On Implications of Groundwater Quality of Shallow Wells in Otte Community, Kwara State, Nigeria

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Abstract

This study is aimed at assessing the groundwater quality of Otte Town in Kwara State, Southwestern, Nigeria, with the objective of finding out the potability of abstracted water from shallow wells in densely populated areas for domestic and drinking purposes. In order to determine the groundwater quality in the study area, physical, chemical and bacteriological analyses were carried out on twelve sampled wells fairly distributed in populated areas of the Otte Community. The concentration of each parameter was compared with the World Health Organization and NAFDAC Standards for Drinking Water in order to determine if the water from each of the wells was good for domestic and drinking purposes. Generally, the water did not meet WHO and NAFDAC standards. Implications of consuming water that had parameters whose concentrations exceeded the permissible limits were thoroughly discussed.

Keywords: Groundwater Quality, Abstracted Water, Parameter, Sampled Wells

1. Introduction

Otte community is located in Asa Local Government Area of Kwara State, with coordinates of **N08^o 18’ to 08^o 19’ and E04^o 23’ to 04^o 22**. It has a population of about 5,000 people. It is the boundary town between Oyo and Kwara States of Nigeria. It has a mixed population consisting of people from different parts of Nigeria, amongst which are the Hausa, Yoruba, Fulani, etc. The main language spoken in the area is Yoruba. The town is located approximately adjacent to another town called Budo Egba. The main occupation in the town is farming. A main road which passes through the town connects the town to Ilorin in the north and to Ogbomoso in the south. The study area, Otte Community, is low lying (low relief) and has a dendritic pattern of drainage which is controlled by the topography of the area. The main river in Otte is the Odo Alalubosa.

The total annual rainfall in the Otte ranges from 800mm to 1,200mm. The town is located in the savannah region of Nigeria. The only means by which refuse is disposed off in Otte is by dumping them on a parcel of land near the abattoir in the only market in the town. There are no sanitary landfills within the town. Several authors have worked on contamination of groundwater through leachates, the world over. Notable amongst such works are those of Acworth (1987), Adegbola (2006), Adekunle (2009), Bhaskar et al (2010), Chukwu et al (2008), Ghulman et al (2008), Ihekoronye and Ngoddy (1985), Jinwal and Dixit (2008), Oyeku and Eludoyin (2010), Singh et al (2010), Sudhir and Amarjeet (1999) and West (2006). The location map of Otte Community is presented in Figure 1. Figures 2, 3, 4 and 5 represent: the geological map of Otte; Ipata dumpsite near abattoir; location of well 11 and well 04 sited near dumpsite, respectively.

The exposed rock outcrops seen on the earth surface in Otte are rock types associated with the basement complex of Nigeria. The town of Otte in Kwara State is underlain by the basement complex rocks with the migmatite gneiss, a coarsely crystalline rock composed of a mixture of bands of metamorphic and igneous rocks and found in areas where high-grade metamorphic rocks have partly melted to form igneous rock.

Porosity and permeability are two factors that are needed for any rock to allow groundwater to flow through it. The igneous and metamorphic rocks of the basement complex are crystalline in nature and therefore have low primary porosity and permeability needed for the unhindered flow of groundwater (Oluyide and Udeh, 1966).

This study is carried out to assess the groundwater quality of Otte Town in Kwara State, Southwestern, Nigeria. The aim is to find out the potability of abstracted water from shallow wells in densely populated areas for domestic and drinking purposes.

