IPS Journal of Applied Microbiology and Biotechnology
IPS J Appl Microbiol Biotech, 1(1): 12-15 (2022)
DOI: https://doi.org/10.54117/ijamb.v1i1.11

Physicochemical and Microbial Assessment of Selected Borehole Water in Ogwashi-Uku, Delta State, Nigeria

Amalachukwu Grace Ofuani and Edward C. Destiny

Department of Science Laboratory Technology, Delta State Polytechnic, Ogwashi-Uku, Delta State, Nigeria.
*Corresponding author e-mail: graceokolobi@gmail.com

Abstract

The assessment of the quality of water samples from Ogwashi-Uku, Delta State, Nigeria was conducted to determine the suitability of these borehole water samples. Three samples of borehole water obtained from three different areas in Ogwashi-Uku were analyzed for physiochemical heavy metals and microbial parameters using standard analytical method of APHA (1998). The results of microbial analysis revealed that total coli form count (0.00CFU/100ml) and *Escherichia coli* (0.00CFU/100ml) were not present in all the water samples analyzed showing that they were within the stipulated standard by WHO (2011). The physiochemical analysis showed that all the samples met the recommended standard except for pH (6.00-6.60) which fell below the range of 6.5-8.5 of WHO standard. From the heavy metals; lead and zinc were only detected in Mega Chi's place water samples with a value of 0.10mg/l for each, cadmium was detected in all the water samples ranging from 0.01mg/l – 0.02mg/l, while copper and nickel were below detectable limit in all the water samples analyzed. This shows that the heavy metals were all within the stipulated limit set by WHO (2011). The depth of the borehole in relation to the distance of the septic tank and distance of refuse dump as obtained from these areas revealed that all the samples are very far apart from the refuse dump and the depths was according to the regulatory standard of 150ft standards and is safe for drinking and for other domestic purposes.

Keywords: *Water, microbial properties, quality, heavy metal, contamination, borehole*

Article History
Received: 16 Feb 2022
Accepted: 07 Mar 2022
Published: 22 Mar 2022

How to cite this paper: Ofuani, A. G., & Destiny, E. C. (2022). Physicochemical and Microbial Assessment of Selected Borehole Water in Ogwashi-Uku, Delta State, Nigeria. *IPS Journal of Applied Microbiology and Biotechnology*, *1*(1), 12–15. https://doi.org/10.54117/ijamb.v1i1.11.

1. Introduction

Water is abundant in the world and plays a crucial role in our ecosystem. It occurs as surface water in lakes, streams, rivers, ponds, shallow aquifers, oceans, seas, ice caps, glaciens etc. and as groundwater (when it accumulates in the ground) which is obtained as spring water, well water and borehole water [1]. About 94 % of all freshwater is ground water [2]. It is thus one of the most widely available and essential natural resources that support life in general and human activities in particular. In developing countries boreholes are economically viable option for water production and supplies for domestic and general use. Generally, many people are dependent on surface water however with increasing challenges of contaminated surface water resulting in diseases such as sleeping sickness, river blindness and guinea worm etc. many societies have adopted digging of borehole [3]. Ground waters are generally considered as 'safe sources' of drinking water because they are produced with low microbial load with little need for treatment of the water before drinking [4].

Groundwater, however, can be contaminated from its recharge source or through interaction with the local geology. Dissolved elements such as arsenic, boron, selenium and radon; a gas formed by the natural breakdown of radioactive uranium in soil may find their way into groundwater through faults and fractures in the geology. These natural contaminants become a health hazard when present in high doses. Human induced contamination may also occur from chemical spillage from industries. Microbial and faecal matters are other contaminants of borehole water. These may arise as a result of improper siting of underground septic and crude tanks and discharge of industrial liquid waste into groundwater recharge zone [4]. Providing safe drinking water is one of the most complex challenges facing African rural communities. The continent has the highest number of people lacking access to safe drinkable water [5].

According to WHO report (2010), Nigeria lacks adequate improved water resources with only 40% of the water resources improved, thus 60% of the water resources are faced with contamination which is beyond the WHO maximum permissible limit which has led to risk of water borne disease like typhoid and diarrhea.

