Quality Assessment of Drinking Well Water near Dumpsite at Ogidi-Oloje Ilorin, Kwara State, Nigeria

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ABSTRACT: This study was conducted to determine the quality of drinking well water near dumpsite at Ogidi-Oloje. Ilorin, Kwara State. Open wells near dumpsite could be polluted due to percolation of chemicals from the decomposition of refuse and scraps of electronic boards having potential of causing diseases to man. Most people at Ogidi-Oloje Ilorin depend on open wells near dumpsite for drinking water during dry season. Water samples were collected from seven open wells (W1 - W7) 9.2 - 18.2 m away from dumpsite and the control well W8 was 45.0 m away from the dumpsite. Physicochemical and bacteriological properties were determined from the water samples during dry season (March, 2019) and rainy season (July, 2019). Phosphate, Cadmium, Lead, Feacal coliform were not detected during dry season but only Feacal coliform was not detected in the water during rainy season. All the values of physicochemical properties of the water were within WHO permissible limits except Iron and Cadmium that above the limits which could cause diseases to mankind. Values of Iron during dry season for six well sources were 3.61, 4.02, 4.26, 3.25, 5.14 and 7.24 mg/L while values for rainy season and control were 0.715, 1.410, 0.650, 0.049, 0.780, 1.110 and 0.775 mg/L(control) but WHO limit is 0.03mg/L. Concentrations of Cadmium in the water during rainy season were 0.010, 0.015, 0.015, 0.020, 0.015, 0.015 and 0.02mg/L(control) but WHO limit is 0.003 mg/L. This study revealed that the water is suitable for consumption during dry season but unsuitable during rainy season.

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INTRODUCTION

Water is one of the most essential natural resources that is indispensable for survival of human race and the demand for potable water is increasing due to the population growth. Potable water is the water that is safe for consumption without causing any disease to man because it is free from pathogens and chemical constituents are within the acceptable limits. Major sources of water for domestics uses are rivers, ponds, lake, spring, rain water and underground water. Contaminated water can cause water-borne diseases such as typhoid, cholera, dysentery and some other diseases (Hammer and Hammer, 2012). World Health Organisation (WHO, accessed on 22th November, 2019) reported that 3.4 million people mostly children died annually due water related diseases. Water is normally scarce during dry season in Ilorin and some people at Ogidi-Oloje, Ilorin, Kwara state, Nigeria mostly depend on open well within their vicinity as the source of water for consumption and other domestic uses. Some of the open wells at Ogidi-Oloje, Ilorin are very close to domestic dumpsite from which the percolating leachate from the dumpsite could pollute the underground water. Areas that are close to dumpsites or landfills have a greater possibility of groundwater contamination because of the pollution by the leachate from the nearby dumpsites. Contaminated water from the dumpsite is toxic to man which could cause cancer and other diseases if the water has high concentration of heavy metals. There is need to determine the quality of the open well water at Ogidi-Oloje that are very close to the dumpsites to create awareness for people in the area. In Nigeria, open dumping site for domestic waste is commonly adopted both in the rural areas and cities because it is cheap and, in most cases, people don’t pay for dumping solid waste at the dumpsite. Al Sabahi et al. (2009) pointed out that open dumpsite is an oldest method of solid waste disposal which is still commonly used in the cities of developing countries. Charles et al. (2013) stated that waste disposal and waste management is still a major problem in some developing countries like Nigeria because solid wastes are disposed indiscriminately at open dumping site and not properly managed. Oyelami et al. (2013) reported
that percolation of leachate from the dumpsite could lead to serious pollution and contamination of groundwater. Soils behave like a natural sink for pollutants that are released from both natural and anthropogenic sources. Vandana-Partha et al. (2011) reported that decomposition of organic matter in the refuse changes the physicochemical properties of the soil and percolation of leachate could pollute the groundwater. The assessment of soil and groundwater pollution is complex because of the different sources of the pollutants and their variability (Vandana-Partha et al., 2011). Yusuf and Suleiman (2016) found out that water from 10 borehole locations at Sango ward Ilorin, Kwara state contained some heavy metals that were above WHO Standards due to human activities and dumping of refuse close to the boreholes. Drinking of water containing high concentration of some heavy metals such as Cadmium, Chromium, Lead, Manganese and Zinc could cause cancer, kidney disease, mental disorder at infants, neurological disorder and hypertension (SON, 2007). Olatunji (2015) pointed out that quality of underground water depends on the quality of recharge water, atmospheric precipitation, in-land surface water and sub-surface geochemical process. Quality and quantity of chemical constituents of water depends on geologic and ecological factors due to the activities of man on the land. Olatunji (2012) reported that geological formation of the study area in Ilorin is composed of the weathered, partly weathered and fresh crystalline basement rocks. The area underlies by rocks mainly porphyritic granite, gneiss and granite-gneiss and quartz-schist (Olatunji, 2012). Adekeye (2001) also reported that over 80 % of Kwara State in which Ilorin is inclusive as the state capital is underlain by crystalline precambrian basement rocks while the remaining part is underlain by cretaceous and younger sediments. The rocks of the basement complex include granites, amphibolites, granites gneiss, biotite gneiss, migmaticites while the younger sediments consist of the alternating beds of sand stones, shales and clays (Adekeye, 2001). The top soil of the study area is sandy loam followed by clay soil.

