ASSESSMENT OF GROUNDWATER QUALITY IN SHALLOW WELLS IN IKORODU LOCAL GOVERNMENT AREA OF LAGOS STATE, NIGERIA

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ABSTRACT

The study examined the physical, chemical and biological qualities of 15 existing shallow wells from 15 different communities in the Ikorodu Local Government Area of Lagos State. Samples were collected and analyzed following standard methods for the examination of water quality (APHA, 2005). Parameters studied include pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Turbidity, Total Hardness, Nitrate, Chloride, Sulphate, Calcium and Coliforms. Physicochemical parameters such as EC, TDS, nitrate, chloride and sulphate were within the limits set by the WHO. However, the water quality observed at Majidun shows that the concentration of calcium, total hardness and TDS were above acceptable limits. Also, e-coli were detected in samples from Majidun along with Gberigbe and Imota.

Keywords: Groundwater, Shallow wells, Ikorodu LGA, Water quality.

INTRODUCTION

The demand for water of sufficient quantity and quality for human consumption, sanitation, agriculture, and industrial uses will continue to intensify as the population increases and global urbanization, industrialization and commercial development accelerate (Flint, 2004). Hence, water resources management is one of the most important challenges the world is facing today. Groundwater is one of the major components of environmental resources that are under threat either from over exploitations or pollution, exacerbated by human activity on the earth's surface (Efe, 2001). Presently, there is a growing concern throughout the world about the contamination of groundwater as a result of human activities. Causes of groundwater contamination include use, spillage or disposal of pesticides, fertilizers, petroleum hydrocarbons, industrial chemicals and waste products. Contamination of groundwater resources can occur naturally over very long period of time, particularly in response to climate change. But the major cause of contamination by far is man's activity (Edward et al., 1983).

In the developing world of which Nigeria is a part, there is a heavy reliance on groundwater as a source of water for domestic use. This is necessitated by a lack of pipe-borne water particularly within the rural environment. In Lagos State for instance, 17 percent (17%) of the population use piped water (LASG, 2010). According to Ayoade (1975), water is still the most sought-after commodity in the rural areas of Nigeria and it ranks very highly on the people's scale of developmental preferences. As a result, people have resorted to various ways of accessing the resource such as the digging of shallow wells. The use of shallow wells as a major source of water supply is a common practice probably because of its low cost and low level of technological know-how. In a recent household survey carried out in Lagos, LASG (2010) observed that about 68% of the population depends on underground water source for their daily water supply. There is no regulation guiding the construction and use of water wells. Therefore, home-owners build wells arbitrarily. According to Egboka, et. al., (1989), groundwater pollution and contamination have become a common occurrence in developing countries such as Nigeria. With this in view, it has become necessary to monitor the quality of underground water being accessed by the populace. This work was embarked upon to study the quality of groundwater within Ikorodu Local Government Area (LGA) of Lagos. In order to safeguard the long-term sustainability of the groundwater resources, the quality of water needs to be continually monitored (Raihan and Alam, 2008). The overall goal of such assessment is to obtain a comprehensive picture of the spatial distribution of groundwater quality and of the changes that occur, either naturally, or under the influence of man (Wilkinson and Edworthy, 1981).

Study Area

Ikorodu LGA is located approximately between latitude 6^0 37’ - 6^0 45’N and longitude 3^0 3’ - 3^0 5’East with a land area of about 394 sq. kilometers. It is bounded in the east and west by Epe and Somolu Local Government Areas respectively, in the south by the Lagos lagoon, and towards the north by Ogun State (Odumosu et al., 1999). The area enjoys a tropical climate with distinct dry and wet seasons. The dry season is short and occurs between November and March while the wet season starts from April to November. Rainfall is less than 2500mm every year and temperature is not less than 30^oC on the average throughout the year (Odumosu and Balogun, 1999). The vegetation pattern is a reflection of the climatic condition of the mangrove forest which is made up of mangrove plants of different species such as mahogany. The climate condition and vegetation pattern favours agricultural practice.

Ikorodu LGA is located in an upland area with topography that enhances effective drainage through which several rivers flow into the Lagos lagoon. The area is directly underlain by the Benin formation which consists largely of sands / sandstones with lenses of shale’s and clays. The formation is thin in Ikorodu and this does not favour it as an important aquifer (Offodile, 2002). In addition, the arenaceous nature of the Benin formation makes it susceptible to contamination from anthropogenic sources. Based on the 2006 census, the population of the study area is put at 535,619.