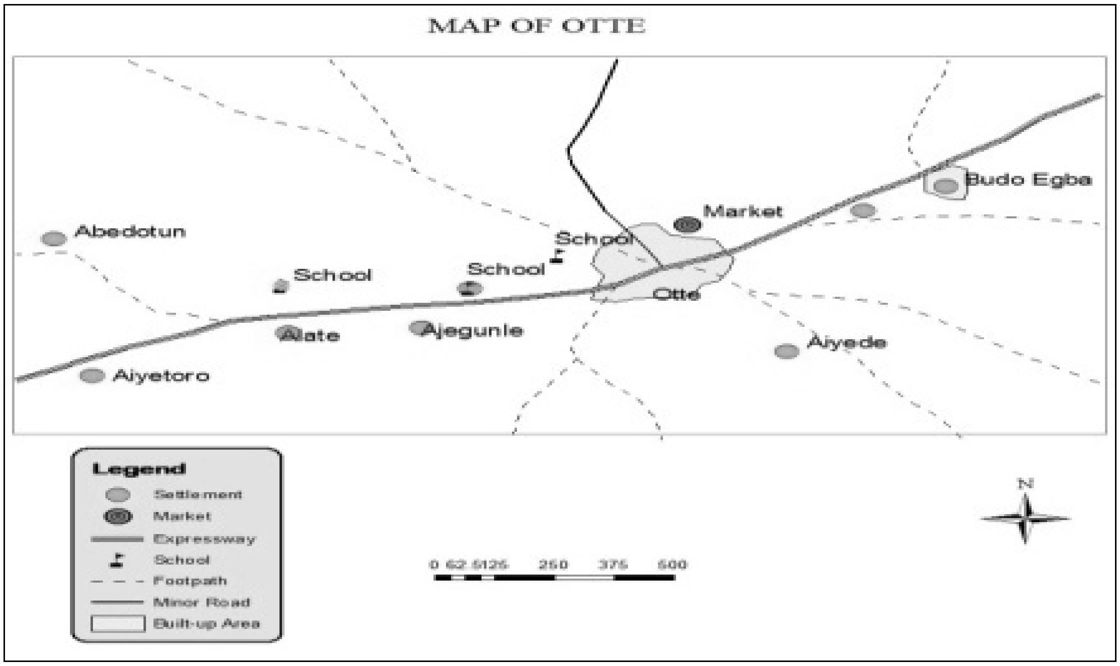

Figure 1: Location Map of Otte Community

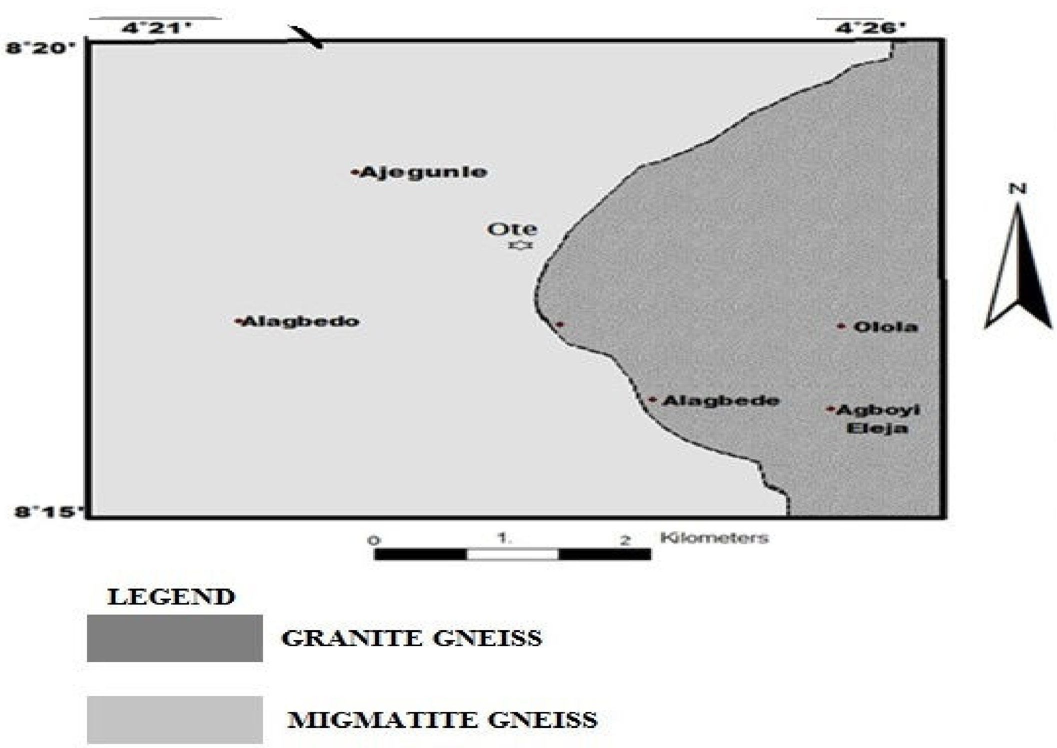

Figure 2: Geological Map of Otte Community

Figure 3: Ipata Dumpsite near Abattoir Slab, Otte, Kwara State

Figure 4: Well 11 (Labelled W068) Located in Canteen near Otte Garage

Figure 5: Well 04 Located near Dumpsite in Otte, Kwara State

2. Methodology

Hydrogeochemical analysis was carried out in the study area to determine the physical, chemical and bacteriological properties of the groundwater in the study area. The water samples collected were sent to Kappa Biotechnologies Laboratory which is located at Ibadan, Nigeria. In order to determine the groundwater quality in the study area, physical, chemical and bacteriological analyses were carried out on twelve sampled wells fairly distributed in populated areas of the Otte Community. The concentration of each parameter was compared with the World Health Organization and NAFDAC Standards for Drinking Water in order to determine if the water from each of the wells was good for domestic and drinking purposes. Implications of consuming water that had parameters whose concentrations exceeded the permissible limits were thoroughly discussed.

3. Results and Discussion

Table 1 below shows the result of the analyse and the WHO and NAFDAC maximum permissible levels.

Table 1: Results of Water Analyses on Sampled Wells in Otte Community

	W 01	W02	W03	W04	W05	W06	W07	W08	W09	W10	W11	W12	WHO	NAFDAC
Color (hazen unit)	1.5	1.0	0.0	0.0	2.0	0.0	1.0	0.0	2.0	1.0	1.0	1.0	15	15
