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PHYSICOCHEMICAL ANALYSIS OF UNDER GROUND RESEVOIR WATER IN OGWA COMMUNITIES IN EDO STATE

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Abstract
Water samples were collected for analysis from dug reservoirs in different residential areas of Ogwa communities in Edo state, Nigeria. Physico-chemical properties of these water samples were determined using standard analytical procedures. Samples were collected from five different sites and analyzed for following parameters such as color, odor, taste, pH, conductivity, total dissolved solids, total hardness and concentration of principal cations and anions such as Na^+, K^+,Mn^{2+}, Fe^{2+}, Cl^-, SO_4^{2-}, phosphate PO_4^{2-} and nitrate NO_3^-. The results of the physico-chemical analysis were obtained in the following range pH (5.71- 6.14), temperature (31.1-31.9˚c), turbidity (0.12-0.37mg/l), conductivity (24.92-113.03µS/cm), odor (odorless), chloride (0.00 -41.34 mg/l), total dissolved solids (13.06- 40.45mg/l), total suspended solids (0.00-0.59mg/l), total hardness (2.6-7.8mg/l), Colour (1-2ptCO), Sulphate (12.5-194mg/l), Phosphate (0.004-0.007mg/l) and Nitrate (0.23-2.15mg/l) .The concentrations of the metals can also be expressed in the following range; Na^+ (2-20 mg/l), K^+ (1-3 mg/l), Mn^{2+}(2.5-9.34 mg/l), Fe^{2+}(0.32-1.48mg/l). The data showed that there is variation in the investigated parameters and the highest value of physico-chemical parameters were obtained in Iyekeki. The concentrations of the investigated parameters of water samples conform to the permissible limits set by World Health Organization except that the pH values of the water samples were below the standards set by WHO/Nigeria standard of drinking water and the concentrations of manganese in the water samples exceed the standard set by World Health Organization.

Key word: ***Physicochemical, underground reservoir, Ogwa communities, water quality standards.***

INTRODUCTION

Water of good drinking quality is of basic importance to human physiology and man's continued existence depends very much on its availability. An average man, require about 3 liters of water in liquid and food daily to keep healthy [12]. Water is regarded as one of the most indispensable substances in life and like air it is the most abundant. However, despite its abundance, good quality drinking water is not readily available to man [13].

Unavailability of good quality drinking water is wide spread and this has serious health implications. In developing nations of the world, 80% of all diseases and over 30% of deaths are related to drinking water [14].

Fresh water has a scare commodity due to over exploitation and pollution of water. Increasing population and its necessities have led to the deterioration of surface and sub-surface water. The importance of ground water for the existence of human society cannot be overemphasized. Ground water is ultimate, most suitable fresh water resource with nearly balanced concentration of the salts for human consumption [18]. Over burden of the population pressure, unplanned urbanization, unrestricted exploration policies and dumping of the polluted water at inappropriate place enhance the infiltration of harmful compounds to the ground water, Contaminants such as bacteria, viruses, heavy metals, nitrates and salt have found their way into water supplies as a result of their inadequate treatment and disposal of waste (human and livestock), industrial discharges and overuse of limited water resources [18]. Contamination of water resources available for household and drinking purposes with heavy elements, metal ions and harmful microorganisms is one of the serious major health problems. Thus there is a need to look for some useful indicators, both chemical and physical, which can be used to monitor the quality of drinking water. This fact apparently accounts for why water is regarded as one of the most indispensable substances in life and like air it is most abundant. However, despite its abundance, good quality drinking water is not readily available to man. According to Federal Ministry of Health statistics, only about 30% of Nigerians have access to portable water while the United Nations estimated that about 1.2 billion people all over the world lack access to portable water. When it’s physical, chemical and microbiological qualities conform to specified standards. To achieve such standards raw water is subjected to purification processes that range from simple long-term storage to enable sedimentation of some suspended solids to aeration, coagulation, flocculation, filtration and disinfection among other treatments [18]. Variation in the combination of treatments required, vary with the source and hence, quality of the raw water [19]. Sources of water are many and varied, the levels of contamination also vary, and consequently a high degree of public health hazard can be associated with drinking water. The implication therefore is that, any drinking water sold to the public must be made wholesome and must meet WHO standards [13]. Unfortunately, the quality of water sold to the public in many places in Nigeria may not be said to be wholesome [20]. According to the Institute of Public Health Analyst (IPAN), 50% of the “pure water” sold in the streets of Lagos may not be fit for human consumption [15]. The possibility that the same situation may be applicable to other cities in the country prompted this work.

