounding wells through the migration of leachate into the underground aquifer. Therefore, there is need to protect these alternative sources from adverse effects of landfill wastes.

McGraw-Hill (1992) reported that various bacteria, protozoa, algae, fungi viruses and animal parasites, some of which are potentially pathogenic may be found in potable water. Microbial faecal contamination indicators are Escherichia coli, Salmonella spp. Shigella, Streptococci, Clostridia spp

(Binni et al., 2002, Scott et al, 2002) and other class of bacteria that could be of human or non human origin. E-coli especially those possessing haemolysin, vero cytotoxin and those belonging to entero pathogenic serotypes have been responsible for gastroenteritis in human (Bell et al., 1994; Griffin and Tanxen, 1991).

This study therefore seeks to assess the bacteriological quality of groundwater and surface water near Aba-Eku and Ajakanga landfills through the use of Total Plate count method.

Study Area

The study areas were two active landfill sites situated within Ibadan metropolis. These are Aba-Eku and Ajakanga landfills. Aba Eku landfill is located along Akanran road in Ona Ara Local Government area. This landfill was established in 1998 and located approximately on Latitude $3^{\circ} 59' 009''$ N and $30^{\circ} 59' 973''$ N and longitude $7^{\circ} 19' 270''$ E and $7^{\circ} 19' 843''$ E. Ajakanga landfill is located along Odo Ona Elewe road in Oluyole Local Government Area between latitude $3^{\circ} 50' 187''$ N and $3^{\circ} 50' 696''$ N and longitude $7^{\circ} 18' 021''$ E and $7^{\circ} 18' 997''$ E, established in 1996. The two study area falls within the humid and sub humid tropical climate of South western Nigeria with a

mean annual rainfall of about 1230mm and mean maximum temperature of 32°C .

The basement complex rocks in Ibadan area are mainly the metamorphic rocks of Precambrian age with few intrusions of granites and porphyries of Jurassic age.

The dominant rock types are quartzites of the meta-sedimentary series and banded gneisses, augen gneisses and migmatites, which constitute the gneiss-migmatite complex. Other minor rock types include pegmatites, quartz, aplites, dolerite dykes, amphibolites and xenoliths (Aizebeokhai, 2010). In most parts of Ibadan, the rocks are overlain by the weathered regolith, thus, outcrops are correspondingly few (as shown in Figure 1). Banded gneiss constitutes over 75% of the rocks in and around Ibadan while augen gneisses and quartzites share the remaining in about equal percentages (Okunlola et al., 2009).

The area is within the humid tropics with a mean rainfall of 1,237 mm (Akintola, 1986). The climate is characterized by two seasons, namely, the rainy season (April – October) and the dry season (November – March). Most of the precipitation is received during the rainy season.

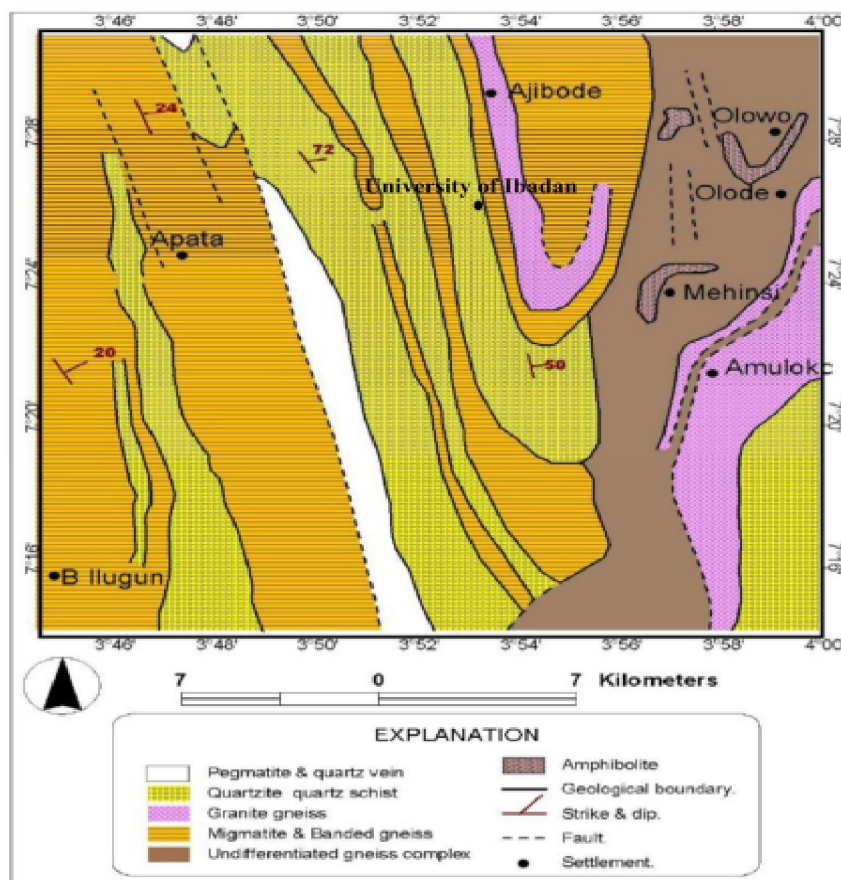


Figure 1: Generalized geological map of Ibadan (after Okunlola et al., 2009)