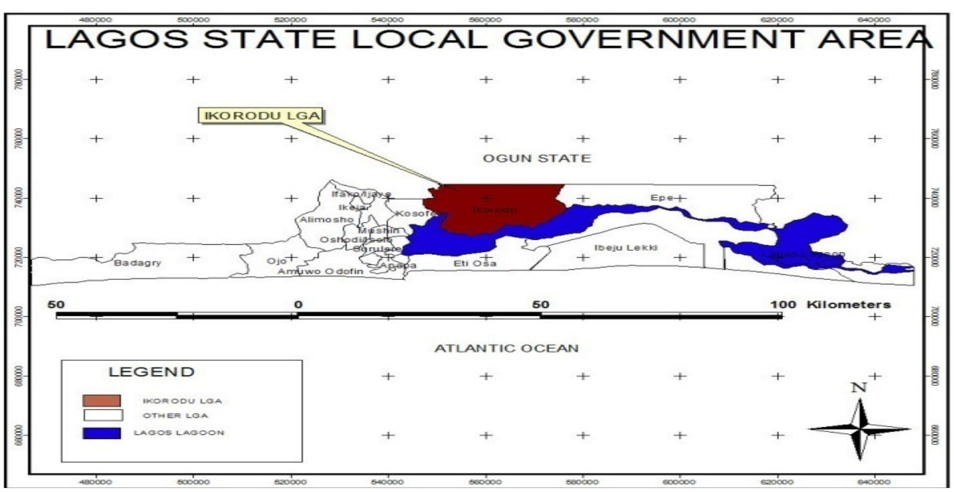


Figure 1. Map of Lagos State, showing the location of the study area

MATERIALS AND METHODS

Groundwater samples were collected from 15 hand-dug wells in different parts of the study area. The water samples were collected using plastic bailers and stored in 1 litre plastic bottles. The bottles were first washed with deionized water, and then rinsed several times with the sample water before collection in order to avoid any contamination. After taking each sample, the bottle was tightly capped to minimize contamination and escape of gases. The bottles were labeled according to the code numbers allotted to each sampling well and were then stored in an ice-packed cooler for onward transfer to the laboratory at Chemistry Department, University of Lagos, Nigeria. The analysis was carried out within 24 hours after collection.

Water quality parameters which were considered in this study include pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Turbidity, Nitrate, Chloride, Sulphate, Total Hardness, Calcium and Coliforms. TDS, pH and EC were determined in the field using mercury filled thermometer, pH meter and Mark electronic switchgear conductivity meter respectively. Other parameters were determined in the laboratory by a chemical analyst using standard methods. The concentration levels of each physical and chemical parameter observed were subjected to descriptive analysis using SPSS 17.0 for Windows. Also, the results were compared with standards set by WHO. This was done using bar charts derived from the laboratory results of each water parameter under study and line graghs from WHO set limits as shown in Figure 3 (a – i). The sampling wells were plotted on the x-axis while the level of concentration of water parameters were on the y-axis. The sampling wells were represented by numbers 1-15 as indicated in Table 2. Number 16 represents the WHO maximum limits for each parameter.

Figure 2. Map of study area showing location of sampling wells

RESULTS AND FINDINGS

pH

The pH value or hydrogen ion concentration is a measurement of the acidity or alkalinity of water. pH is measured on a scale that runs from 0-14. Seven (7) is neutral, while measurements below 6.5 indicates the presence of acid and measurements above 7 indicates alkalinity. The water analysis results derived from the samples taken in the field are shown below in Table 1. The pH value varied between 5.79 and 8.78. The minimum pH which is 5.79 was found in sample point 12 (Agbowa) while the maximum pH (8.78) was from sample point 14 (Igbogbo). The mean pH value as presented in Table 2 is 6.92 with a standard deviation of 0.826.

In the WHO (1998) standard for drinking water, pH level was set at between 6.5 and 8.5. From the bar chart shown in Figure 3(a), pH was found below the 6.5 minimum in 6 locations namely Odogunyan, Boge, Ladegboye, Oke-Agbo, Agbowa and Itamaga confirming slightly excess hydroxyl ion and more hydrogen ions indicating an acidic solution with a pit value less than 7.0 (Powell, 1964). However, the pH values in Isawo, Oke-Eletu, Abule-Eko, Gberigbe, Agura, Imota, Igbogbo and Majidun were slightly alkaline. The varied pH levels in the study areas may be partly attributed to the differential organic matter content in the soil. Richard et al. (1996) noted that low pH levels obtained in well waters may be traced to the acidity produced by organic waste decomposing under partially reducing conditions into organic acids.