Water pollution means that some damage has been done to an ocean, river, lake or other water source.

According to Woodford Chris [21] water pollution means when one or more substance has built up in water, to such an extent that they cause problem for human and animals.

Surface water and underground water are two types of water resource that pollution affects, there are two different ways in which pollution can occur, if pollution comes from a single location, such as a discharge pipe attached to a factory, it is known as point source pollution. Another example of point source pollution is oil spill from a tanker.

A great deal of water pollution happens not from one single source but from many different scattered sources. This is called non-point – source pollution [21]

Sometimes chemical released by smoke stack can enter the atmosphere and then fall back to earth as rain, entering seas, river lakes reservoirs and causing water pollution. Water pollution has a many different causes and this is one of the reasons why it is such a difficult problem to solve [6].

Water pollution is all about quantities, how much of a polluting substance is released and how big a volume of water it is released to.

Water quality standards for surface water vary significantly due to environmental conditions, ecosystems, and intended human uses. Toxic substances and high population of certain microorganisms can present a health hazard for non – drinking purpose such as irrigation, swimming, fishing, and rafting, boating and industrial uses [3]. Therefore, it is necessary that the quality of water should be checked at all times, due to use of contaminated drinking water, human population suffer from varied water borne diseases [4].

Water quality is dependent on the type of the pollutant added and the nature of mineral found at particular zone of bore well. Monitoring of the water quality of ground water is done by collecting representative water samples and analysis of physicochemical characteristics of water samples at different locations. Underground water is used for domestic and industrial water supply and also for irrigation purposes in all over the world. In the last few decades, there has been a tremendous increase in the demand for fresh water due to rapid growth of population and the accelerated pace of industrialization. According to WHO organization, about 80% of all the diseases in human beings are caused by water [25]. Once the water is contaminated, its quality cannot be restored back easily and to device ways and means to protect it. Water quality index is one of the most effective tools to communicate information on the quality of water to the concerned citizens and policy makers. It, thus, becomes an important parameter for the assessment and management of groundwater. Underground water is the major sources of drinking water in Ogwa (Esan-land) area of Edo state.

Different types of storage

1. **Rainwater storage**

Storage is usually the most expensive component of a rainwater system and often determines the type of filtration and pumping system.

a. Surface storage:

Free-standing plastic tanks provide the least expensive means of rainwater storage, both in purchase cost and installation cost. They are relatively easy to handle, require little or no excavation, and work with almost any topography. On the other hand, they have many liabilities;

b. Underground storage:

In contrast to surface tanks, underground tanks are invisible, are unaffected by freezing weather, and can last indefinitely. Plumbing and pre-filtration is straightforward, even for large roofs with multiple downspouts. Since underground tanks provide a cool, dark environment inhospitable to algae and microbial growth, they are always preferred when rainwater is to be reused inside buildings. On the other hand, underground storage is usually two to three times as expensive as surface storage and involves significant excavation which can be problematic for sites with large rocks or high groundwater.

c. Diffusers and Traps:

If rainwater is simply dumped into a storage tank, it will create turbulence that will suspend solids that have accumulated at the bottom and submerge debris floating on the surface. Until the water column has sufficient time to re-stratify, often several days, the quality of extracted rainwater will be diminished. This problem can be largely avoided by using a diffuser at the bottom of the tank, a device that reduces the water velocity and re-directs the water upward and away from the sediment layer.

But in this area of Edo state majority uses excavation method. This method is a process of digging the ground to a particular depth and, plasters the ground to a four corner sides before covering with sink or aluminum materials.

Study Area

Ogwa is located in Esan West Local Government Area of Edo State. It is the second largest after Ekpoma. The major sources of drinking water in this area are underground reservoir and borehole water. Lack of safe drinking water, basic sanitation, and hygienic practices are associated with high morbidity and mortality from excreta related diseases. In this part of Edo state, it is difficult to get water because the ground level is higher than the sea level and it is very difficult to get good water especially for drinking. Underground water is the major sources of drinking water in Ogwa, Esan-land area of Edo state.

This work is aimed at providing necessary information on the quality of the reservoir water in Ogwa Communities and compare them with WHO and Nigeria standards of drinking water quality with a view to know the possiblehealth implications for the consumers.

