

GROUND WATER USE NEAR AN OPEN DUMPSITE IN A PERI-URBAN COMMUNITY

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ABSTRACT

Quality of groundwater used for drinking and domestic purposes near an open dumpsite was investigated. Groundwater parameters for wells GW1, GW2, GW3 and GW4 were analysed and their values were compared with World Health Organization (WHO) and Nigerian Standard for Drinking Water Quality (NSDWQ). Physico-chemical and bacteriological analysis were carried out to determine the quality. Parameters analysed include; Temperature, Turbidity, Total Hardness, pH, Alkalinity, Electrical Conductivity, Total Dissolved Solids, Total Suspended Solids, Total Solids, Magnesium, E-coli, Calcium, Nitrate, BOD, COD, DO, Chloride, Sulphate, Iron, Manganese and Lead. The results indicated that all parameters except turbidity, iron and lead were within the standards, all samples showed high concentration of iron and lead while GW1, GW2 and GW3 showed high Turbidity. The study concluded that groundwater situated around the dumpsite is unfit for drinking purposes. An engineered landfill located away from residential community was recommended.

Keywords: Groundwater, Safe water, Water analysis, Drinking water, Domestic water, Open dumpsite

INTRODUCTION

Waste disposed in open dumpsites can be subjected to infiltration from precipitation. As water percolates through the waste, it picks up a variety of organic and inorganic compounds flowing out of the waste and accumulates at the bottom of the dumpsites as leachates (Mokuolu *et al.*, 2017; Akinbile *et al.* 2016; Aderemi *et al.* 2011; Longe and Balogun 2010). Leachates are the liquid discharge of dumps and landfills, they are composed of rotted organic wastes, liquid wastes, infiltrated rainwater and extracts of soluble material. The impact of dumpsite leachates on groundwater has attracted a lot of attention because of its overwhelming

environmental significance. Over time, areas near the dumpsite have greater possibility of groundwater contamination because of the potential pollution source of leachate originating from the nearby site (Tiware *et al.* 2017). Such contamination of groundwater poses a substantial risk to local resource users and to the natural environment; Four thousand children die on a daily basis as a consequence of diseases caused by digestion of contaminated water (Md.Lookman *et al.* 2014; Lo-Karija *et al.* 2013;)

In Ilorin metropolis, open dumping is the major form of solid waste disposal which is now a pollution source to the air, groundwater and surface water. Due to the inadequate supply of the Kwara state Water Corporation, access to potable water in major cities of the state has been ever-

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increasingly difficult. More than 70% of the population lack access to improved water sources (World Bank, Nigeria 2000), hence the population solely depends on boreholes and hand dug wells. Groundwater quality assessment is important to check for the presence of contaminants and monitoring before usage to prevent the consumers from harm, research has shown that soil stratigraphy significantly influences contaminants in ground water (Abd El-Salam and Abu-Zuid, 2015; Md *et al.* 2014; Aderemi *et al.* 2011). This study was therefore designed to critically study the effects of the dumpsite on the Groundwater being used for drinking and other domestic uses at Ago market, Ilorin South local Government area of Kwara State as a case study

METHODOLOGY

Description of the Study Area

Study area is Ilorin, the capital city of Kwara state, Nigeria which came into being on the 27th May 1967. It lies on latitude 8°35'East and longitude 4°35'North (Route, 2015). It has an area of about of 32,500km²

Baseline information

Reconnaissance survey was carried out in order to identify the location of groundwater structures around the open dumpsite. The open dumpsite is the only source of waste disposal in the community and the composition of waste materials in the dump site comprises of mostly paper, plastics, scraps, nylon, agricultural waste, human excreta and so on (Figure 2). Four hand dug wells were found close to the

dump site used for drinking and domestic purposes and they were tagged GW1, GW2, GW3, and GW4 (Figures 3 – 6). The internal and external diameter of the wells, the height of the ring above the ground surface, the depth of well, and the distance of the well to the dumpsites were measured during the survey before the water samples were collected as indicated in Table 1.