Turbidity	2.5	1.0	0.0	0.0	3.0	1.0	1.0	2.0	2.0	2.0	2.0	1.0	5	5
Ph	6.8	6.5	6.6	6.7	6.5	6.8	6.6	6.7	7.2	6.9	6.7	6.7	6.5 -8.5	6.6 – 8.5
Conductivity	373	445	325	383	444	376	358	423	224	332	544	222	1000	1000
Total solid	2030	2233	1446	1533	2426	1453	1463	1353	2043	1856	1750	1326	1500	500
Total Dissolved solid	513	505	534	385	376.7	250	126.7	158.3	521.7	475	391.7	90	1000	500
Total Suspended solids	1516.7	1731.7	1101.7	1151.7	2050	1220	1336.7	1195	1520	1371.7	1355	1236.7	500	500
Dissolved Oxygen	4.77	4.5	5.0	4.6	1.8	4.5	4.8	5.3	3.6	5.0	5.6	6.0	<4	5
Biochemical Oxygen Demand	1.27	2.23	2.03	1.13	1.13	0.27	0.53	0.47	1.2	0.77	0.47	0.0	5	5
Alkalinity	1.43	1.37	1.0	1.5	1.93	1.03	2.2	1.06	1.73	1.23	1.7	0.5	50	100
Total Hardness	42.5	44.3	46.0	44.6	54.3	55.73	52.6	48.2	44.7	42.4	38.4	36.0	500	100
Cyanide (mg/L)	0.02	0.02	0.02	0.01	0.1	0.05	0.05	0.0	0.1	0.0	0.1	0.01	0.07	0.01
PO_4^{---} (mg/L)	0.5	0.0	0.2	0.05	0.6	0.05	0.2	0.5	1.0	0.0	1.2	0.4	0.1	0.1
Fe^{++} (mg/L)	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.1	0.1	-	0.3
Pb^{++} (mg/L)	0.02	0.0	0.01	0.0	0.01	0.0	0.02	0.0	0.02	0.0	0.01	0.0	0.01	0.01
Cu^{++} (mg/L)	0.2	0.05	0.2	0.1	0.1	0.05	0.2	0.05	0.2	0.02	0.1	0.1	0.07	0.01
Zn	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.05	0.02	0.02	0.04	0.05	3	3
Na^+ (mg/L)	43	55.7	59.3	46.3	47	53.7	51	48.3	56.3	45	58.3	39.3	200	200
K^+ (mg/L)	15	10.7	16.7	12.6	10.3	13.7	15.3	13	12.6	13.3	13.3	12.6	55	15
Ca^{++} (mg/L)	37.9	39.7	41.0	40.0	46.2	49.9	46.8	42.9	39.6	37.8	34.1	32.9	75	75
Mg^{++} (mg/L)	4.13	4.63	4.67	4.46	8.3	6.56	6.36	5.9	5.23	4.83	4.57	3.53	20	20

