Water quality assessment of some selected Boreholes in Awka, Anambra State, Nigeria

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ABSTRACT

In this study, the water quality assessments of six boreholes were carried out using 19 parameters which included odour, colour, pH, temperature, alkanility, total hardness, calcium (Ca^{2+}), magnesium (Mg^{2+}), nitrate (NO^{3-}), total dissolve solid (TDS). Sulphate (SO_4^{2-}), iron, manganese, zinc, cadmium, lead, chromium, arsenic and total coliform. The results indicated that the water quality of the boreholes were poor as far as WHO guideline is concerned. The results obtained in some of the samples exceeded WHO recommended limit. EBE had the highest value for Arsenic at 0.06 mg/L. UMU and OBU had Lead values of 0.02 mg/L. The highest value for Zinc (13.41 mg/L) and Manganese (0.84 mg/L) were recorded in EBE. NRI had the highest value of Iron (4.12 mg/L) and coliform count of 2 was recorded in EBE. Thus, there is a considerable need for proper treatment of water from these areas to provide adequate water that meets the WHO guideline values for drinking water. The origin of the contamination observed in this study was not ascertained, therefore there need for further study to determine the source of the contamination of the borehole water and thus recommend preventive approach.

Keywords: *Water quality, Boreholes, Chemical substance, Heavy metals*

INTRODUCTION

Water is a common natural chemical substance containing two atoms of Hydrogen and an atom of Oxygen. It is very essential for human existence and sustenance of life. In spite of its importance in sustenance of live and livelihood, the body cannot survive longer than few days without adequate water (Alepu *et al.*, 2016). A primary concern of people living in developing countries is that of obtaining clean and safe drinking water. It is generally perceived that wells, springs and boreholes are "clean" sources of water. Although it is true that soil generally function to attenuate heavy metals and microorganisms by simple filtration mechanism, pollution of groundwater by industrial waste water and microorganisms, including those of public health significance do occur (Ashbolt and Veal, 1994 and Stanley *et al*., 1998).

The chemical, physical and bacterial characteristics of boreholes determine its safety for human consumption. Chemical analysis of groundwater includes the determination of the concentrations of inorganic constituent, pH and specific electrical conductance. Temperature, colour, turbidity, odour and taste are evaluated in a physical analysis. Bacteria analysis generally consists of tests to detect the presence of coli form organisms (Ojo *et al.*, 2012).

Groundwater is a reliable source of water supply, because it is often unpolluted due to restricted movement of pollutants in the soil profile (Lamikanra 1999 and Lamb, 1985). However, it is becoming increasingly difficult to maintain the purity of borehole water. One of the major sources of pollution of borehole water include seepages from underground storage tanks, oil wells, septic tanks, landfills, agricultural leaching and industrial waste (Adewuyi *et al.*, 2010). Thus there is the need to continually check the borehole water quality to ascertain their purity for human consumption. Hence, the objectives of this study are to investigate the quality of the selected borehole water within Awka metropolis and to compare the results of the water quality tests with WHO drinking water standards.

MATERIALS AND METHODS

Collection of sample and analysis

Water samples were collected from six selected boreholes located in six different villages in Awka, Anambra State of Nigeria. These included Ifite village borehole (IFE), Umunriofia village borehole (UMU), Obuno village borehole (OBU), Nriofia village borehole (NRI), Obinri village borehole (OBI), and Ebenato village borehole (EBE). The water sources that were selected are those that were used for drinking and other domestic purposes such as cooking and cleaning. 500 ml glass sampling bottles were used. The sampling bottles were washed with detergent, diluted HNO_3 and deionised distill water respectively. The water from each borehole was left to run for 3 to 4 min before collection. Three samples were taken from each point. The containers were completely filled to avoid oxidation. After sampling, the physical parameters were measured Physical and chemical properties of the water samples were determined on the same day of sampling. Each sample was analyzed for 19 parameters using standard procedures (Samie *et al.*, 2013 and APHA, 1992).They include odour, colour, pH, temperature, alkanility, total hardness, calciul (Ca^{2+}), magnesium (Mg^{2+}), nitrate (NO^{3-}), total dissolve solid (TDS). Sulphate (SO_4^{2-}), iron, manganese, zinc, cadmium, lead, chromium, arsenic and total coliform. The resultant levels of the parameters were compared with the WHO guideline values to ascertain their quality for safe consumption.