Longe and Balogun (2010) pointed out that high concentration of nitrate has negative effect on infants less than three to six months of age. Nitrate could also be reduced to nitrite which could oxidize haemoglobin to methaemoglobin and this could affect the transportation of oxygen in the body system (Longe and Balogun, 2010). Sugirtharan and Rajendran (2015) concluded that leachate slowly percolates through soil and pollutes the groundwater resource which adversely affect the well water (groundwater) within the vicinity by pollution and make the water not suitable for drinking. Sugirtharan and Rajendran (2015) recommended that an effective management programme of existing open dumping site and the landfill were necessary to control the environmental pollution. The objective of this study was to determine the quality of water from open wells at Ogidi-Oloje Ilorin, Kwara State, Nigeria near dumpsites.

**MATERIALS AND METHODS**

*Location of the study:* The study was conducted at Ogidi-Oloje, Ilorin, kwara State, Nigeria during dry season (March, 2019) and rainy season (July, 2019). Ilorin lies on latitude 8°30’N and longitude 4°35’ E at an elevation of about 340 m above mean sea level (Ejieji and Adeniran, 2009). Ilorin is in the Southern Guinea Savannah Ecological Zone of Nigeria with mean annual rainfall of about 1300 mm. The wet season begins towards the end of March and ends in October while the dry season starts in November and ends in March (Ogunlela, 2001). The location of Ogidi-Oloje, Ilorin is shown on the map of Kwara State as shown in Figure 1. Table 1 shows some physicochemical and bacteriological properties of drinking water and their health implication when the parameters above permissible limit as given by SON (2007).

![Fig 1. Location of Ogidi-Oloje on the map of Ilorin West from the map of Kwara State. Source: WHO (Accessed on 22th November, 2019)](image)

**Computation of paired t-test statistical analysis for this study:** A paired t-test statistical analysis was used in this study to check if the effect of nearness or closeness of the open wells to the dumpsite was statistically significant or not on the quality of the water in the well. The difference between the two mean of the water quality based on the chemical parameters of the water was used to determine the mean, standard deviation, standard error and value of t-test using Equations (1), (2a) or (2b), (3) and (4), respectively as given by Montgomery (1998).

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Water samples collection and analyses: For this study, water samples were collected from seven (7) open wells that are available within the vicinity and close to the dumpsites in the study area. Water samples were collected from six (6) wells during dry season (March, 2019) but from seven (7) wells during rainy season (July, 2019). The distance of the wells to the dumpsites varied from 9.2 to 45.0 m with 45.0 m serves as the control because that was only open well far away from the dumpsite that could be assessed with the permission of the owner. Locations of the wells and the distance of the wells to the dumpsites are shown in Table 2 for details.

Water samples were collected using cleaned plastic bottles which had been washed with a detergent, rinsed with distilled water, 1:1 nitric acid solution and then rinsed with distilled water (cadmium – free de-mineralized water). The water samples were digested within 6 hours by addition of 5 mL concentrated nitric acid to preserve the water for a longer period against any decomposition by bacteria before chemical analysis of the water. All physicochemical properties of the water including Cadmium, Lead, Manganese and Iron were determined using the Standard Methods for the Examination of Water and Wastewater by American Public Health Association (APHA, 2005). The instruments used during the determination of the physicochemical and bacteriological parameters were Water Engineering Kit by Hach (DREL/5), multi-parameter bench-photometer by Hanna (HI83200), pH meter and conductivity meter.

The data used for the computation of the paired t-test as an illustration in this study were extracted from Table 5 (Chemical parameters of water closest to dumpsite 45.0 m which is W2 and W7 which is far away from the dumpsite 45 m during rainy season) and presented in Table 3. The calculated values of the t-test and that of table values of the t-test were compared if the effect of nearness to dumpsite was statistically significant on the water quality in this study or not.

\[
d = \frac{\sum d^2 - n(\bar{d})^2}{n - 1}
\]

\[
d = \sqrt{\frac{\sum (d - \bar{d})^2}{n - 1}}
\]

\[
\delta = \frac{\delta}{\sqrt{n}}
\]

\[
t_{cal} = \frac{\bar{d}}{\delta_{er}}
\]
Where $\bar{d}$ is the mean of the difference from the data $x_1$ and $x_2$, $\Sigma d$ is the summation of $d$, $n$ is the number of the observations, $\delta$ is the standard deviation, $\delta_0$ is the calculated value of $t$ at $\alpha = 5\%$ significant level which is equivalent to $2.5\%$ for paired t-test ($\alpha = 0.05/2 = 0.025$).