MATERIAL AND METHODS

Collection of samples

Water samples were collected from residential underground reservoirs in Egbawa, Idewingie, eguare, Ikpogho, Iyakeki of Ogwa town. This was possible by using a clean fetcher attached with a line. The water pH and temperature were determined immediately the water was collected and water samples were preserved in the refrigerator at 4 ^{o}C.

Chemicals used

All chemical used were of analytical grade and reagent grade from BHD, JDH and AR chemical and used without further purification.

Physicochemical Analysis of Samples

Determination of Colour

Rinse the filter by pouring 50ml of water through it. Discard the rinse water. Pour another 50ml of water through the filter. Fill a cuvette with 25ml of the filtered water sample. Read at 455nm.

Calculation

Colour of water in mg/l PtCo = Sample Colour – Water Colour.

Determination of odour

A wide-mouthed glass Stoppard bottle was rinsed internally and externally with 4 molar (M) hydrochloric (HCl) until it was completely odorless and then finally rinsed with distilled water. A sample was obtained and was half-filled into the bottle, a stopper was inserted and was shook vigorously for two (2) to three (3) second, the stopper was then removed and the odor was quickly observed by putting the nostrils near the mouth of the bottle (Njosi, 2010).

Temperature determination

This was determined at the time of analysis. An aliquot of 50 ml of sample was measured into a 100ml beaker and a 0-60^{o}C thermometer immersed in the solution. The reading on the thermometer was then recorded.

Total dissolved solids (TDS) determination

A 50ml well-mixed sample was measured into a beaker. The WTW TDS/ Conductivity meter probe was immersed in the sample and its conductivity recorded.

Conductivity determination

The conductivity meter was standardized with 0.01N potassium chloride (KCl) solution. The conductivity of this solution was found to be 1413 µS/cm at 25^{o}C with a cell constant of 1. Each sample of 100ml volume was measured into a beaker, and its conductivity was determined using Hanna 911 conductivity meter. The test was done after refrigerated samples were allowed to attain room temperature.

Mineral analysis

Sodium and potassium were determined using the flame photometer (Jenwaymodel PFP7/C). Manganese (Mn^{2+}) and iron metals (Fe^{2+}) were determined atomic absorption spectrometric (AAS) methods (APHA, 1992).

RESULT AND DISCUSSION

Table 1**:** Physicochemical Properties of water sample

A- Egbawa, B- Idewingie, C- Eguare, D- Ikpogho, E- Iyekeki.
N/G- No guidelines.

Table 2: Concentration of metals in the water samples

Samples		**EC (µs/cm)**	**TSS (mg/l)**	**TDS (mg/l)**	**Turbidity (mg/l)**	**Odour**	**Temp. °C**	**Chloride Cl (mg/l)**	**Total Hardness (mg/l)**	**Nitrate NO_3^-**	**Appearance (ptCo)**	**Phosphate PO_3^{2-} (mg/l)**	**Sulphate mg/l SO_4^{2-}**
A	5.97	48.00	0.53	24.85	0.37	Odorless	31.1°C	7.45	2.6	1.15	1	0.007	141
B	5.71	24.92	0.59	13.06	0.21	Odorless	31.7°C	14.8	7.8	2.15	1	0.006	68.5
C	6.11	33.82	0.42	17.39	0.12	Odorless	31.9°C	4.96	5.2	1.5	2	0.005	12.5
D	5.97	48.00	0.00	24.85	0.37	Odorless	31.8°C	0.00	3.6	0.15	1	0.004	194
E	6.14	113.03	0.11	40.45	0.17	Odorless	31.1°C	41.34	4.2	0.23	2	0.007	144
WHO Standards	**6.5-8.5**	**1000**	N/G	**1000**	**5**	Odorless	N/G	250	**100-500**	50	15	50	500
Nigeria Standard for drinking water quality	6.5-8.5	N/G	N/G	500	5	Unobjectionable	Ambient	250	150	50	15	N/G	100

Samples	Na (mg/l)	K (mg/l)	Detection limit (ppm)	Iron (mg/l)	Mn (mg/l)
A	20	1	0.20	0.32	7.64
B	6	2	0.20	0.67	4.18
C	3	1	0.20	0.39	2.50
D	3	1	0.20	0.32	7.04
E	2	3	0.20	1.48	9.34
WHO Standards	>20	>12		0.5-50	0.5
Nigeria Standard for drinking water quality.	200	N/G		0.3	0.2