Table 1. Result of Laboratory Analysis of Water Samples

Sample Code	Location	Detected Level of Water Parameter									
		pH	EC (μScm^{-1})	TDS (mg/l)	Turbidity (FTU)	Nitrate (mg/l)	Chloride (mg/l)	Sulphate (mg/l)	Total Hardness (mg/l)	Calcium (mg/l)	Coliforms (cfu/ml)
1	Isawo	7.35	202.0	142.0	2.0	1.7	62.0	5.0	74.0	42.0	0.0
2	Odogunyan	6.03	56.4	37.0	0.0	0.41	18.0	2.0	18.0	16.0	0.0
3	Boge	5.86	53.5	35.8	8.0	0.32	16.0	2.0	6.0	6.0	0.0
4	Yarakan-OkeEletu	7.34	81.7	55.9	0.0	0.49	12.0	3.0	48.0	6.0	0.0
5	Abule Eko	7.35	112.4	78.9	0.0	1.01	16.0	4.0	66.0	44.0	0.0
6	Gberigbe	7.58	271.0	198.0	6.0	3.26	14.0	8.0	94.0	48.0	1.0×10^1
7	Agura	7.56	59.2	38.7	3.0	0.58	10.0	1.0	20.0	12.0	0.0
8	Ladegboye	6.30	49.8	32.8	0.0	0.24.	16.0	2.0	16.0	14.0	0.0
9	Igbe	6.84	99.3	64.5	0.0	0.49	14.0	3.0	54.0	50.0	0.0
10	Oke Agbo	6.24	59.8	38.3	0.0	0.27	14.0	2.0	26.0	22.0	0.0
11	Imota	7.23	387.0	227.0	4.0	5.17	36.0	6.0	64.0	56.0	1.4×10^1
12	Agbowa	5.79	281.0	203.0	2.0	4.92	48.0	5.0	92.0	74.0	0.0
13	Itamaga	6.27	42.3	27.3	0.0	0.17	16.0	2.0	14.0	10.0	0.0
14	Igbogbo	8.78	171.4	119.3	0.0	3.08	56.0	4.0	22.0	12.0	0.0
15	Majidun	7.29	730.0	529.0	0.0	7.87	21.0	15.0	178.0	138.0	1.2×10^1

Source: Fieldwork, 2011

Table 2. Descriptive Statistics of Water Parameters

Parameters	N	Minimum	Maximum	Mean	Std. Deviation
pH	15	5.79	8.78	6.9207	.82602
EC	15	42.30	730.00	177.1200	185.40360
TDS	15	27.30	529.00	121.8333	132.14594
Turbidity	15	0.00	8.00	1.6667	2.55417
Nitrate	15	0.17	7.87	1.9987	2.36376
Chloride	15	10.00	62.00	24.6000	17.16225
Sulphate	15	1.00	15.00	4.2667	3.51460
Total Hardness	15	6.00	178.00	52.8000	45.26620
Calcium	15	6.00	138.00	36.6667	35.24337
Coliforms	15	0.00	14.00	2.4000	5.02565

Electrical Conductivity (EC)

EC is the ability of water to conduct electric current signifying chemical purity of a low electrical conductance (Benain et al., 1993). The values of EC ranged from 42.3 to 730.0μScm^{-1}. The mean value of EC for all the samples analyzed is 177.12μScm^{-1} while the standard deviation is 185.40360 as shown in Table 2. From Fig. 3, all the samples were within the permissible limits of WHO standards for drinking water. This shows that the water samples are not saline, the concentration of salts dissolved in the water is minimal, and the salt content of a water body is determined by its ability to conduct an electric current. The higher the salt concentration in water, the larger the current conducted and the higher the EC of water. Variations in EC could be as a result of poor casing of some of the wells and the effect of this can be pollution of the water through rust. The poor casing of well, when corroded, releases reddish-brown substances (rust) into the well, and this could lead to the accumulation of heavy metals such as iron which caused variations in EC values in the study area.