The maximum permissible limit for cyanide standardised by WHO and NAFDAC are 0.07mg/l and 0.01mg/l respectively. The chart below shows that wells 05, 09 and 11 have concentrations of cyanide greater than the NAFDAC and WHO standards while wells 01, 03, 06, 07 and 02, have concentrations of cyanide greater than the NAFDAC standard. Over-concentration of cyanide in the human body causes thyroid gland damage and nervous system damage and in some cases, death. Sources of cyanide include fertilizer, electronics, steel, plastics, mining and cassava effluent. Phosphate has a concentration of 0 – 1.2mg/l. The Table shows that wells number 03, 04, 06 and 07, have concentrations lower than the WHO and NAFDAC maximum permissible limit of 0.1mg/l. Wells 01, 05, 03, 07, 08, 09, 11 and 12 have concentrations higher than the maximun permissible limit. Phosphate is produced by natural processes and are found in sewage and from the breakdown of organic pesticides which contain phosphates. Higher concentrations of phosphate can cause algal growth in wells. Phosphates are not toxic to people or animals unless they are present in very high levels. Digestive problems could occur from consumption of extremely high levels of phosphate.

Concentrations of copper ranges from 0.02mg/l to 0.2mg/l and Table 1 above shows that the samples have a concentration higher than both the maximum permissible limit of 0.07mg/l (WHO) while wells 06, 08, 10 and 02, have a lead concentration lower than the WHO limit but higher than the NAFDAC's limit. Copper is a very common substance that occurs naturally in the environment and spreads through the environment through natural phenomena. Leaching from copper water pipes and tubing, algae treatment, industrial and mining waste, wood preservatives and natural deposits can be the source leachate of copper. Although humans can handle proportionally large concentrations of copper, too much copper can still cause eminent health problems. Long-term exposure to copper can cause irritation of the nose, mouth and eyes and it can also cause headaches, stomach aches, dizziness, vomiting and diarrhea. Intentionally high uptakes of copper may cause liver and kidney damage and even death. Industrial exposure to copper fumes, dusts, or mists may result in metal fume fever with atrophic changes in nasal mucous membranes. Chronic copper poisoning results in Wilson's Disease, characterized by a hepatic cirrhosis, brain damage, demyelization, renal disease, and copper deposition in the cornea.

The concentration of lead in wells sampled ranges from 0 to 0.05mg/l which is higher than the WHO/NAFDAC's maximum permissible limit of 0.01mg/l. Wells 03, 05 and 11 have concentrations of 0.01mg/l while wells 01, 07 and 09 have concentrations of 0.02mg/l. The primary natural source of lead is in the mineral galena (lead sulfide). Sources of lead in groundwater includes paint, diesel fuel combustion, pipes and solder, discarded batteries, leaded gasoline and natural deposits. Lead is used as an additive in gasoline and is dispersed throughout the environment in the air, soils, and waters as a result of automobile exhaust emissions which in turn finds its way into the aquifer. The human body contains approximately 120 mg of lead. About 10-20% of lead is absorbed by the intestines. Symptoms of over-exposure to lead include colics, skin pigmentation and paralysis. Generally, effects of lead poisoning are neurological or teratogenic. Organic lead causes necrosis of neurons. Inorganic lead causes axonal degeneration and demyelination. Lead may cause cerebral oedema and congestion. Organic lead compounds are absorbed quicker, and therefore pose a greater risk. Organic lead derivates may be carcinogenic. Women are generally more susceptible to lead poisoning than men. Lead causes menstrual disorder, infertility and spontaneous abortion, and it increases the risk of stillbirth. Foetuses are more susceptible to lead poisoning than mothers, and generally foetuses even protect mothers from lead poisoning. A long time ago lead was applied as a measure of birth control, for example as a spermicidal, and to induce abortion. The concentration of potassium in all the wells is within the WHO limit of 75mg/l while wells 03, 01 and 07, have concentrations higher than the NAFDAC maximum permissible limits of 15mg/l. Potassium is a dietary requirement for human beings. The total potassium amount in the human body lies somewhere between 110 and 140 g and mainly depends upon muscle mass. Higher concentrations of potassium in groundwater is as a result of the potassium leaching from the country rock through which the water has flowed. It has a concentration ranging from 10.3mg/l to 16.7mg/l. The intake of a number of potassium compounds may be particularly harmful. At high doses potassium chloride interferes with nerve impulses, which interrupts with virtually all bodily functions and mainly affects heart functioning. Potassium alum may cause stomach complaints and nausea at concentrations as low as 2g, and may be corrosive and even lethal in higher concentrations.