Heavy metal contamination in water has also been responsible for mortality and morbidity in human due to intoxication and

constitutes a major public health problem [6,7]. Examples of these heavy metals are Lead, Mercury, Arsenic, Manganese, Cadmium etc. [6,8,9]. Although some of the heavy metal are importance to human health at lower concentration, such as iron, zinc, copper etc.

Due to the adverse effects heavy metals have on humans' when it accumulates, regulation bodies which include the WHO, Food and Agricultural Organization (FAO), United State Environmental Protection Agency (USEPA), have set up standard for heavy metals contamination to ensure the quality and safety of water [10,11,12]. The quality of water is determined by its physical, chemical and microbiological properties.

In Ogwashi-Uku town, borehole is one of the major source of water, however with increase in population, reliance on borehole water resources is increasingly creating challenges of provision of adequate quality water. In view of this, the study aimed to assess the physicochemical properties, heavy metal contents and the microbial properties of borehole water in Ogwashi-uku, Delta State of Nigeria.

2. Material and Method

2.1 Sample Location

Ogwashi-Uku is a town in Delta State, Nigeria. It is located West of the State capital, Asaba and is the headquarters of Aniocha South Local Government Area. Its geographical co-ordinances are 6º.10' 41.20 ºN, 6 º.31' 28.60 º E (Latitude 6''10' 41.2ºN, Longitude 6 º.31 28.6ºE) with the latitude of 252m. The climate is classified as tropical and season spans May to October with a brief dry spell in August. The average annual temperature in Ogwashi-Uku is about 26ºC. According to geographical database, Ogwashi-Uku has a population of about 26,137.

2.2 Sample Collection

A total of six (6) water samples were collected from three (3) different boreholes in Ogwashi-Uku namely; Mega chi's place, Aboh and General Hospital using sterile sample bottles. The samples collected were kept between the temperature of 4-10ºC and transported immediately to the laboratory for proper analysis.

2.3 Sample Preparation and Analysis

The physiochemical parameter determined are pH, Electrical conductivity (EC), total dissolved solid, Nitrates and phosphates. While the heavy metals analyzed are Lead (Pb), Cadmium (Cd), Copper, Zinc (Zn) and Nickel using the method of APHA 1998. The total microbial parameters are total microbial counts and coli form count.

2.4 Determination of Physiochemical Parameter

The pH was read at the point of collection using electronic pH meter while Electrical conductivity (EC), total dissolved solid, Nitrates and phosphates were determined according to APHA (1998) standard method [13].

2.5 Determination of Heavy Metals

Heavy metals were analyzed according to the method of American Public Health Association (APHA, 1998) using varian AA240 AAS (Atomic Absorption spectrophotometer). 100ml of the samples was thoroughly mixed by shaking in a beaker and 5ml of concentrated nitric acid was added. The mixture was heated to evaporate until the volume was reduced to about 20ml and concentrated nitric acid was further added till the point of complete dissolution of all the residues. The sample was cooled and distilled water was added to complete the volume 100ml. The sample was placed inside the AAS.

2.6 Determination of Microbial Parameters

The Total Coliform Count (TCC) and *Escherichia coli* was performed using the membrane filtration technique [14]. Overall, 50 mL of each water sample was filtered through 0.45-µm filter papers and the filters were placed on nutrient, mFC, and mENDO agar plates that were incubated at 37 °C for 24 to 48 hours. Blue and metallic sheen colonies from mFC and mENDO plates were purified and identified while the colonies from nutrient agar plates were purified and sub-cultured on MacConkey agar, blood agar, mannitol salt agar, cetrimide agar, and bile esculin agar plates, which were incubated aerobically at 37 °C, respectively, for 24 to 48 hours. Pure colonies were isolated and screened by gram staining and morphological/biochemical methods [15,16,17].

3. Results

The results of the mean values obtained from the physicochemical, heavy metals and microbial analysis of boreholes water in Ogwashi-uku, Delta State of Nigeria are shown in Tables 1, 2, & 3 respectively. These results were compared with that of the World Health Organization (WHO, 2011). From the physiochemical parameters (pH, conductivity, total hardness, nitrate, phosphate and total dissolved solid) as presented in Table 1 shows that borehole sample from Aboh has the highest pH (6.60) while Mega chi's place and general hospital has the lowest values of (6.00 and 6.20) respectively.