Total Dissolved Solids (TDS)

TDS is a measure of the amount of materials dissolved in water. The values of the TDS ranged between 27.3 to 529.0 mg/l with mean value of 121.8333. The highest value of 529.0mg/l was obtained from sampling well 15 (Majidun) and this exceeds the 500mg/l WHO maximum standard. The materials present which could determine the amount of TDS include carbonate, bicarbonate, chloride, sulphate, phosphate, nitrate, calcium, magnesium, sodium, organic ions and other ions. It could be implied in this study that the possible cause of low amount of TDS where applicable was the minimal presence of these chemicals in groundwater. On the other hand, the higher TDS value which exceeded WHO standard at Majidun could be due to the presence of the chemicals in groundwater.

Turbidity

Turbidity is caused by the presence of suspended matter in water such as clays, mud, algae, silica and bacteria. Turbidity is a measure of cloudiness in water. The more turbid the water, the murkier it is. Turbidity may not adversely affect health but may cause need for additional treatment. In this study, the value of turbidity varies from 0.0 to the highest value of 8.0 FTU. The mean turbidity values of 1.6667 FTU in the study area are within the WHO standard. The maximum value was recorded at Boge village with 8.0 FTU which exceeded WHO standard. High turbidity values may indicate that sanitary integrity has been compromised.

Total Hardness

Total hardness is characterized by the formation of insoluble salts of the fatty acids found in soaps and by the deposition of scale in heated surface (Powell, 1964). Total hardness is due to the presence of multivalent metal ions which come from minerals dissolved in the water. Large amounts of hardness are undesirable mostly for economic or aesthetic reasons. Total Hardness ranged from 6.0 to 178.0mg/l. Values at Isawo, Oke-Eletu, Abule-Eko, Gberigbe, Igbe, Imota, Agbowa and Majidun were above the WHO desirable limit of 30mg/l (Fig.3g).

Nitrate

The concentration of nitrate was lowest at Itamaga with a value of 0.17 mg/l while the highest value of 7.87 mg/l was recorded at Majidun and the mean value was 1.9987 mg/l. The presence of nitrate could have been as a result of fecal coliform in water due to closeness of septic tank or soak away to wells in some locations. An excessive concentration of nitrate and or nitrite can be harmful to humans. Haruna and Mokhtar (2005) maintained that nitrate in water results from the production of toxic nitrogenous chemicals in water. The presence of nitrates in groundwater indicates possible contamination from decaying plant or animal material, agricultural fertilizers, manure or domestic waste and formations containing naturally occurring nitrogen compounds. There are potential health implications to high levels of nitrate in drinking water particularly to very young children. However, the result obtained shows that the nitrate level did not go beyond the World Health Organization (WHO) permissible limit of 10 mg/l in all the wells sampled in this study (Fig.3e).

Sulphate

The presence of sulphate in water, determines the hardness of water. From Table 2, sulphate ranged from a minimum of 1.0 mg/l to a maximum of 15.0mg /l. The minimum value of sulphate was recorded at Agura with 1.0mg/l and the maximum value was recorded at Majidun with 15.0mg/l. All the wells in the study area are within the safe limit of sulphate concentration (200 mg /l*)* which makes it fit for drinking (Fig.3g).

Chloride

The concentration of chloride at a range of 10 to 62 mg/l within the study area is low and falls within the WHO standards of 250 mg/l for potable water (Fig.3f). Its presence in all locations might have been as a result of fecal contaminant. According to Haruna and Mokhtar (2005), the presence of chloride in spring water is associated with fecal contamination.

Calcium

From Table 2, the lowest value was 6mg/l while the highest value was 138 mg/l. Calcium, which is essential for nervous system and for the formation of bones, is commonly present in all water bodies where it usually comes from the leaching of rocks. With the exception of Majidun, calcium concentration falls below the WHO maximum permissible level (MPL) of concentration in water for drinking purpose. This may be due to little or no interaction of water with the underlying basement rock (the principal source of calcium). The concentration of calcium

(138.0mg/l) in Majidun sampling well is higher than the WHO maximum limit of 75 mg/l (Fig.3i).