The NAFDAC's maximum permissible limit for iron is 0.3mg/l and the concentration of iron in the wells sampled 0.1 – 0.2mg/l which is within the maximum permissible limit. Wells 02, 03, 05, 07 and 09, have the highest concentrations of iron in all wells sampled. The iron occurs naturally in the aquifer but levels in groundwater can be increased by dissolution of ferrous borehole and handpump components. Iron-bearing groundwater is often noticeably orange in colour, causing discoloration of laundry, and has an unpleasant taste, which is apparent in drinking and food preparation. Iron dissolved in groundwater is in the reduced iron II form. This form is soluble and normally does not cause any problems by itself. Iron II is oxidised to iron III on contact with oxygen in the air or by the action of iron related bacteria. Iron III forms insoluble hydroxides in water. These are rusty red and cause staining and blockage of screens, pumps, pipes, reticulation systems etc. If the iron hydroxide deposits are produced by iron bacteria then they are also sticky and the problems of stain and blockage are many times worse. The presence of iron bacteria may be indicated by rusty slime inside headwork's, reduced water flow form the bore and unpleasant odour from water pumped from the bore. Long term consumption of drinking water with a high concentration of iron can lead to liver diseases (hemosiderosis). Iron also promotes the growth of iron-bacteria. This gives a rusty appearance to the waters. Colonies of these bacteria may also form a slime which causes problems in water closets, pipes, pumps and distribution system. High concentration of iron in water is not suitable for processing of food, beverages, ice, dyeing, bleaching and many other items.

The concentration of manganese ranges from 0 – 0.05mg/l which is lower than NAFDAC's maximum permissible limit of 0.2mg/l. All the wells sampled have manganese concentrations lower than the maximum permissible limit. Manganese is one of the most abundant metals in soils, where it occurs as oxides and hydroxides, and it cycles through its various oxidation states. Manganese effects occur mainly in the respiratory tract and in the brains. Symptoms of manganese poisoning are hallucinations, forgetfulness and nerve damage. Manganese can also cause Parkinson disease, lung embolism and bronchitis. When men are exposed to manganese for a longer period of time they may become impotent.

A syndrome that is caused by manganese has symptoms such as schizophrenia, dullness, weak muscles, headaches and insomnia. All wells sampled are within the maximum permissible limit. Concentrations of ammonium in sampled wells range from 0mg/l - 0.05mg/l and is lower than NAFDAC's maximum permissible limit of 0.1mg/l. Wells 05, 09 and 11, all have the highest concentrations of 0.05mg/l, which is still within the limit. The range of concentration of zinc in the wells sampled is 0.01mg/l – 0.05mg/l which is less than the maximum permissible limit of 3.0mg/l standardised by NAFDAC and WHO. Zinc leaks from zinc pipes and rain pipes, consequential to circulation of carbon rich water. Car tires containing zinc and motor oil from zinc tanks release zinc compounds on roads. Zinc compounds are present in fungicides and insecticides, and consequently end up in water. The human body contains approximately 2.3 g zinc, and zinc has a dietary value as a trace element. Its functions involve mainly enzymatic processes and DNA replication. The human hormone insulin contains zinc, and it plays an important role in sexual development. Minimum daily intake of 2-3 g, prevents deficiencies. The human body only absorbs 20-40% of zinc present in food, consequently many people drink mineral water rich in zinc. Symptoms of zinc deficiencies are tastelessness and loss of appetite. Children's immune systems and enzyme systems may be affected. Higher zinc application appears to protect people from cadmium poisoning. Zinc may also decrease lead absorption.