RESULTS AND DISCUSSION

The results of the water quality test for the six selected borehole water are presented in Table 1, odour and colour of the water samples were found to be unobjectionable and clear. Colour in water is usually caused by the presence of particles, accumulation of solids and slits (Mgbemena *et al.,* 2014). Odour in natural water usually result from volatile substances associated with organic and inorganic chemical materials such as algae and hydrogen respectively (La Dou, 2004). The pH ranged from 5.32 (IFE) to 6.58 (NRI). From the pH values, it is observed that the samples were acidic. This could be as a result of underground pollution caused by industrial, economic and agricultural activities within the sampling area. Except for NRI, the pH of all the samples were below the WHO guideline values of 6.5 to 8.5 (WHO, 2011). pH is generally considered to have no direct impact on humans. However, long term intake of acidic water can invariably lead to mineral deficiencies (Adekola *et al.,* 2015 and Fairweather-Tait and Hurrell, 1996). The temperature ranged between 21.40 (NRI to 28.15 (EBE). The values were not above the WHO maximum permissible limit. The TDS ranged between 15.05 in IFE to 30.65 in OBU. The values were below the maximum permissible values for drinking water. TDS is an indicator of the status and quality of water. They are due to soluble materials. TDS may induce an unfavourable physiological reaction in the consumer (ASTM, 2004). High concentration of TDS in water is also responsible for hardness, turbidity, odour, taste, colour and alkalinity (ASTM, 2004).

Total hardness varied from 21.50 mg/L in IFE to 32.01 mg/L in OBU. Water hardness is caused by calcium and magnesium and sometime iron. Though water hardness does not pose any health risk, high concentration of calcium and magnesium may be linked to outcomes in heart diseases (Nkamare *et al.*, 2012). The alkanility ranged from 28.81 mg/L in UMU to 32.30 mg/L in EBE. The values were below the WHO maximum permissible limit of 100 mg/L. The nitrate and sulphate levels fell within the permissible limits for drinking water with ranges from 0.55 mg/L (OBU) to 1.35 mg/L (OBI) and 17.72 mg/L (NRI) to 25.05 mg/L (OBU) respectively.

Table 1
The results of the water quality test for the six selected borehole water in awka, Anambra State, Nigeria.

Parameter tested	IFE	UMU	OBU	NRI	OBI	EBE	WHO standard limit
Odour	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless
Colour	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless
pH	5.32 ±0.02	5.80 ±0.22	5.5 ±0.10	6.58 ±0.12	5.81 ±0.12	5.60 ±0.02	6.5 – 8.5
Temp ^{0}C	23.34 ±0.01	25.70 ±0.5	26.20 ±0.12	21.40 ±0.10	26.41 ±0.20	28.15 ±0.01	30 – 32^{0}C
Alkalinity $CaCO_3$ (mg/l)	30.41 ±0.02	28.81 ±0.05	29.70 ±0.03	31.50 ±0.03	30.00 ±0.30	32.30 ±0.03	120 mg/L
Total hardness (mg/l)	21.50 ±0.02	22.01 ±0.02	32.01 ±0.20	27.10 ±0.14	28.10 ±0.10	25.50 ±0.3	100 mg/L
Ca ion (mg/l)	13.80 ±0.02	16.10 ±0.04	22.30 ±0.20	20.10 ±0.02	18.95 ±0.03	18.20 ±0.01	70 mg/L
Mg ion (mg/l)	7.70 ±0.02	5.80 ±0.03	10.79 ±0.20	6.40 ±0.02	7.25	6.30 ±0.01	70 mg/L
Nitrate mg/l	1.0 ±0.14	0.64 ±0.10	0.55 ±0.11	NIL	1.35 ±0.20	0.83 ±0.11	45 mg/L
TDS (mg/l)	15.05 ±0.11	24.05 ±0.20	30.65 ±0.12	15.85 ±0.02	21.01 ±0.20	28.05 ±0.01	1000 mg/L
Sulphate (mg/l)	21.01 ±0.03	20.60 ±0.15	25.05 ±0.21	17.72 ±0.12	20.91 ±0.02	21.70 ±0.20	250 mg/L
Iron (mg/l)	1.30 ±0.01	1.40 ±0.02	0.61 ±0.10	4.12 ±0.5	0.88 ±0.02	1.57 ±0.02	0.3 mg/L
Manganese (mg/l)	0.24 ±0.02	0.21 ±0.00	0.34 ±0.10	0.43 ±0.10	0.48 ±0.12	0.84 ±0.21	0.05 mg/L
Zinc (mg/l)	12.04 ±0.04	11.12 ±0.4	8.41 ±0.13	11.00 ±0.10	4.2 ±0.14	13.41 ±0.5	3.00 mg/L
Cadmium (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	0.03 mg/L
Lead (mg/l)	0.01 0.01	0.02 ±0.10	.02 ±0.10	BDL	0.01 ±0.05	BDL	0.01 mg/L
Chromium (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	0.05 mg/L
Arsenic (mg/l)	0.02 ± 0.0.3	0.02 ± 0.30	0.01 ±0.03	0.04 ±0.01	0.01 ±0.10	0.06 ±0.31	0.01 mg/L
Total coliform /(100ml)	Nil	Nil	Nil	Nil	Nil	2	Nil