Coliforms

Result from Table 2 shows that ecoli is present in three sampling wells namely Gberigbe, Imota and Majidun. Coliform in water in these communities is an indication of fecal contamination. This shows that substances which are present in waste matter leaches to groundwater and are transported in it. Dillion (1997) asserted that in areas where the waste matter is not properly disposed, for example a pit latrine, the liquid soaks away through the base and sides of the pit. The presence of fecal coliform in water indicates that fecal pollution had. This poses great danger to human health. Contamination of water by human waste deposit constitutes the most common mechanism for transmission of micro-organisms to humans (WHO, 1985). These pathogenic organisms are responsible for the infection of the intestinal tracts and the diseases caused include diarrhea, cholera, bacillary dysentery, typhoid, hepatitis and so on. The incidence of water borne diseases can therefore be attributed to untreated or poorly treated groundwater that contains pathogens.

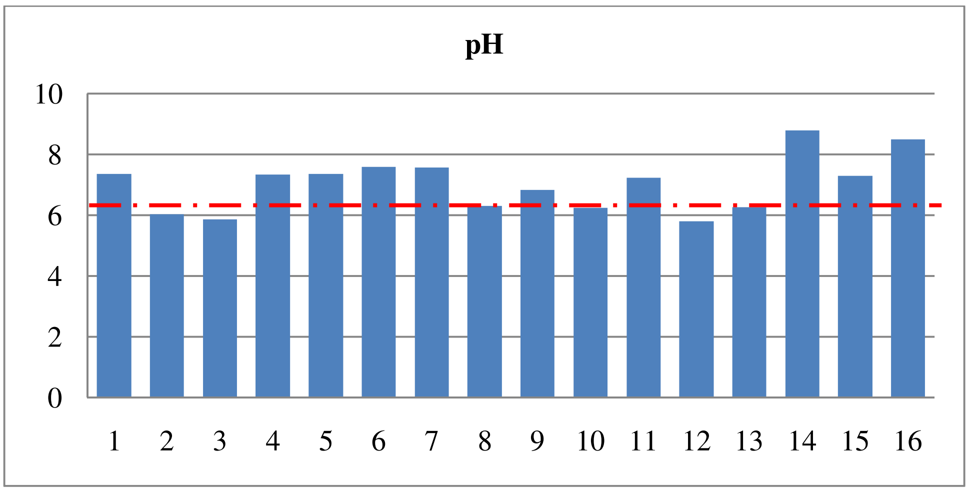


Figure 3 (a).

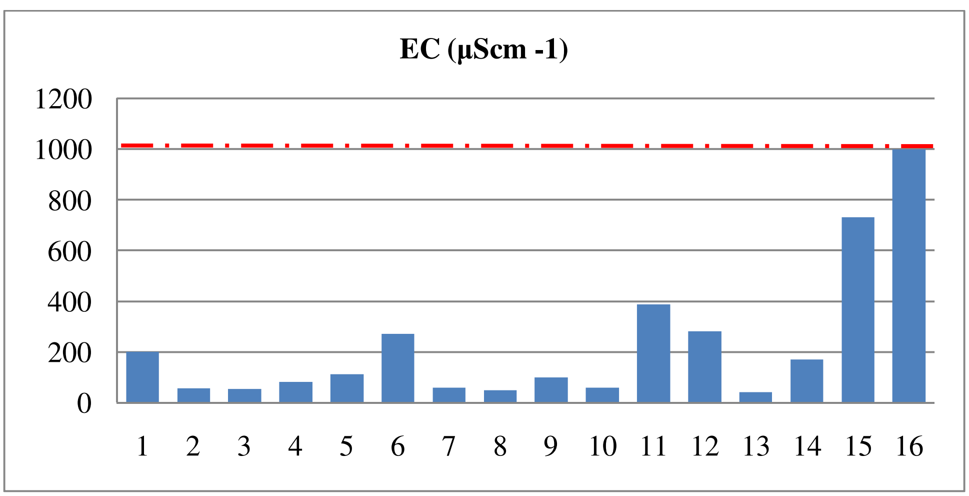


Figure 3 (b).