Materials And Method

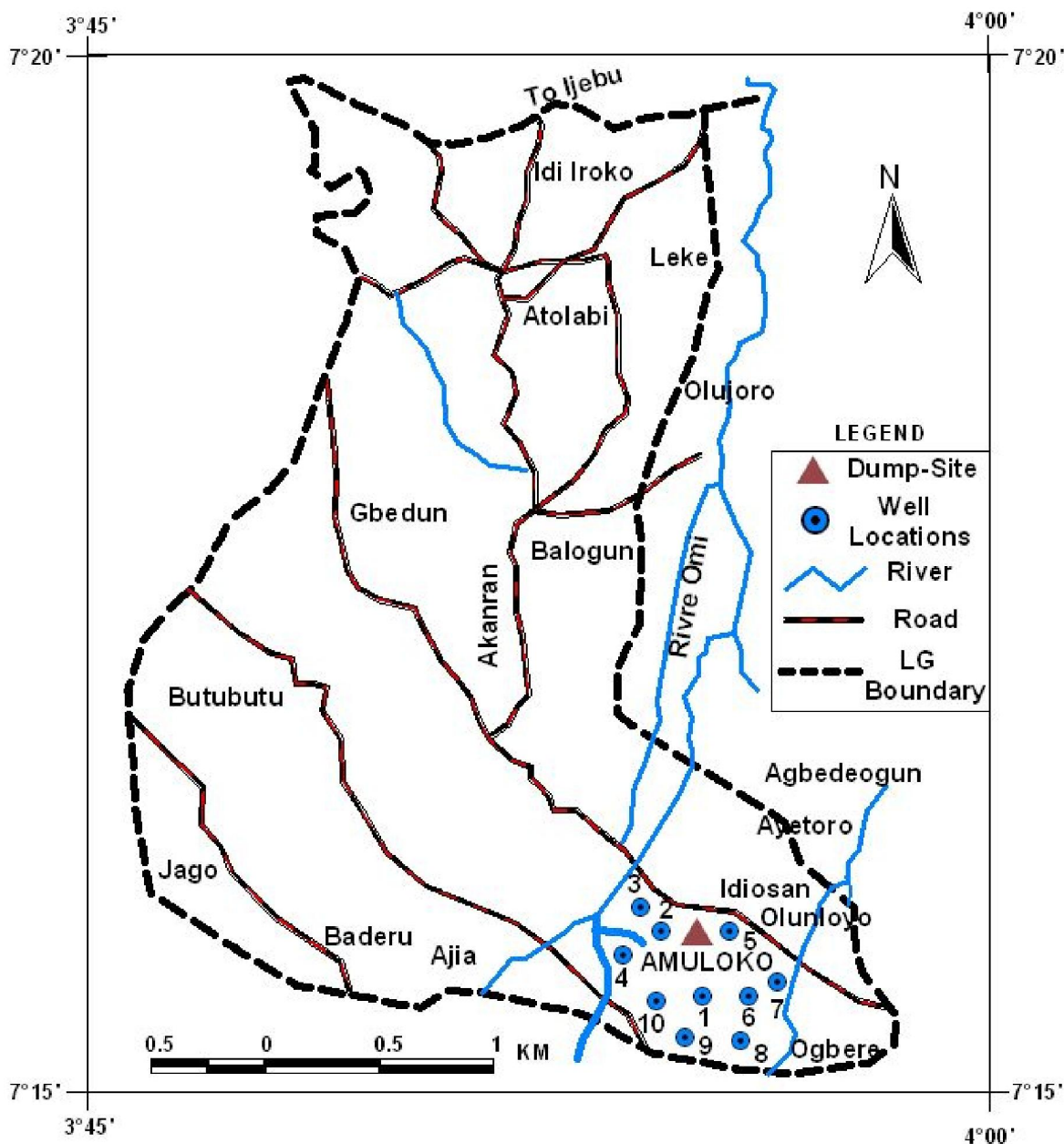


Figure 2: Map of Aba Eku Dumpsite and water samples locations

In each study area, Ten groundwater samples were collected from hand-dug wells around each landfill site making twenty samples for the two sites in March, 2013. Sample 1- 10 were collected from hand-dug wells around Aba-Eku dumpsite while samples 11-20 were collected within Ajakanga dumpsite. Each water sample was collected inside a sterile 20ml bottle. After collection, they were transported to the laboratory on Ice in order to maintain the microbial population for proper microbial analysis. A hand held Garmin Etrex GPS was used to record the geographic location of the