Calcium and magnesium concentrations in the water samples analysed in the study have a range of 32.9mg/l – 49.9mg/l and 3.53mg/l to 8.3mg/l respectively. The chart below shows that all the wells sampled has a calcium and magnesium concentration below the WHO and NAFDAC's highest permissible limit of 75mg/l and 150mg/l. Higher concentrations of calcium and magnesium in water causes poor lathering during washing and deterioration of the quality of clothes, It also induces scale formation and incrustation in pipes. High intake of magnesium causes gastro-intestinal irritations and it also contributes to the hardness of water. In the study area, the chemical with the most concentration in the wells is sodium which has a concentration range of 0.01mg/l to 59.30mg/l which is less than the maximum permissible limit of 200mg/l standardised by WHO and NAFDAC. The reason for the high concentration of sodium might be due to the fact that sodium makes up 2.5% of the earth crust. Conductivity in groundwater is affected primarily by the geology of the area through which the water flows. Groundwater that has flowed through granitic rocks will have a low electrical conductivity while groundwater that has flowed through clayey soils will have a high electrical conductance. The maximum permissible limit for electrical conductance is 250 and the range of electrical conductance for the sampled wells is 222-544µS and this indicates that nearly all the sampled wells have a high electrical conductance when compared to the maximum permissible limit of WHO. Well 11 has the highest electric conductance of all the wells sampled. The range of concentration of total hardness is 3.6-55.73mg/l while the maximum permissible limit is 500mg/l (WHO) and 150mg/l (NAFDAC) which indicates that the entire wells sampled have a concentration within the acceptable limits. This shows that the water in the area is soft. Hard water is useful and also detrimental to the human health. Hard water causes poor lathering with soap, deterioration of the quality of clothes, scale forming, skin irritation, and boiled meat and food become poor in quality. Soft water also increases the chances of heart failure in humans. Low Alkalinity (i.e. high acidity) causes deterioration of plumbing Alkalinity is usually as a result of deterioration of pipes, from sanitary landfills and hazardous waste landfills.

The pH is the measure of the acidity or basicity of an aqueous solution. Low pH causes corrosion, and gives metallic taste to water supply while high pH gives a bitter/soda taste to solutions. The most common disorder in acid-base homeostasis is acidosis, which means an acid overload in the body, generally defined by pH falling below 7.35. The range of concentration of pH in sampled wells is 6.5 -7.2. The chart above shows that the wells all have a pH value within the maximum permissible limits of 6.5 - 8.5 (WHO) and 6.6 – 8.5 (NAFDAC). From Table 1, it can be seen that sodium has the highest concentration in all the sampled wells, followed by calcium and potassium.

This may be due to the fact that sodium is the sixth most abundant element in the earth's crust, which contains 2.83% of sodium in all its forms. Sodium is a compound of many foodstuffs, for instance, common salt. It is necessary for humans to maintain the balance of the physical fluids system. Sodium is also required for nerve and muscle functioning. Too much sodium can damage the kidneys and increases the chances of high blood pressure. High sodium levels in drinking water can have adverse effects on humans with high blood pressure or pregnant women suffering from toxaemia. Well 11 which is located in a canteen near a car park has the second highest concentration of sodium. Also, the abundance of sodium, calcium and potassium in Well 04 and Well 02 is due to the fact that they are both located near the dumpsite in the abattoir area of the town. They are suspected to have come from the refuse dumpsite, especially calcium which may have leached from the bones of the animals.