Collection of water samples

A case study research method was adopted for water



FIGURE 2
The dumpsite under study



FIGURE 1
Study area



FIGURE 3
GW1



FIGURE 4
GW2



FIGURE 6
GW4



FIGURE 5
GW3

samples from the four ground wells. Samples were taken in the morning at 6AM, in the afternoon at 12noon, and evening at 6PM. One sample each was taken at a time. A total of 12 samples were taken altogether.

The following procedure was observed for each sample collected: One litre (1L) of water sample was collected into plastic bottles that were earlier washed with non-ionic detergent and rinsed with distilled water prior to collection, the bottles were rinsed three times with well water at the point of collection (Longe and Balogun, 2010). During collection, each bottle was kept under the surface of water, to

eliminate the impurities floating on the surface. Care was taken to avoid bubbling during sampling. The test for temperature with the use of a clinical thermometer was carried out immediately when the samples were taken without delay to avoid temperature rise and fall. The test for the pH was taken immediately after the temperature reading has been taken using the electrode method. The geographical location of each groundwater structure was determined using a GPS device. Each sample was labelled according to the location and the time, preserved at 4°C and transported to the Chemistry Laboratory, University of Ilorin to determine the physicochemical and bacteriological parameters in each sample in accordance with the standard chemical and analytical procedure detail of which were contained in the World Health Organization and standard methods of examination of water and waste water (Mokuolu *et al.* 2017: WHO, 2004).

The following parameters were evaluated in each water sample; Temperature, pH, Electrical Conductivity (EC), Alkalinity, Turbidity, Total Dissolved Solids, Total Suspended Solids, Total Solids, Chloride (Cl^-), Hardness, Iron (Fe), Lead (Pb), Calcium (Ca), Magnesium (Mg), Sulphate (SO_4^{2-}), Nitrate (NO_3^-), Manganese (Mn), BOD, COD, DO and E-coli.

RESULTS AND DISCUSSION

Results

Outcome of Laboratory analysis of the water samples are shown on Table 2.

TABLE 1
The sample Location and well characteristics

	GW 1	GW 2	GW 3	GW 4
Internal diameter (m)	1.00	0.90	1.23	1.40
External diameter (m)	1.40	1.25	1.55	1.80
Depth of water (m)	3.60	1.20	1.27	1.00
Distance of well to the dumpsite (m)	13.60	14.50	36.00	51.00

TABLE 2
Average result of the Physicochemical and Bacteriological parameters for the water samples

S/N	Measured Parameters	Samples				Standards	
		Mean GW1(SD)	Mean GW2(SD)	Mean GW3(SD)	Mean GW4(SD)	NSDWQ	WHO
1	Temperature (°c)	26.00(0.10)	28.00(0.12)	27.30(0.20)	27.80(0.26)	Ambient	Ambient
2	Turbidity (NTU)	6.55(0.56)	5.70(0.17)	5.20(0.10)	4.90(0.05)	5	5
3	Alkalinity (mg/l)	4.60(0.08)	4.30(0.07)	4.10(0.16)	3.90(0.17)	NS	100
4	Electrical Conductivity (µs/cm)	124.60(8.26)	118.40(1.91)	112.30(4.61)	108.50(1.65)	1000	600
5	pH	6.55(0.05)	6.58(0.02)	6.62(0.03)	6.68(0.13)	6.5-8.5	6.5-8.5
6	TS (mg/l)	27.70(5.18)	24.60(2.00)	21.60(0.64)	20.70(1.16)	NS	NS
7	TDS (mg/l)	9.30(2.12)	8.40(2.95)	6.60(4.52)	6.50(4.50)	500	500
8	TSS (mg/l)	18.40(6.76)	16.20(4.94)	15.00(4.08)	14.20(3.41)	NS	500
9	DO (mg/l)	171.20(25.79)	190.40(5.60)	118.40(65.13)	136.00(41.70)	NS	5
10	BOD (mg/l)	26.50(7.09)	25.80(7.04)	24.10(7.69)	24.00(5.72)	NS	5
11	COD (mg/l)	5.30(0.09)	4.80(0.10)	4.40(0.13)	3.80(0.52)	NS	10
12	Calcium ion (mg/l)	2.20(0.25)	2.10(0.06)	1.98(0.11)	1.90(0.34)	75	75
13	Magnesium ion (mg/l)	2.55(0.45)	2.40(0.20)	2.22(0.24)	2.05(0.30)	0.20	NS