sampling points. The locations of sampling points in each dumpsite are shown in Figure 2 and 3 respectively. The samples collected were taken to the microbiology laboratory of the Department of Microbiology, Federal University of Agriculture, Abeokuta (FUNAAB), Ogun State, Nigeria for microbial analysis. Coliform and E.Coli were microbial parameters analysed for this study. The Mac Conkey Agar was used for the detection of Coliform while Eosine methylenes Blue Agar (EMBA) were used for E-coli count. The total plate count method was used in

the counting of microbial organism. The samples were serially diluted to 10^{-2} . Using the standard plate method, 0.5ml of each of the dilution water sample was placed into separate and properly labelled petri dishes. The prepared media of Mc Conkey Agar and EMBA

were separately poured over the samples in petri dishes. This was then swirled for proper mixing before incubated at 37°C for 24hrs. For the coliform count, only lactose fermenters (pink colonies) were counted by counting the colonies directly (Olutiola et al., 1991).

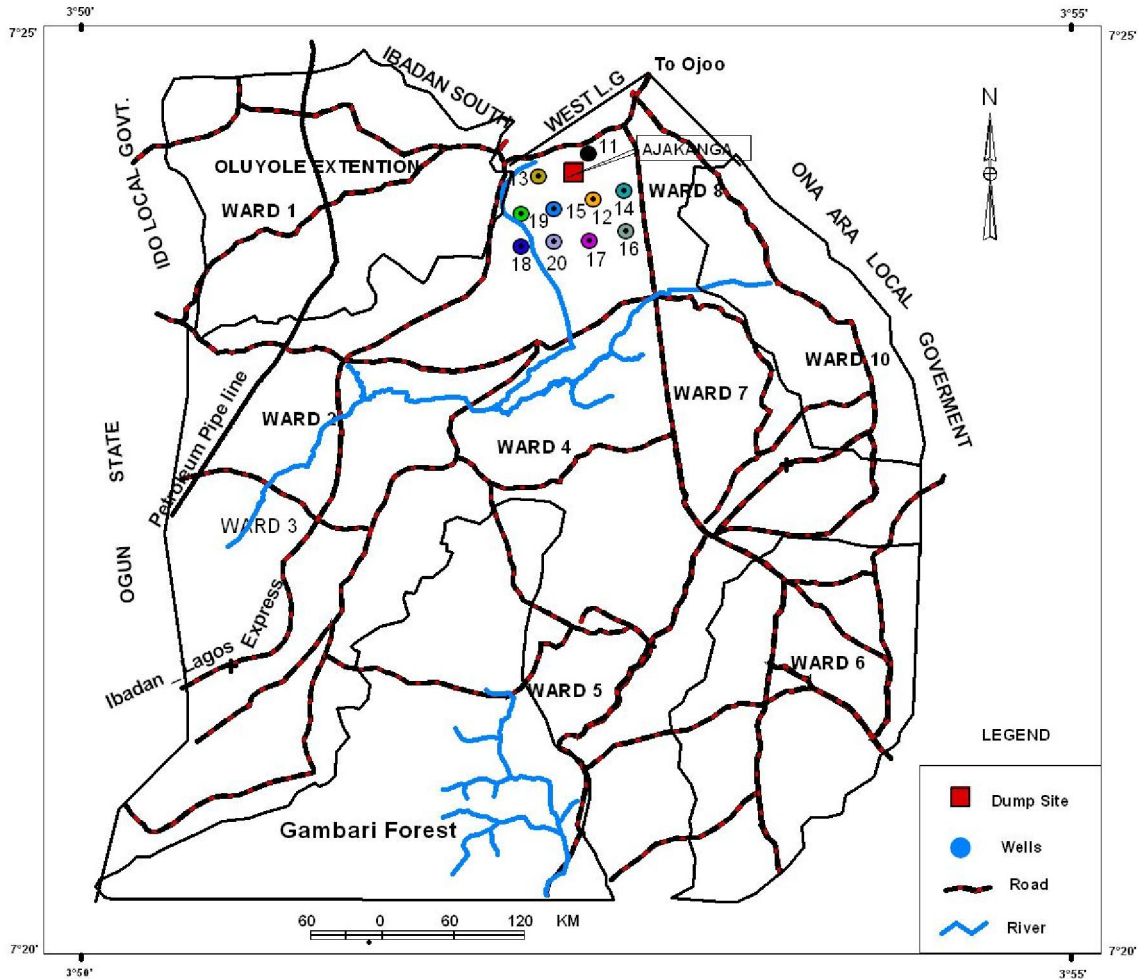


Figure 3: Map of Ajakanga Dumpsite and Water sampling locations

Results And Discussions

The results of microbial analysis of all the samples in the two landfill sites were as shown in Table i. It was observed that all the water samples from the two study areas were contaminated with coliforms while two wells (wells 2 and 7) in Aba-Eku area have E.coli presence. There is no presence of E.coli in all wells and stream around Ajakanga landfill. All the values obtained were far above the World Health Organisation (WHO) and United State Environmental Protection Agency (USEPA) standards. Presence of E-coli is an indication of fecal contamination and associated with water borne epidemic thereby rendering the water samples unfit for human consumption (Mackenzie et al., 1995).

The presence of E.coli in wells 2 and 7 of Aba-

Eku area may be due to unhygienic practices of inhabitants using these two wells. For instance, E-coli presence in well 2 which is about 30m from the landfill may not be primarily due to leachate migration but also due to human activities such as open defecation and bathing. This is consistent with the findings of (Shimizu et al. 1980) that more microbial activities were found in wells close to organic wastes in Japan. Besides the distance of well 2 to Aba-Eku landfill, there is an open defecation practice, bathing and washing of clothes near the well by people living around it during sampling period. These poor sanitary practices around the well may also introduce bacteria into the water. The major diseases that could arise from bacteriologically contaminated groundwater include typhoid, diarrhea