The results showed that cadmium and chromium were not detected. Ingestion of elevated levels of cadmium results in kidney and skeletal system toxicity, increased hypertension and cardiovascular diseas (Obiri, 2007). Similarly, long term exposure to chromium can cause damage to the kidney, liver, circulatory and nervous tissues (Njar *et al.,* 2012). The results for iron and zinc were above the WHO maximum permissible limit in all the samples. The presence of iron may be due to clay deposit in the area and high rainfall that dissolves iron as it infiltrates the soil causing it to seep into aquifers that serve as sources of ground water for borehole (Adekola *et al.,* 2015 and Sawere and Ojeba, 2016). The manganese levels in IFE, UMU and OBU were within the WHO recommended permissible limit while NRI, OBI and EBE were above the limit. Lead was not detected in EBE and NRI. It was within the maximum permissible limit in EFE and OBI but above the limit in UMU and OBU. Lead is a poisonous metal that can damage nervous connection and cause blood and brain disorder. It can also accumulate in soft tissues and bone where it poses as a potent neurotoxin and a possible human carcinogen (Ehi-Eromosele *et al.,* 2012). Except for samples OBU and OBI, all other samples had high values of Arsenic when compared with WHO guideline values of 0.01 mg/L. Arsenic could be introduced in water through the dissolution of rocks, minerals and ores, industrial effluents and atmospheric deposition (WHO, 2011). Arsenic has not been demonstrated to be essential in humans (IPCS, 2001). There is overwhelming evidence that consumption of elevated levels of arsenic through drinking water is casually related to the development of cancer at several sites, particularly skin, bladder and lungs (WHO, 2011). An important indicator of water quality is the number of bacteria present in the water (Nkamure *et al.,* 2012). In this study, all samples, except EBE, indicated no presence of bacteria. EBE showed a total coliform count of 2, thus there is need to treat water from EBE before consumption. The presence of the bacteria is of great concern and implies faecal contamination. The presence of bacteria in water meant for drinking is generally unaccepted (Ukpong and Okon, 2013).

CONCLUSION

In this study, the water quality assessments of six boreholes were carried out. The results indicated that the water quality of the boreholes were poor as far as WHO guideline is concerned. The results obtained in some of the samples exceeded WHO recommended limit for Arsenic, Lead, Zinc, Manganese, Iron and coliform count. Thus, there is a considerable need for proper treatment of water from in these areas to provide adequate water that meets the WHO guideline values for drinking water. The origin of the contamination observed in this study was not ascertained, therefore there need for further study to determine the source of the contamination of the borehole water and thus recommend preventive approach.

REFERENCES

1. Alepu, O. E., Segun, G. A. and Ikhumhen, H. O. 2016. Borehole Water Quality Assessment in Bekwarra, Nigeria. *Advance Recycling Waste Management*, 2(1): 116
2. Adekola, O., Bashir, A. and Kasimu, A. 2015. Physico-chemical characteristics of borehole water quality in Gassol Taraba State, Nigeria, *African Journal of Environmental Science and Technology*, 9(3): 143-154.
3. Adewuyi, G. O. Oputu, O. U and Opasina, M. A. 2010. Assessment of Groundwater Quality and saline intrusions in Coastal Aquifers of Lagos Metropolis, *Nigeria. J. Water Resource and Protection* 2: 849-853.
4. APHA 1992. Standard Methods for the Examination of Water and Wastewater. American Water and Water works Association and Water Environment Federation. 1000: 1010-3500.