Colour in water may be due to the inorganic ions, such as iron and manganese, humus and peat materials, plankton, weeds and industrial wastes. The maximum permissible limit for color is 15mg/l (WHO/NAFDAC). The concentration of color in all the wells sampled range from 0 – 2.0 mg/l which is less than the maximum permissible limit. Color in water is usually due to the presence of suspended particles and materials. Turbidity is a measure of the degree to which the water loses its transparency due to the presence of suspended particulates. The more the total suspended solids in the water, the murkier it seems and the higher the turbidity. Turbidity is considered as a good measure of the quality of water. The concentration of turbidity ranged from 0 – 3.0NTU, which falls within the maximum permissible limit of 5.0NTU standardised by WHO and NAFDAC. Well 04 has the highest value of 3NTU, followed by well 01, while wells 08, 09, 10, 11, have a value of 2NTU. The main impact is merely aesthetics, as no one likes the look of dirty water. But also, it is essential to eliminate the turbidity of water in order to effectively disinfect it for drinking purposes. This adds some extra cost to the treatment of surface water supplies.

There is no permissible limit for dissolved oxygen. Measures of dissolved oxygen (DO) refers to the amount of oxygen contained in water, and it defines the living conditions for oxygen-requiring (aerobic) aquatic organisms. The concentrations of dissolved oxygen in the study area ranges from 1.8 – 6 mg/l. All the wells sampled have a high concentration of dissolved oxygen except well 05, which has a concentration of 1.8mg/l. Total solids are dissolved solids plus suspended and settleable solids in water. Suspended solids include silt and clay particles, plankton, algae, fine organic debris, and other particulate matter. The concentration of total solids range from 1326 – 2426mg/l. The maximum permissible limit for total solids (WHO, 2005) is 1000mg/l which indicates that the wells in the study area have a concentration higher than the maximum permissible limit. Well 05 has the highest concentration of 2426mg/l. The concentration of total dissolved oxygen ranges from 1101.1 – 2050mg/l which is much higher than the maximum permissible limit of 500mg/l of WHO and NAFDAC. The maximum permissible limit standardised for total dissolved solids by the World Health Organization is 1000mg/l while the concentration of total dissolved solids in sampled wells ranges from 90 – 534mg/l, which is lower than the maximum permissible limit. Water with higher solids content often has a laxative and sometimes the reverse effect upon people whose bodies are not adjusted to them. High concentration of dissolved solids (about 3000mg/l) may also produce distress in livestock. Sources of total dissolved solids in groundwater are livestock waste, septic system, landfills, nature of soil, hazardous waste landfills, dissolved minerals, iron and manganese. Wells 01, 02, 03 and 09, all have the highest TDS value, while wells 07, 08 and 12, have the lowest values. Based on Todd (1980), classification of water's total dissolved solid, which classified groundwater with total dissolved solids concentration less than 1000mg/l as fresh, the groundwater of the study area can be so classified.

Biochemical oxygen demand is the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic materials present in a given water sample at certain temperature over a specific time period. There is no permissible limit for biochemical oxygen demand. Table 2 depicts the results of the bacteriological analysis.