Table 3. Chemical properties of water used for computation of the paired t-test

| Parameter     | $W_1$ | $W_2$ | $d = W_1 - W_2$ | $d^2$ |
|---------------|-------|-------|-----------------|-------|
| Nitrate       | 8.80  | 6.95  | 1.850           | 3.42250|
| Phosphate     | 1.60  | 2.50  | -0.700          | 0.49000|
| Chloride      | 26.25 | 27.75 | -1.500          | 2.25000|
| Magnesium     | 26.75 | 26.20 | 0.550           | 0.30250|
| Iron          | 1.410 | 0.775 | 0.635           | 0.40423|
| Calcium       | 40.15 | 29.30 | 10.850          | 117.72250|
| Manganese     | 0.030 | 0.040 | -0.010          | 0.00010|
| Lead          | 0.010 | 0.010 | 0.000           | 0.00000|
| Cadmium       | 0.015 | 0.020 | -0.005          | 0.00003|
| Total         |       |       | $\Sigma d = 11.670$ | $\Sigma d^2 = 124.592$ |

\[
\bar{d} = \frac{11.670}{9} = 1.291
\]  

\[
\delta = \sqrt{\frac{124.592 - 9(1.291)^2}{9 - 1}} = 3.701
\]  

\[
\delta_{er} = \frac{3.701}{\sqrt{9}} = 1.234
\]  

\[
t_{cal} = \frac{1.291}{1.234} = 1.046
\]  

However, the table value of t-test = 2.306

RESULTS AND DISCUSSION

The results of physicochemical and bacteriological properties of the water from six wells at Ogidi-Oloje, Ilorin during dry season (March, 2019) were presented in Table 4 while the results obtained in rainy season (July, 2019) from seven (7) wells were presented in Table 5. All the results of physicochemical properties of water assessed during dry season were within the WHO (1996) permissible limits except Iron that was above the permissible limit in all the 6 wells during dry season as shown in Table 4. The higher values of the concentration of Iron in the water could not cause disease to man according to SON (2007). The concentrations of Lead which could cause cancer and Manganese that could cause Neurological disorder were within the permissible limits of WHO (1996) and SON (2007) as presented in Table 4. Total faecal counts was not detected from the water during dry season which means that the faecal had been filtered by the soil profile before the water seeped or recuperated into the open wells. Total coliform counts were higher than the WHO (1996) permissible limits, although it could not cause any disease to man but it is an indication of traces of faecal contamination in the water. Cadmium which is toxic to kidney was not detected in all the well water during dry season. This means that the water from the six (6) wells are suitable for consumption during dry season.

The results of physicochemical properties of the well water during rainy season were higher than the values obtained during dry season. This was so because excess water from precipitation (rainfall) during rainy season dissolves more chemicals from the wastes at the dumpsite and wash down the chemicals through the soil profile to the groundwater (wells). There is no excess flow of water in the underground that could carry the chemicals to groundwater (well) during dry season. The concentration of Cadmium in all the seven wells water were above the permissible limit of WHO (1996) and SON (2007) and would make the water unsuitable for consumption during rainy season because Cadmium is toxic to kidney and could cause kidney disease. The concentration of nitrate at well $W_1$ (Well at Al-Jawahir 2) was higher during rainy season which could cause methemoglobinemia-the blue baby disease (Cyanosis) in infants and stomach disorder in adults as reported by SON (2007). The value of Cadmium was not detected during dry season because there was no migration of the Cadmium and other chemicals from the dumpsite into the wells and this would make the well water suitable for consumption during dry season when water is normally scarce at Ogidi-Oloje Ilorin. The decomposition of materials produced concentrated leachate, which could pollute surface and groundwater (Oyelola et al., 2009) during rainy season. Pollution of well water due to the effect of distance of the dumpsite to the well water by comparing two wells $W_2$ (9.2 m) and $W_1$ (45.0 m away from dumpsite which served as control) was not statistically significant in this study because the calculated value of paired t-test was 1.046 which is less than the Table value of t-test of 2.306 at $\alpha \leq 0.025$ (2.5%).

Conclusion: The physicochemical properties of the six wells water assessed during dry season were within the permissible limits of WHO and SON drinking water quality. The physicochemical properties of the seven wells water assessed during rainy season were higher than the values obtained during dry season and values of Cadmium during rainy season were above the permissible limits of WHO and SON. The water from the wells are suitable for consumption during dry season but not suitable for consumption during rainy season due to pollution by the leachate from the dumpsites. Excess water during rainy season help in carrying the contaminants in the leachate produced from the decomposition of refuse in the dumpsites and pollute the wells. It is recommended that more readings should be taken from January to December.
Government at all levels should legislate that dumpsite should be located far away from habitation and far away from wells with at least 1000 m away to prevent pollution of the groundwater.

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