5. Ashbolt, N. J. and Veal, D. A. 1994. Testing the waters for a redundant indicator, *Todays Life Science*, 6(6): 28-29.
6. ASTM-American Society for Testing and Material 2004. Annual book of ASTM Standard, water and environmental technology, ASTM International, West Conshohocken, 11(1): *p*. 352-371.
7. Ehi-Eromosele, C. O. and Okiei, W. O. 2012. Heavy Metal Assessment of Ground, Surface and Tap Water Samples in Lagos Metropolis Using Anodic Stripping Voltammetry. *Resources and Environment*, 2(3): 82-86
8. Fairweather-Tait, S. and Hurrell, R. F. 1996. Bioavailabilty of minerals and trace elements, *Nutrition Research Reviews*, 9(1): 295-324.
9. IPCS, 2001. Arsenic and Arsenic compounds, Geneva, World Health Organization, International Programme on Chemical Safety, *p.* 224.
10. La Dou, J. 2004. Currnt occupational and Environmental Medicine, USA, Mc Graw-Hill, *p.* 241-534.
11. Lamb, J. C. 1985. Water quality and its control, New York, John Wiley and Sons, *p.* 23-78.
12. Lamikanra, A. 1999. Essential Microbiology for Students and Practitioner of Pharmacy, Medicine and Microbiology (2nd ed), Amkra Books, Lagos, *p.* 406.
13. Mgbemena, N. M., Obodo, G. A., Okonkwo, N. A. and Onwukeme, V. I. 2014. Physico- Chemical Assessment of Borehole Waters in Ovim, Isiukwuato Lga, Abia State, Nigeria., *IOSR Journal of Applied Chemistry,* 7(10): 31-33.
14. Njar, G. N., Iwara, A. I., Offiong, R. A. and Deekar, T. D. 2012. Assessment of heavy metal status of boreholes in calabar south local government area, Cross River State, Nigeria, *Ethiopian J. Environ. Studies and Management,* 5(1): 86-91.
15. Nkamare, M. B., Ofili, A. N. and Adeleke, A. J. 2012. Physico-chenical and microbiological assessment of borehole water in Okutukutu, Bayelsa State, Nigeria, *Advances in Applied Science Research*, 3(5): 2549-2552.
16. Obiri, S. 2007. Determination of Heavy Metals in Water from Boreholes in Dumasi in the Wassa West District of Western Region of Republic of Ghana, *Environmental Monitoring and Assessment*, 130:455–463.
17. Ojo, O. I., Otieno, F. A. O. and Ochieng, G. M. 2012. Groundwater: Characteristics, qualities, pollutions and treatments: An overview, *Int. J. Water Resources Environ. Engineering,* 4(6): 162-170.
18. Samie, A., Makonto, O. T., Mojapelo, P., Bessong, P. O., Odiyo, J. O. and Uaboi-Egbenni, P. O. 2013. Physico-chemical assessment of borehole water used by schools in Greater Giyani Municipality, Mopani district, South Africa, *African J. Biotechnology,* 12(30): 4858-4865.
19. Sawere, B. T. and Ojeba, C. K. 2016. Assessment of Heavy Metal Concentrations in Borehole-Hole Water in Ozoro Town, Delta State, *Int. Res. J. Adv. Engi. Sci*., 1(3): 61-65.
20. Stanley, K. N., Cunningham, R. And Jones, K. 1998. Thermophilic campylobacters in ground water, *J. Applied Microbiology,* 85: 187-191.
21. Ukpong, E. C. and Okon, B. B. 2013. Comparative Analysis of Public and Private Borehole Water Supply Sources in Uruan Local Government Area of Awka Ibom State, *Int. J. Appl. Sci. Tech.*, 3(1): 76-91.
22. WHO, 2011. Guideline for drinking water quality, 4th ed, Geneva, Switzerland, *p.* 227-318.