Discussion

The results and comparison of the sample parameters with the World Health Organization (WHO) and Nigerian Standard for Drinking Water Quality (NSDWQ) are presented in Table 2. These comparison helps to ascertain if the water samples are within the permissible standards limits. *pH and Alkalinity of Water.* pH is the indicator of acidic or alkaline condition of water status. The pH of the water samples ranged from 6.55- 6.68 with all the values within the permissible limit of WHO and NSDWQ Standard. The pH values obtained show that the samples were acidic and also indicated the presence of metals in the samples. Metal such as lead from damaged battery cells and improperly disposed used cans of aerosol and other disinfectants, deposited in the landfill as waste, after exposure to air and water may have

found their ways to the well water levels through seepage to give that toxic, acidic nature it currently has (Akinbile and Yusoff, 2011). Neutral value 7.0, up to 9.2 may be tolerated, provided microbiological monitoring indicated no deterioration in bacteriological quality (WHO, 2004). The alkalinity values of the water samples range from 3.90- 4.60 mg/l, which is within the WHO permissible limit of 100 mg/l for typical drinking water.

Temperature. According to Oyelami *et al.* (2013), temperature is relatively high for most wells. Cool water is generally more palatable than warm water as water with high temperature improve micro-organisms growth and usually raises taste, odour, and colour (Ilori *et al.* 2019). Temperature value for this study ranged between 26°C and 28 °C. Therefore, they were found within permissible limit of WHO

standard (i.e. 30 °C). This conforms with the findings of Ilori *et al.* (2019).

Turbidity. The haziness of water caused by large numbers of individual particles that are generally invisible to the naked eye is referred to as turbidity. The turbidity readings of the samples were mostly above the WHO and NSDWQ standards with samples GW1, GW2, GW3 and GW4 having turbidity values of 6.55 NTU, 5.7 NTU, 5.2 NTU and 4.9 NTU respectively, hence need to be treated before usage. According to Akinbile and Yusoff (2011), unlined wells can contribute to high turbidity of the water in the well. Also, soil particles may have found their way into the wells from the unstable side walls, thereby raising turbidity of the water. The WHO recommends a value of 5 NTU (Nephelometric Turbidity Unit) as the maximum above which disinfection is unavoidable. The observed turbidity value in sample GW1 was slightly higher than the others, this may be due to nearness to the dumpsite, indicating higher sediment flow when compared with others (Akinbile and Yusoff, 2011).

Electrical Conductivity and TDS is a valuable indicator of the amount of materials dissolved in water. Conductivity ranges from 108.50 to 124.60 $\mu\text{S}/\text{cm}$ for the water samples. This shows a certain level of pollution from the effect of leachates from the dumpsite on the surrounding wells, this is due to closeness to the dumpsite (Oyelami *et al.* 2013). Though all conductivity and TDS values with ranges of 108.50 to 124.60 $\mu\text{S}/\text{cm}$ and 6.5 to 9.3 respectively, fall within the permissible limit of drinking water as prescribed by WHO and NSDWQ standard. The result suggests that the water around the dumpsite is believed to be polluted but not contaminated yet. The result agrees with the findings of Oyelami *et al.* (2013).

Chlorides. The values of Chloride detected in the water samples which ranged from 5.75 to 6.50 mg/l are within the limits for chloride in water (250 mg/l). Large concentrations increase the corrosiveness of water and in combination with sodium, give water a salty taste (David *et al.* 2017).