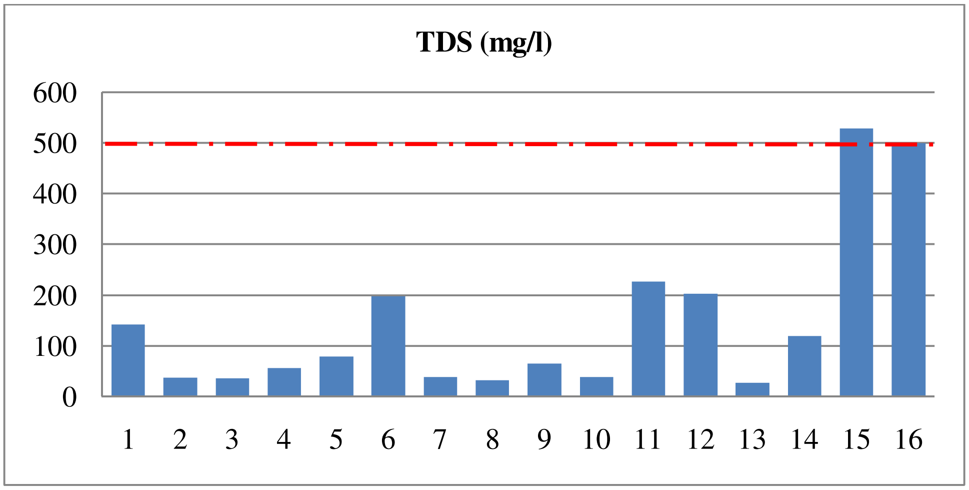
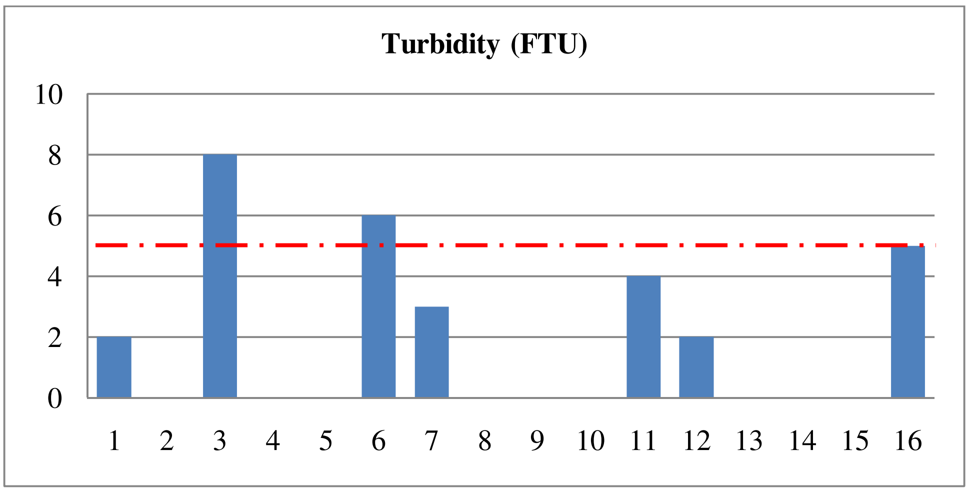


Figure 3 (c).



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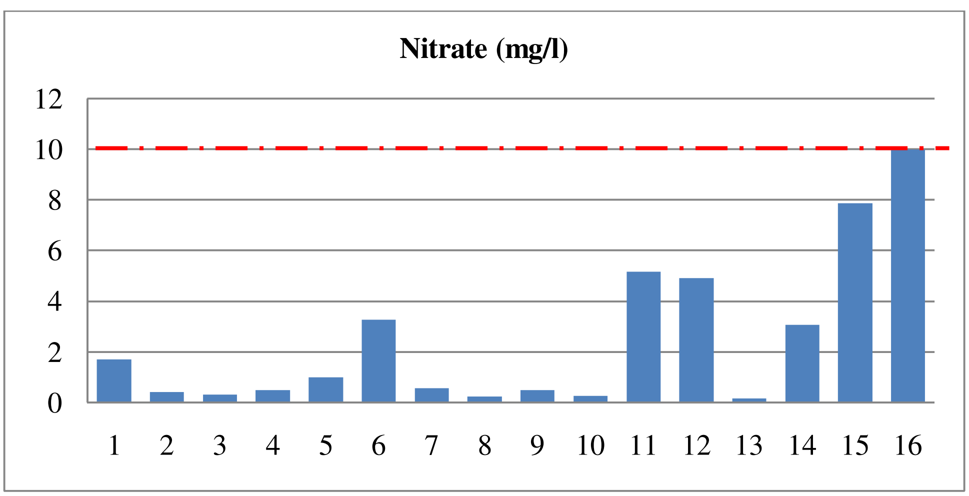

Figure 3 (e).

