Adamawa State University Journal of Scientific Research
ISSN: 2251-0702 (P)
Volume 6 Number 2, August, 2018; Article no. ADSUJSR 0602014
http://www.adsujsr.com

Assessment of the Concentrations of some Anions in Bolehole Water in Yola South Local Government Area, Adamawa State, Nigeria

Maspalma , G. A., *[1] Ndonya, A. E[1] and Artimas S. P.[2]

[1]Chemistry Unit, Department of Science Laboratory Technology, Adamawa State Polytechnic Yola. Adamawa State, Nigeria.

[2]Department of Pure Sciences, Adamawa State Polytechnic Yola. Adamawa State, Nigeria

Contact: *agoddypalma@yahoo.com* +234 07035410631

Abstract

An investigation study was carried out to determine the concentrations of anions of borehole water in Yola South Local Government Area. of Adamawa State. Eighteen water samples were collected within the six wards selected. Anionic parameters were determined using standard methods. The results obtained showed variation of the parameters in samples as follows; Nitrate (NO_3^{2-}) 29.80 ± 0.01- 81.50±0.01mg/L. Bicarbonate (HCO_3^-) 57.00± 0.01 - 339.00 ± 0.01 mg/ L. Chloride (Cl^-) 99.50± 0.01- 411.00 ± 0.03mg/L. Sulphate (SO_4^{2-}) 21.00 ± 0.02- 45.50 ± 0.02mg/L. Phosphate (PO_3^{4-}) 0.40 ± 0.01- 0.80 ± 0.01mg/L. The values recorded for bicarbonate and phosphates were within the WHO permissible limits for drinking water. Sulphate content in the entire sample was below the WHO standards. However, values obtained for chloride were higher than the WHO standard. The concentration of most of the investigated parameters in the drinking water samples from the selected wards were either below, within and above the permissible limits of the World Health Organization drinking water guidelines. Hence it is an indication of health risk to the inhabitants of the communities.

Keywords: Borehole, Water, Anions, Concentration; Yola South

Introduction

Quality drinking water is essential for life. Unfortunately, in many countries around the world, including Nigeria, water has become a scarce commodity as only a small proportion of the populace has access to treated water (IDLO, 2006). Alternative sources of water such as rainwater and ground water have become major sources of drinking water for people living in new settlements and some residents who do not have access to treated water in Nigeria. The need to assess the quality of water from some of these alternative sources has become imperative because they have a direct effect on the health of individuals (WHO, 1996). Contaminants such as bacteria, viruses, heavy metals, nitrates and salt have polluted water supplies as a result of inadequate treatment and disposal of waste from humans and livestock, industrial discharges, and over-use of limited water resources (Singh and Mosley 2003). Even if no sources of anthropogenic contamination exist there is potential for natural levels of metals and other chemicals to be harmful to human health.

The borehole is categorized as groundwater, because it is obtained from aquifers (underground layers of water-bearing rock) (Singleton, 1999). As the population grows worldwide, water demand also rises. The increasing demand for portable water supply for domestic and commercial needs have necessitated the inevitable use of groundwater (Sandhu *et al.*, 1979). Before water can be described as potable, it has to comply with certain physical, chemical and microbiological standards, which are designed to ensure that the water is potable and safe for drinking (Tebutt, 1983).

Water quality is the standard of purity that is necessary for the protection of aquatic and wildlife populations, for recreational uses in and on the water and for human activities. Physical and chemical standards are set for maximum acceptable concentrations of pollutants and other parameters in water. Drinking water quality standards particularly those set by World Health Organization (WHO) describe the quality parameters set for drinking water.

Different countries have their standards for their drinking water but even where standards do exist, and are applied, the permitted concentration of individual constituents may vary. These variations have been observed to be obvious in borehole water in relation to location and time. In respect to this, the need to constantly observe, measure and determine the quality of borehole water of different locations over time is imperative and necessary considering the domestic importance of borehole water in the study area and other geographical locations. This research is to assess the level of quality of anions in borehole water in the selected wards of Yola South LGA and check the portability of the borehole water within the study area in comparison to World Health Organization (WHO) standard.