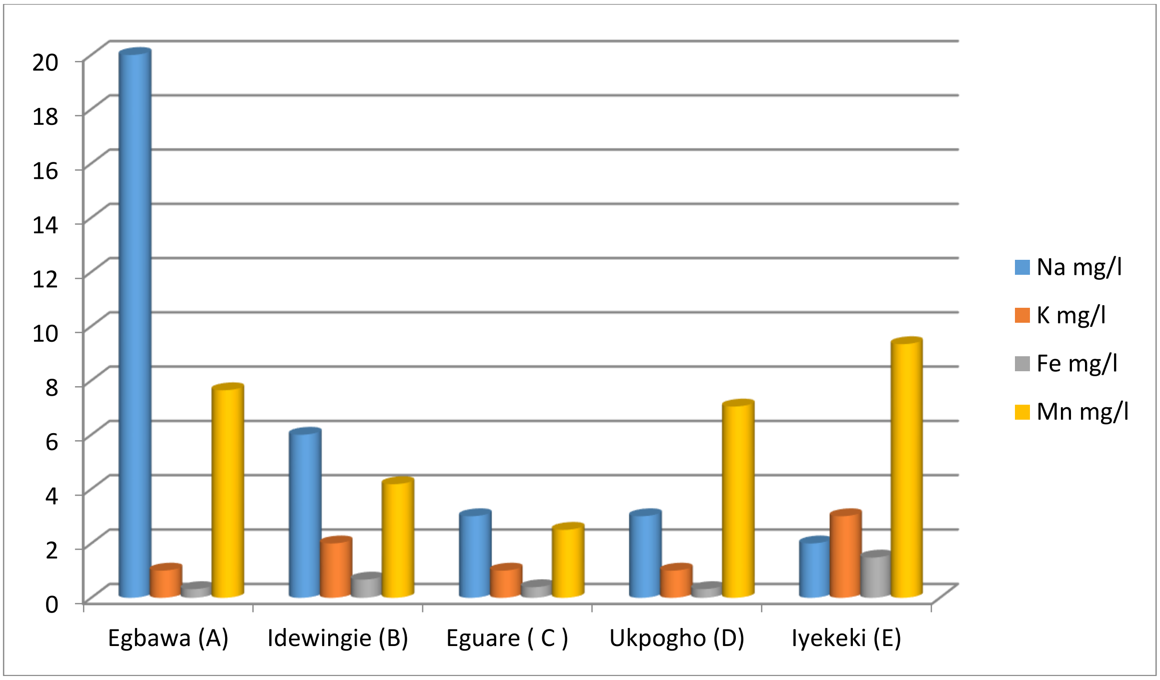

Fig. 1: Variation of the concentrations of metals in the various samples

Table 3: Statistics of Physico-Chemical Parameters of the water samples

Parameters	**Mean ± SD**	**CV (%)**	**WHO Std.**	**Nigeria Standard**
pH	5.98 ± 0.17	2.843	**6.5- 8.5**	**6.5-8.5**
EC(μs/cm)	53.55± 34.67	64.74	1000	N/G
TSS (mg/l)	0.33± 0.26	79.10	N/G	N/G
TDS (mg/l)	24.12± 10.43	43.24	1000	500
Turbidity (mg/l)	0.248± 0.118	0.37	5	5
Temperature (^{O}C)	31.52± 0.77	2.442	N/G	Ambient
Chloride (mg/l)	13.71± 16.34	119.18	250	250
Total Hardness (mg/l)	4.68± 1.98	42.35	100-500	150
Nitrate (mg/l)	1.036± 0.85	82.14	50	50
Apearance(ptCo)	1.4± 0.54	38.57	15	15
Phosphate (mg/l)	0.029± 0.026	89.66	50	N/G
Sulphate (mg/l)	112± 71.38	63.73	500	100