Table 1: Mean Values of the Physicochemical Parameters of the different Borehole Water Samples analyzed

S/N	Samples	Sample designation			WHO Standard
		Aboh	Mega Chi's	General Hospital	
1.	*pH*	6.60	6.60	6.20	6.5-8.5
2.	Electrical conductivity (Ns/cm)	700.00	604.00	581.50	1500mg/l
3.	Total dissolved solid (mg/l)	35.25	62.65	28.85	800mg/l
4.	Total hardness (mg/l)	86.16	79.23	86.15	150
5.	Nitrate (mg/l)	1.14	1.18	1.33	50
6.	Phosphate (mg/l)	8.85	9.62	18.09	0.1mg/l

The Electrical conductivity of the water samples ranges from 581.5 to 700.00 (Ns/cm), while the quantity of nitrate found in

the borehole water samples ranged from 1.334 mg/l to 1.1835 mg/l and the highest value was recorded in Mega chi's place (1.1835mg/l) borehole water sample.

The phosphate measured ranged from 8.85 to 18.094mg/l. The highest value for hardness was 86.16mg/l which was observed in water sample collected from Aboh while borehole water samples from Mega Chi's place and General Hospital and the least hardness of 79.23mg/l.

From Table 2, the cadmium value ranges from 0.01 to 0.02 (mg/l) which is within WHO standard. All borehole water samples from Aboh and General Hospital have no trace of lead and copper except water sample from Mega Chi's place with lead value of 0.1mg/l, there was no trace of nickel in all the borehole samples. The results from the study shows that heavy metal content in all the borehole water samples were within WHO standard.

Table 2: Mean Values of Heavy Metals of the different Borehole Water Samples Analyzed

S/N	Samples	Sample designation			WHO Standard
		Aboh	Mega Chi's	General Hospital	
1.	Lead (mg/l)	BDL	0.1	BDL	0.1mg/l
2.	Cadmium (mg/l)	0.01	0.02	0.01	0.05mg/l
3.	Copper (mg/l)	BDL	BDL	BDL	2mg/l
4.	Zinc (mg/l)	BDL	0.01	BDL	3.00mg/l
5.	Nickel (mg/l)	BDL	BDL	BDL	0.02mg/l

The results of the microbial analysis of the borehole water samples were within WHO set standard (Table 3).

Table 3: Mean Values of Microbial Parameters of different Borehole Water Samples Analyzed

S/N	Samples	Sample location			WHO Standard
		Aboh	Mega Chi's	General Hospital	
1.	Total Coliform count ($CFU/100ml$)	0	0	0	0
2.	*Escherichia coli* ($CFU/100ml$)	0	0	0	0

Discussion

Table 1 shows that borehole water samples from Aboh has the highest pH (6.60) while Mega chi's place and general hospital has the lowest values of 6.00 and 6.20 respectively. This shows that pH values of water samples from Megachi's place and General hospital is below the standard requirement by WHO. The pH range in this study is close to neutrality and would allow the growth of most bacterial species. Eniola et al (2007) obtained similar pH ranges of 6.54-7.80 and 6.54-7.0 for borehole water [19].

The low conductivity which ranges from 581.5 to 700.00 Ns/cm was observed in the water samples collected from all the three areas, and this is in agreement with WHO standard. The total hardness of borehole water in Ogwashi-uku is 86.15mg/l which falls below the WHO set standard of $\leq$ 150mg/l, according to Udom et al, 2002, the borehole water samples are soft water and suitable for drinking, cooking and other domestic use [20].

The quantity of phosphate and nitrate found in the borehole water samples are within the set standards by WHO.
The heavy metals analyzed in the borehole water samples were all within the standards stipulated by WHO (2011).

The results of the microbial study show that *Escherichia coli* and total coliform counts in the borehole water samples was 0.00CFU/100ml. They are generally within the standard and requirements of WHO.