Materials and Methods

Precaution

To ensure reliability of the result, samples were carefully handled to avoid contamination. All glass and plastic were washed and cleaned with detergent and then rinsed thoroughly with distilled water before immersion in 10 % nitric acid solution for a day and then rinsed with water and finally dried in the oven at 105^0C. Each container was rinsed with the solution to be stored or taken in before used (Maspalma, 2006).

Yola metropolis, Adamawa State, is in North-Eastern part of Nigeria (Akindawa *et al.,* 2009). It lies between latitude 7^0N and11^0N of the equator, and11^0E and14^0E of the Greenwich Meridian, share national boundaries with Gombe (west) Yobe (North-West), Borno (North) and Taraba (South-East) State. It also, shares international boundary with Republic of Cameroun by the East and South. The town is located along the Benue valley, with a population of 392,845 (Census, 2006). The climate is tropical, characterized by dry and wet seasons. The dry season last from November to March, While the wettest month are August and September, with an average annual rainfall of 759mm.The relative humidity of the area drop from $82^0/_0$ to $92^0/_0$ between June and October to about $25^0/_0$ to $36^0/_0$ between November to December. The annual temperature ranges from 24.1^0C to 45^0C.The vegetation is that of Sub-Sudan vegetation marked by short grass with short tress (Brown *et. al.,* 2005).

Sample collection

The boreholes were randomly selected based on where they were found in the wards, i.e. (Bole, Mbamba, Namtari, Ngurore, Yelwa and Yolde-Pate). A total of eighteen water samples were collected from the randomly selected boreholes, Three from each of the six selected wards in Yola LGA. The samples were collected using a 1.5-liter plastic container and chemical analysis was conducted using standard laboratory methods suggested by APHA (American Public Health Association, 2008). All the borehole water samples were collected after the water from the borehole has been pumped for at least 10 min (Ketata *et al.,* 2011).

Assessment of anionic quality

The quality of the samples was assessed by checking the concentration of the anions. The concentration of anions such as chlorides, nitrate, sulphates and phosphates were measured using a metrohm 850 professional ion chromatograph (Mande *et al.,* 2011). While Potentiometric method was used measure the concentration of Bicarbonate (APHA, 2008).

Results and Discussion

The mean concentration of the analyzed anions (chlorides, nitrate, sulphates, phosphates and bicarbonate) in the borehole water samples are shown on Table 1, while a cluster chart of the analyzed anions in the water sample are shown in Figure -1 respectively. Different anions come from different sources, they create diverse perception and an effect on water.It is closely correlated with many other major ions, and especially with the Ca cation. The distribution pattern is controlled by climate and carbonate rocks distribution. Bicarbonate and carbonate ions in water can remove toxic metals, such as lead and cadmium, by precipitating the metals out of solution (Salminen *et al.,* 2004).The mean concentration for bicarbonate (HCO^-_3) (Table 1) in this study ranged from 57.00± 0.01mg/liter to 339.00 ± 0.01 mg/liter, with the highest measured at Mbamba and the lowest was at Namtari ward. These values are within the WHO quality standard for drinking water of 250 -500mg/L.

Table: .Mean concentration of analyzed Anions in Water sample from selected wards in Yola metropolis (mg/L).

Wards	Cl^-	HCO^-_3	NO_2^{3-}	PO_3^{4-}	SO_4^{2-}
Bole	411.00 ± 0.03	315.50 ± 0.02	74.50 ±0.02	0.40 ± 0.01	45.50 ± 0.02
Mbamba	202.00 ± 0.01	339.00 ± 0.01	81.50 ±0.01	0.60 ± 0.01	32.60 ± 0.01
Namtari	136.00 ± 0.01	57.00 ± 0.01	36.30 ± 0.00	0.60 ± 0.01	22.50 ± 0.01
Ngurore	363.00 ± 0.02	119.00 ± 0.02	65.50 ± 0.01	0.80 ± 0.01	21.00 ± 0.02
Yelwa	158.00 ± 0.01	112.00 ± 0.02	29.80 ± 0.01	0.50 ± 0.02	24.50± 0.00
Yolde-Pate	99.50 ± 0.01	333.00 ± 0.01	65.00± 0.02	0.40± 0.01	31.50 ± 0.01