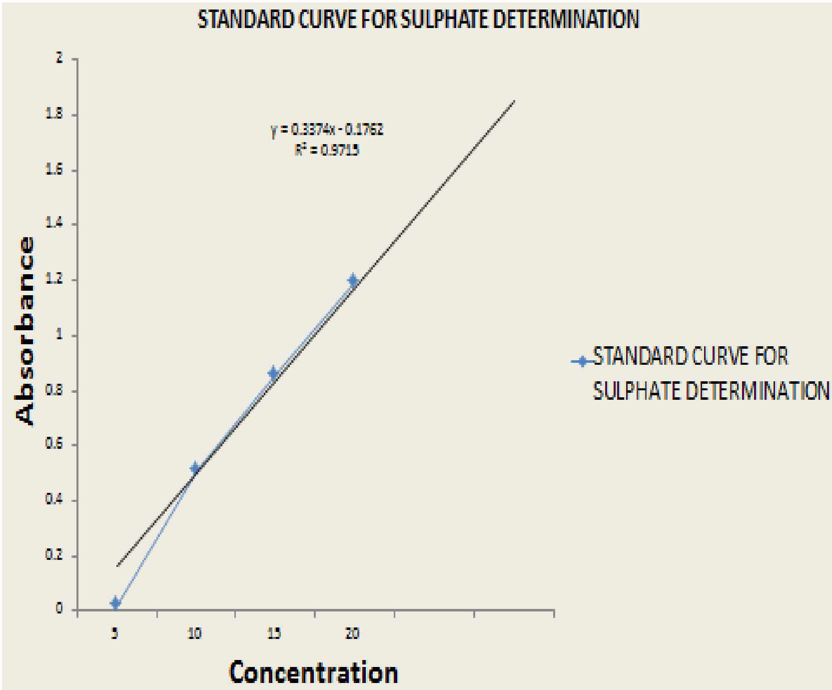

Fig 1: STANDARD CURVE FOR SULPHATE DETERMINATION

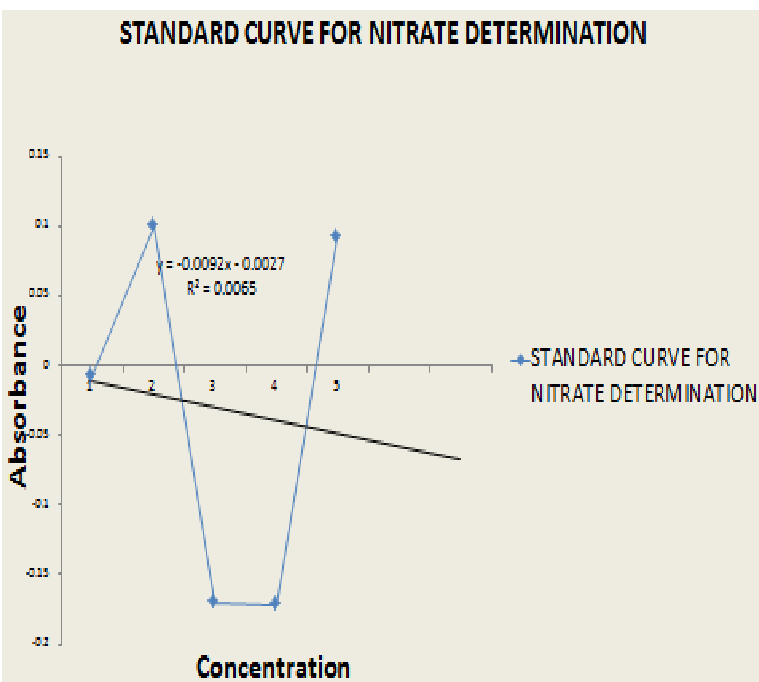

Fig 2: STANDARD CURVE FOR NITRATE DETERMINATION

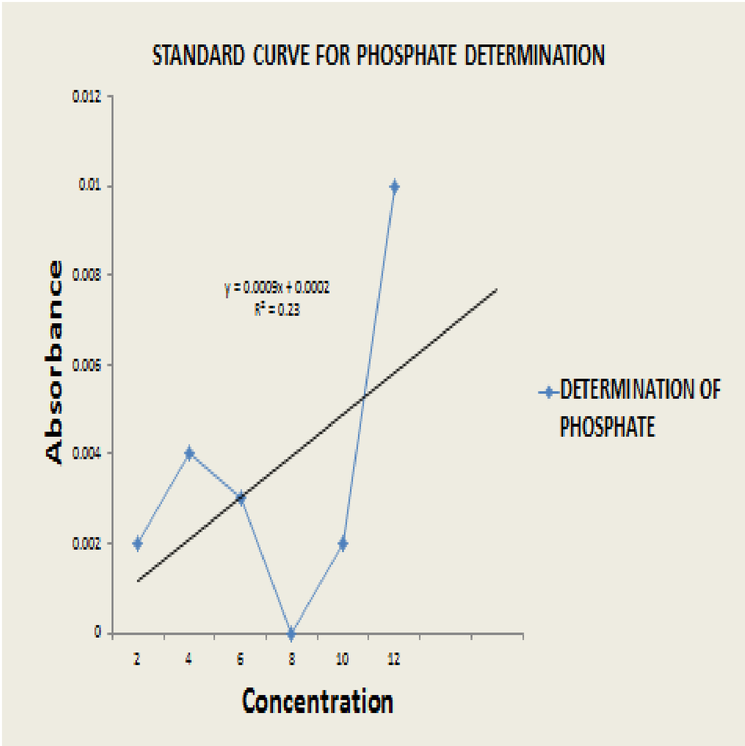

Fig 3: STANDARD CURVE FOR PHOSPHATE DETERMINATION

The result of the physicochemical analysis (Table 1) indicates that the water sample analysed was odourless and have pH values between 5.71 and 6.14 which falls below the WHO and Nigeria standards of drinking water quality. Water with a low pH (< 6.5) could be acidic, soft, and corros ive. Therefore, the water could contain metal ions such as iron, manganese, copper, lead, and zinc...or, in other words, elevated levels of toxic metals [10]. Electrical conductivity values is between 24.92 and 113.03, Total Dissolved Solids (TDS) of water sample is between 13.06mg/l and 40.45mg/l, the Total Suspended Solids (TSS) values is between 0.00 and 0.59, The values for water hardness ranges between 2.6 mg/l to 7.8mg/l, Turbidity; 0.12 and 0.37mg/l,Colour; 1 and 2ptCO, Chloride; 0.00 mg/l to 41.34mg/l, Sulphate; 12.5 to 194, Phosphate; 0.004 to 0.007mg/l and Nitrate; 0.23 to 2.15mg/l all fell within the standard set by WHO and Nigeria standards of drinking water.

The concentrations of manganese (Mn) in the water samples (Table 2) are very high with respect to the standard set by Nigeria and WHO. High level of manganese in drinking water can result in Neurological disorder [9]. The range of values obtained for sodium (2-20mg/l) and potassium (1-3mg/l) are within the limits set by WHO but high values of sodium (20mg/l) was obtained from water samples collected from Egbawa. High concentration of iron (1.48mg/l) was obtained from sample collected from Iyekeki exceeding the standard of drinking water in Nigeria. Iron is an essential trace element for the human body; however, a high concentration of Iron gives water a bad taste and reddish colour [24]. It could also cause encrustation, staining of laundry and toilet fixtures [26]. Fig. 1 shows the variation in the concentrations of metals in the water samples.