Table 2: Result of Bacteriological Analyes

PARAMETER	W01	W02	W03	W04	W05	W06	W07	W08	W09	W10	W11	W12	WHO	NAFDAC
Total Viable Count (cfus/ml)	5.2×10^{5}	3.8×10^{5}	2.5×10^{5}	8.8×10^{4}	4.0×10^{5}	4.1×10^{4}	4.4×10^{4}	3.0×10^{5}	3.2×10^{5}	6.5×10^{4}	3.8×10^{5}	2.2×10^{5}	100	100
Organisms Isolated	*Bacillus spp; Pseudomonas sp; Flavobacterium sp*	*Bacillus spp; Pseudomonas sp Proteus sp; Staphylococcus sp*	*Bacillus spp; Pseudomonas sp; Proteus sp*	*Bacillus spp; Pseudomonas sp; Proteus sp*	*Bacillus spp; Pseudomonas sp; Proteus sp; Flavobacterium sp*	*Bacillus spp; Pseudomcnas sp*	*Bacillus spp; Pseudomonas sp; Staphylococcus sp*	*Bacillus spp; Pseudomonas sp Proteus sp*	*Bacillus spp; Pseudomonas sp; Staphylococcus sp*	*Bacillus spp; Pseudomonas sp; Salmonella sp*	*Bacillus spp; Pseudomonas sp; Staphylococcus sp*	*Bacillus spp; Proteus sp; Staphylococcus sp*		
Total Coliform Count (cfus/ml)	8.0×10^{4}	6.0×10^{4}	1.0×10^{4}	2.6×10^{4}	5.0×10^{4}	1.2×10^{4}	1.1×10^{4}	3.3×10^{4}	8.4×10^{3}	3.2×10^{4}	8.6×10^{4}	1.5×10^{4}	0-10	10
Organisms Isolated	*Pseudomonas sp; Aeromonas sp*	*Pseudomonas sp; Proteus sp; Enterobacter sp*	*Pseudomonas sp; Aeromonas sp; Proteus sp*	*Pseudomonas sp; Proteus sp; Enterobacter sp*	*Proteus sp; Pseudomonas sp; Aeromonas sp*	*Pseudomonas sp;; Enterobacter sp*	*Pseudomonas sp; Aeromonas sp*	*Pseudomonas sp; Proteus sp; Enterobacter sp*	*Pseudomonas sp; Aeromonas sp*	*Pseudomonas sp; Enterobacter sp*	*Pseudomonas sp; Aeromonas sp*	*Proteus sp; Enterobacter sp*		

From Table 2, the organisms isolated are ***Bacillus spp, Pseudomonas spp, Flavobacterium, Proteus spp, Staphylococcus spp, Aeromonas spp and Enterobacter spp*** and their concentrations in the sampled wells are higher than the maximum permissible limits standardised by WHO and NAFDAC. The most basic test for bacterial contamination of a water supply is the test for total coliform bacteria. Total coliform counts give a general indication of the sanitary condition of sampled water. Aeromonas is a gram-negative, facultative anaerobic rod that morphologically resembles members of the family Enterobacteriaceae. The organisms are ubiquitous in fresh and brackish water. It was isolated in the samples from wells 09, 01, 03, 05, 07 and 12. When water containing *Aeromonas spp* is ingested, it can cause opportunistic systemic disease in immuno-compromised patients, and diarrheal disease in otherwise healthy individuals. Gastrointestinal disease caused by *Aeromonas spp* in children is usually an acute, severe illness, whereas that in adults tends to be chronic diarrhea.

4. Conclusions and Recommendations

The chemistry of groundwater is a reflection of the composition of both man made materials and country rocks through which it has come into contact with. In the groundwater analysis of Otte in Kwara State, it was found out that sodium is the most abundant element found in all the sampled wells followed by calcium and potassium. Their occurrence can be traced to their abundance in the earth crusts and through pollution by human impact on the environment. In well 04, the abundance of calcium in the well could be traced to abundance of animal bones that were observed on the dumpsite. In most of the wells sampled, the elements analysed were over the maximum permissible limits used by WHO and NAFDAC. Cyanide had a concentration over the WHO and NAFDAC limits of 0.08mg/l. Concentration of phosphate is higher than 0.1mg/l standard used by WHO. Lead also has a concentration higher than the maximum permissible limit of 0.01mg/l used by WHO. Higher concentration of lead can cause lead poisoning. The pH of all wells sampled is within standardized limit, while the concentration of total solids and total suspended solids is high, which has an effect on the conductivity, which is high in all the wells.

It is confirmed from the analyses that the groundwater of Otte area is polluted. The life of residents of Otte Community is endangered as long as inhabitants depend on abstraction of polluted water from shallow wells for domestic and drinking purposes. It is recommended that a pragmatic approach be deployed by all stake-holders, particularly, the Kwara State Environmental Protection Agency, in the area of safeguarding the quality of groundwater in the environment, and also, prevent avoidable exposure of residents of Otte Community to ingestion of contaminated water.

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