Mean ± standard deviation, n =3

Therefore, borehole sources in our study can be regarded to be free from bicarbonate pollution. The presence of chloride may be associated with sodium in drinking water, it is often introduced to the water body as a result of saltwater intrusion, mineral dissolution and domestic waste. Above secondary maximum contaminant level, taste becomes noticeable. Chloride concentration in this study varied between 99.50± 0.01mg/liter to 411.00 ± 0.03mg/liter, with the highest measured at Bole and the lowest at Yolde-Pate ward. The 250mg/L guideline set by the WHO is exceeded by water sample in Bole ward (411.00mg/L) and Ngurore ward (363mg/L).

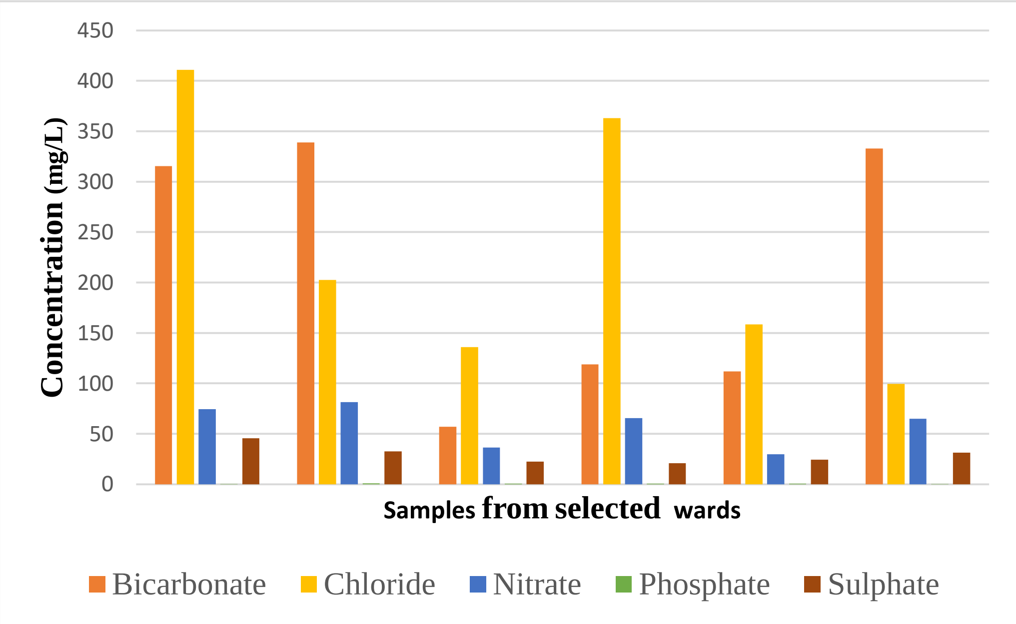

Figure -1: **A cluster chart for anions in borehole water samples.**

According to Anon (1997) excess chloride content in water can impacts bad taste and cause corrosion in intestinal system when consumed. It is noted that the removal method of chloride concentration is expensive. Nitrate on the hand mainly enters the environment from fertilizers, sewage disposal and human or farm animal waste. Toxicity results from the ability of the body to naturally breakdown the nitrates to nitrites. The concentration of Nitrate (NO_2^{-3}) in this study ranges from 29.80 ±0.01mg/liter to 81.50±0.01mg/liter, with the highest measured at Mbamba and the lowest was at Yelwa ward. Nitrate in the investigated samples deviate from the 50mg/liter suggested by World Health Organization. High concentration of Nitrate may give rise to potential health risks such as methmoglobinenia or blue-baby – syndrome, particularly in pregnant women and bottle – fed infants respectively (Kempster *et al.*, 1997). Nitrate at elevated concentration is also known to result in cyanosis in infants.

High concentration of sulphate in groundwater may result from saltwater intrusion, mineral dissolution and domestic or industrial waste. At high dose it can change the taste of water, and even have a laxative effect when ingested. The mean concentration for Sulphate (SO_4^{-2}) in our study ranged from 21.00 ± 0.02mg/liter to 45.50 ± 0.02mg/liter, with the highest measured at Bole and the lowest was at Ngugore ward. Taste threshold for sulphate in water have been found to ranges from 250mg/liter for sodium sulphate to 500mg/L for calcium sulphate. The values obtained for sulphate in all the samples are below the WHO permissible limit as shown in (Table 1).