There was a significant difference in the concentration of sodium and manganese over the five samples with Egbawa having the highest concentration of Sodium and Iyekeki having the highest concentration of manganese. There was no significant difference in the concentration of iron except in Iyekeki where we have the highest concentration of iron. The highest concentration of potassium was obtained in Iyekeki followed by idewingie.

The results in table 3 revealed that pH recorded a mean value of 5.98 and a standard deviationof ± 0.17, the electrical conductivity (EC) has a mean value of 53.55 **(μs/cm)** and a standard deviation of ± 34.67. Phosphate recorded the lowest mean value of 0.029 mg/l and a standard deviation of ± 0.026. The result of the coefficient of variation varies from 2.843% to 119.18%. However,the physicochemical properties of the water samples conform to the permissible limits set by World Health Organization except the pH values of water samples that were below the standards set by WHO/Nigeria standard of drinking water and the concentrations of manganese in the water samples exceeding the standard set by World Health Organization.

CONCLUSION AND RECOMMENDATION

The well water samples in Ogwa community are of acceptable physicochemical and metal values according to World Health Organization Standards for drinking water and Nigeria standard of drinking water quality except for the pH and the concentration of manganese that are higher than the standard values. It is important that possible treatment is carried out on the underground reservoir water before drinking. The data showed that there is variation in the investigated parameters and the highest value of physico-chemical parameters were obtained in Iyekek. In conclusion, there is the need for constant routine analysis to ensure safety and non-contamination of the underground reservoir and further investigation can be carried out on the microbial analysis and possibility of heavy metals contaminations like Zn, Cu, Cr, Ca, Mg, Pb in the water samples should be investigated.

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