Total hardness. The hardness values in the water samples range from 3.95 to 150 mg/l which falls within the limit of drinking water as prescribed by WHO and NSDWQ limits. Values above 200 mg/l for total hardness (TH) do not have any associated adverse health related effects on humans but is an indication of deposits of Ca and/or Mg ions. Their presence will disallow water from forming lather with soap thereby preventing economic management of water resources (Akinbile and Yusoff, 2011). Calcium concentration ranges from 1.90 to 2.20 mg/l. Magnesium concentration ranges from 2.05 to 2.55 mg/l. Calcium and magnesium vary in all the well samples with a relatively low concentration, the presence of these two ions in groundwater identify with hardness of the water. Though all values are within the permissible limit of 75mg/l and 30mg/l for calcium and magnesium respectively.

Heavy metals. The trace metals detected in the water samples included iron, lead and manganese. Heavy metals in the water

samples indicate presence of toxic wastes in the landfill which could be from damaged battery cells, improperly disposed used cans of disinfectants and other materials with certain degree of toxicity deposited in the landfill as waste, which after exposure to air and water may have found their ways to the well water through seepage to give the toxic nature.

Iron and lead ranged from 0.408 to 0.440 mg/l and 0.012 to 0.020 mg/l respectively, these were above the standard limits for iron and lead in water. Iron and Manganese when present in groundwater can lead to change in coloration of groundwater (Rowe *et al.* 1995). The values of Manganese detected in the water samples ranged from 0.20- 0.026 mg/l were slightly above the standard limits for manganese in water (0.2 mg/l). In deep wells manganese may reach concentrations as high as 2 to 3 milligram per liter, this is because, solid waste when dissolved usually contains abundant manganese (Hughes, 2004). The harmful impact of heavy metals on the environment is linked with their solubility in soil which eventually found its way to the groundwater as a result of indiscriminate open dumping of waste (Ihedioha *et al.* 2017; Adewumi and Ajibade, 2015; Ogundiran and Osibajo, 2009) and becomes a threat to the human health via the food chain (Ahmed *et al.* 2018).

Bacteriological Result analysis. The microbiological characteristics of the samples were also investigated. The *Escherichia coli* bacteria was not detected in any of the samples analyzed. This suggests that there was no faecal pollution of human wastes from the surrounding landfill. Also, these results showed that all the samples satisfy the WHO and NSDWQ requirements for bacteriological characteristics of water for human consumption.

Sulphate. The sulphate concentration in the water samples vary from 70.55 mg/l to 88.60 mg/l which is low compared with the permissible limit of 200 mg/l and 100mg/l of WHO and NSDWQ respectively. According to Abdurafiu *et.al.* (2011), these show that the groundwater under review are free from possible sulphate toxicity which include gastrointestinal irritation.

BOD, COD and DO: A low BOD is an indicator of good quality water, while a high BOD indicates polluted water. The BOD values in the water samples vary from 24.00 to 26.50 mg/l. These values for BOD were much greater than the WHO standard of 5mg/l. This implies that the water samples were polluted. The values for COD in the samples also varied from 3.80 to 5.30 mg/l and these were within the permissible limit of 10 mg/l of WHO. The DO values were above 5mg/l in all the samples which implies oxygen depletion and also suggest, pollutants that use up the oxygen in water are present. High usage of the DO by the pollutants was observed and showed that the wells were unsafe for consumption.

Nitrate. According to Oyelami *et al.* (2013), the most highly oxidized form of nitrogen compounds is nitrate and is commonly present in surface and groundwaters because it is the end product of the aerobic decomposition of organic

nitrogenous matter. Uncontaminated natural waters mostly contain only minute quantities of nitrate. The nitrate concentration values in the study ranged from 2.00 to 2.90 mg/l as compared with 45 mg/l and 50 mg/l limit of WHO and NSDWQ respectively. In a study by Adeyemo *et al.* (2002), nitrate concentration of 0.1 mg/l to 10 mg/l was described as being in its natural concentration in groundwater.

CONCLUSION

The results of analysis showed that the following parameters: turbidity, iron and lead are above the permissible limit set by WHO and NSDWQ. The result also revealed that the quality of the groundwater resource underlying the Ago market dumpsite has been polluted and unfit for human consumption.

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