and cholera (Victoria and Ismail, 2011). The presence of E.coli in well 7, about 200m from the dumpsite, may be due to unhygienic condition of the well as rearing of goats and hens, animal faeces were noticed close to this well during the sampling period. These two wells need to be taken care of by adopting proper control measures such as chlorination, disinfection of well, boiling the water, proper hygienic practice and good sewage treatment (Ogedengbe and Akinbile, 2007) before use for domestic consumption.

It was observed that out of all the twenty water samples analysed for this research work, none of the samples was able to satisfy the minimum required condition for potability of water meant for public consumption according to WHO specification of 100cfu per ml of drinking water. These high values of coliform count obtained in all the samples are similar to values on earlier work conducted by Fabiyi (2008), Akinbile and Yusoff (2011). Adejuwon and Mbuk (2011) in basement complex terrain.

Other factors such as the geology of the area where the well was sited, level of hygiene of the well, absence of protective embankment thereby making the well prone to bacterial contamination due to run-off and the population of people the well is serving could be considered as possible sources of contamination apart from dumpsite leachate (Ifabiyi, 2008, Victoria and Ismail, 2011). Also high level of coliform count and presence of E.coli in two wells around Aba-Eku dumpsite over that of Ajakanga area may follows from the lithological results obtained from Vertical Electrical Sounding (VES) data interpretations of the two sites (Aba Eku and Ajakanga) done earlier by (Ibitola et. al. 2011) where groundwater percolation at Aba Eku landfill site travels faster through the vadoze zone than that of Ajakanga landfill

Conclusion

The study reveals high values of coliform counts in all samples collected around the selected landfills. The values obtained were far above WHO and USEPA standard. This indicates poor human waste management system of the inhabitants around the two study areas, such as bathing, shallow pit toilet and open defecation. These high values of coliform count and presence of E.coli in few wells in Aba-Eku area should be of great concern to inhabitants living around these two dumpsites. This is because E.coli and coliform in water indicate recent fecal contamination and may indicate possible presence of disease causing pathogens such as bacteria, viruses and parasites. Remedial measures suggested should be adopted to reduce groundwater contamination through leachate percolation and unhygienic practices.

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Table 1: Result of total microbial counts of the water samples

Sample code	Coliform (cfu/ml)	E-Coli
S ₁	1.36 x 10 ⁴	0
S ₂	1.52 x 10 ⁴	1
S ₃	1.96 x 10 ⁴	0
S ₄	2.4 x 10 ³	0
S ₅	1.92 x 10 ⁴	0
S ₆	2.98 x 10 ⁴	0
S ₇	2.00 x 10 ⁴	2
S ₈	1.36 x 10 ⁴	0
S ₉	1.72 x 10 ⁴	0
S ₁₀	1.84 x 10 ⁴	0
S ₁₁	1.14 x 10 ⁴	0
S ₁₂	9.2 x 10 ³	0
S ₁₃	5.2 x 10 ³	0
S ₁₄	2.2 x 10 ³	0
S ₁₅	1.24 x 10 ⁴	0
S ₁₆	1.42 x 10 ⁴	0
S ₁₇	1.68 x 10 ⁴	0
S ₁₈	7.6 x 10 ³	0
S ₁₉	1.38 x 10 ⁴	0
S ₂₀	1.72 x 10 ⁴	0

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