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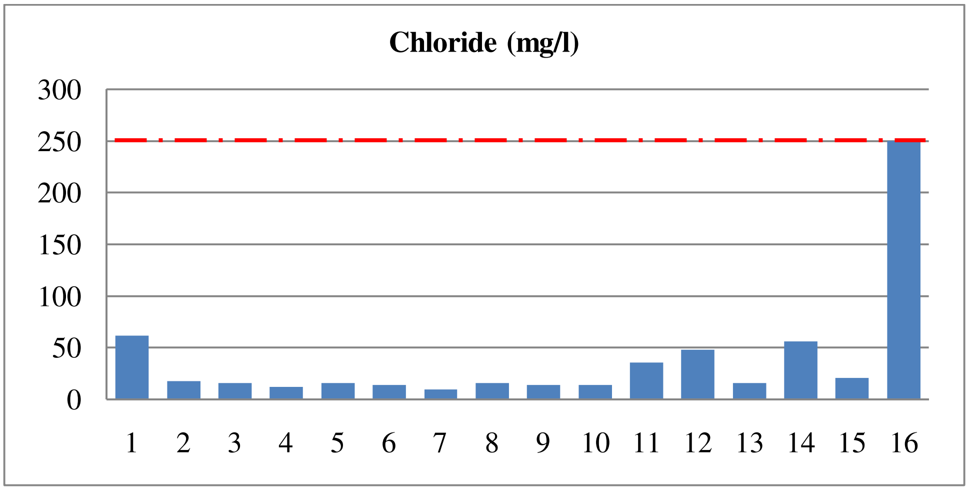

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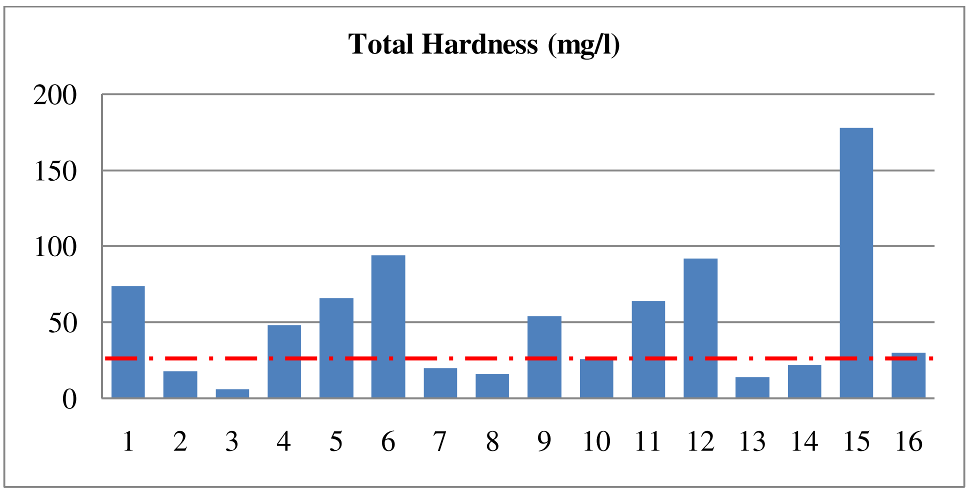

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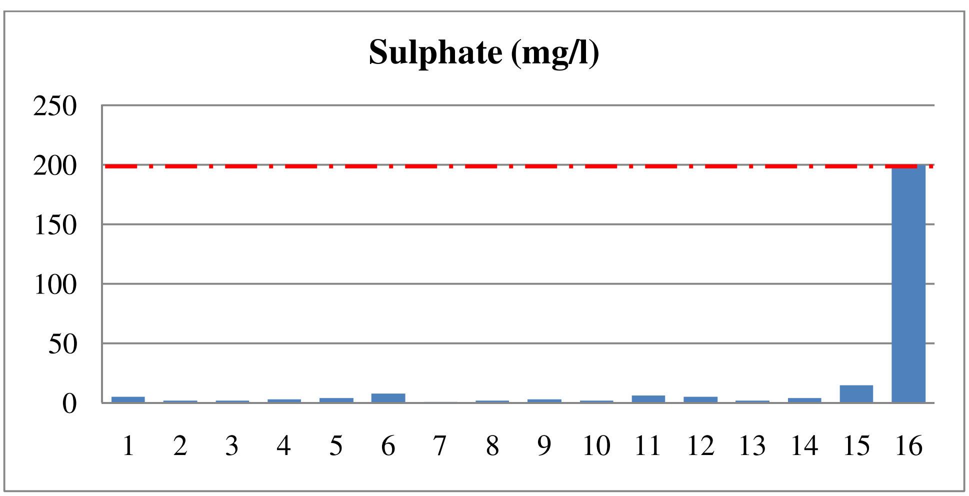