Conclusion

Based on the results from physiochemical analysis, heavy metals and microbial analysis, the borehole waters in Ogwashi-Uku, are safe for consumption as it complied with the standard requirements by WHO. The principal aim of monitoring drinking water is to prevent the spread of water borne diseases and to protect the health of the community. The importance of access to good quality water cannot be over-emphasized. However, it is recommended that there is need for continuous water quality monitoring and steady sanitation around the borehole areas.

References

[1] Chandra S, Singh A, Tomar PK (2012). Assessment of water quality values in Porur Lake Chennai, Hussain Sagar Hyderabad and Vihar Lake Mumbai, India. Chem. Sci. Trans., 1: 508-515

[2] Groundwater Hydrology by The United States Department for Interior and The United States Geological Survey,1983

[3] WHO (2004). WHO Guidelines for Drinking Water-quality, Second Edition, Volume One, Geneva. pp145-196

[4] UNEP and WHO, (1996). Characterization and Assessment of Groundwater Quality Concerns in Asia-Pacific region. UNEP/DEIA/AR.961, United Nations Environmental Programme, Nairobi, Kenya

[5] WHO, (2008), International program on chemical safety. Environmental Health Committee Report 5:65-78.

[6] Ibrahim D., Froberg B., Wolf A., Rusynaik D.E., (2006). Heavy Metal Poisoning Clinical Preventions and Pathophysiology. Clin. Lab. Med. 26:67-97

[7] Cabrera C., Lorenzo M.L., and Lopez M.C. Lead and Cadmium Contamination in Dairy Products and Its Repercussion on Total Dietary Intake. *Journal of Agricultural and Food Chemistry* **2005** *43* (6), 1605-1609, DOI: 10.1021/jf00054a035

[8] Galadima A, Garba ZN (2012). Heavy metals pollution in Nigeria: causes and consequences. Elixir J. Pollut 45: 7917-7922.

[9] Duffus J.H. (2002). "Heavy metal- a meaningless term? Pure Appl. Chem. 74:793-807

[10] WHO (2011). Guidelines for Drinking-Water Quality, Vol. 38, 4th edn. World Health Organization, WHO, Geneva, Switzerland, pp. 104–108

[11] Food and Agriculture Organisation (FAO) (1997). Chemical analysis manual for food and water, 5th Ed, FAO rome, 1: 20-26

[12] USEPA (United States Environmental Protection Agency) (2011). 2011 edition of the drinking water standards and health advisories. Office of water US Environmental Protection Agency Washington, D.C

[13] American Public Health Association (APHA) (Ed.) *Standard Methods for the Examination of Water and Wastewater*, 20th ed. American Public Health Association: Washington, DC. 1998.

[14] United States Environmental Protection Agency. *Method 1603: Escherichia coli in Water by Membrane Filtration using Modified Membrane-Thermotolerant Escherichia coli Agar (Modified mTEC)*. Washington, DC, USA: US Environmental Protection Agency office of water (4303 T); 2009. 42 p.

[15] Cruikshank R, Duguid JP, Marmoin BP, Swain RH. *Medical Microbiology*. **2**. 12th ed. New York, USA: Longman Group Limited; 1975.

[16] Simmons JS. A Culture Medium for Differentiating Organisms of Typhoid-Colon Aerogenes Groups and for Isolation of Certain Fungi: With Colored Plate. *J Infect Dis*. 1926;**39**(3):209-14. doi: 10.1093/infdis/39.3.209.

[17] Prescott LM. *Introduction to Microbiology*. **20**. 5th ed. New York, USA: McGraw-Hill companies; 2002. p. 21-92.

[18] American Public Health Association (APHA) (Ed.) *Standard Methods for the Examination of Water and Wastewater*, 20th ed. American Public Health Association: Washington, DC. 1998.

[19] Eniola KIT, Obafemi DY, Awe SF, Yusuf II, Falaiye OA (2007). Effects of Containers and Storage conditions on Bacteriological Quality of Borehole Water. Nigerian J. Microbiol., 21(3): 1578 – 1585

[20] Udom GJ, Ushie FA, Esu EO (2002). A Geochemical Survey of Groundwater in Khana and Gokana Local Government of Rivers State, Nigeria. Environmental Magnagement, 6 (1): 53-59.

• *Thank you for publishing with us.*