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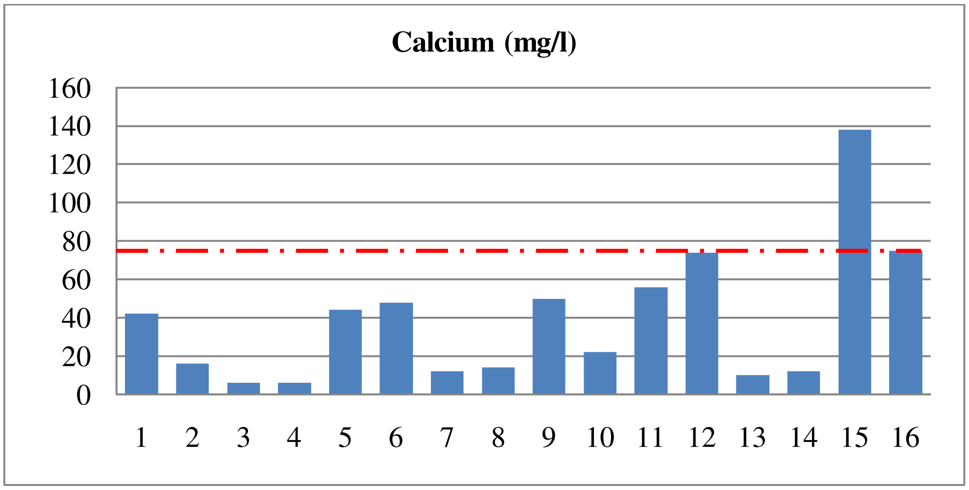

Figure 3 (i).

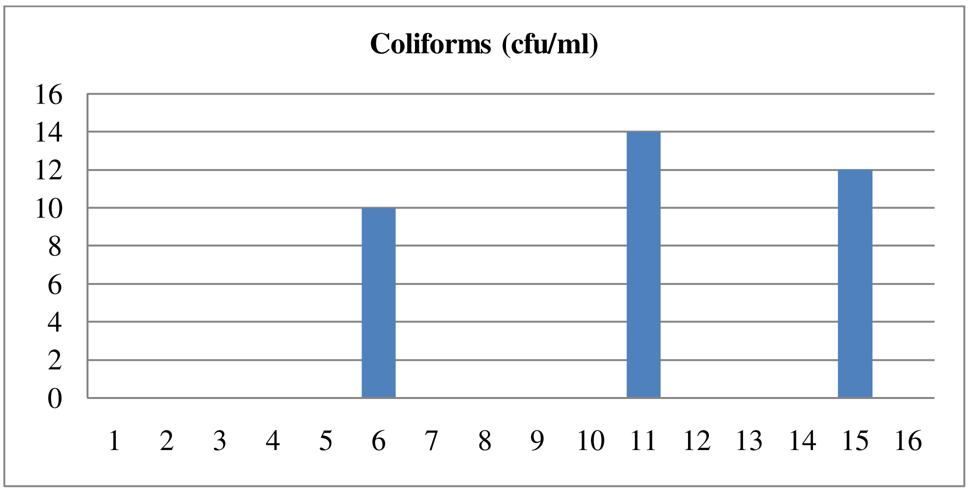

Figure 3 (j).

Figure 3. Concentration of water parameters in relation to the WHO (1998) standard

CONCLUSION

From this study, it can be concluded that most of the results are in line with the safe limits of the standard set by the WHO for drinking water. However, some results like Total Hardness and Coliforms are beyond the standard set by the WHO for drinking water in some locations. The presence of significant counts of coliforms bacteria is indicative of inadequacy of the depth of the wells or a breach of sanitary integrity of the wells. Water quality in shallow wells at Gberigbe, Imota and Majidun found to be contaminated may be related to these causal factors. Other water quality parameters investigated (pH, EC, TDS, turbidity, Nitrate, Chloride, sulphate, and Calcium) are within the WHO standards or are at the borderline of permissible limits, making the water acceptable for many domestic uses.

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