Phosphorus gets into water in both urban and agricultural settings. Phosphorus tends to attach to soil particles and, thus, moves into surface-water bodies from runoff. It can also migrate with groundwater flows. Since groundwater often discharges into surface water, such as through stream banks into rivers, there is a concern about phosphorus concentrations in groundwater affecting the water quality of surface water. When there is too much of it in water, it can speed up eutrophication (a reduction in dissolved oxygen in water bodies caused by an increase of mineral and organic nutrients) of rivers and lakes. The mean concentration for Phosphate (PO_3^{-4}) in this study varied from 0.40± 0.01mg/liter to 0.80 ± 0.01mg/liter, with the highest measured at Ngurore and the lowest was at Bole and Yoldepate wards. The WHO does not have a nutritional basis for the regulation of phosphorus levels in drinking water. The values recorded in our study are below the maximum of 10mg/L suggested by Fadiran *et al.*, (2008).

The clustered chart for concentration of the anions in this study (Figure 1) shows that the concentration of Chloride (Cl^-) was highest followed by those of HCO_3^-, NO_3^{2-}, SO_4^{2-} and the lowest was that of PO^{-2}_4.The order of their concentration is PO_3^{4-}>SO_4^{2-}>NO_3^{2-}>HCO_3^->Cl^-at Bole, whileSO_4^{2-}>PO_3^{4-}>NO_2^{3-}> Cl^->HCO_3^-at Mbamba.SO_4^{2-}>NO_2^{3-}>HCO_3^->PO_3^{4-}> Cl^-at Namtari .SO_4^{2-}>.NO_2^{3-}>PO_3^{4-}>HCO_3^->Cl^-at Ngurore.SO_4^{2-}>NO_2^{3-}>PO_3^{4-}>HCO_3^->Cl^-at Yelwa.SO_4^{2-}>PO_3^{4-}>NO_2^{3-}>Cl^->HCO_3^-at Yoldepate respectively

Conclusion and Recommendations

The qualities of water obtained in most of the wards have their Nitrate and Chloride concentrations above the World Health Organization standard. In this study the concentration of sulphate in all the wards were found to be below acceptable guidelines while the quality of bicarbonate and phosphate recorded were within the World Health Organization standards. Based on these finding the water may be safe to be used as drinking water. Communities with high Nitrate content should treat their water before use as it poses serious health effect.

It is recommended that public awareness in respect of the dangers associated with the consumption of sub-standard water should be encouraged. It is also recommended that further investigation be carryout to cover other communities, this is because the assessment of the quality of drinking water is required as levels of contaminants may vary due to different soil type, water chemistry and different human activities.

References

Akindawa, A.B Hassan, A. and Balla S.K(2009): An assessment of the impact of abattoir effluent on river Chouchi, Yola Metropolis, Adamawa State, Nigeria, Nigerian *Journal of Tropical Agriculture* (11):178 -184

Anon, J (1997): National Water Rehabilitation Project (NWRP). Water Quality Testing and Control Course, National Water Resources Institute Kaduna, 36 -80

American Public Health Association (APHA) (2008): Standard Methods for the Examination of Water and Wastewater (21 edition). Washington, DC. American Public Health Association, American Water Works Association and Water Environment Federation.

Brown, M. Mitchell N and Beresford M, (2005): The protection landscape approach; Linking nature, culture and community. PP 6-43

Census, (2006): Details of the breakdown of the national and state provisional population census.Available from www.population.gov.ng/index/census.

Fadiran, A.O,Diamini S.C,Mavuso A. (2008):A comparative study of the Phosphate levels in some surface and ground water bodies of Swaziland.*Bull.Chem.Soc.Ethiopia* 22(2):197 -206.

International Development Law Organization (2006): Water Tenure Reform and Pubic Access to Water as a Basic Need, International Development Law Organization Voice of Development Jurists Series.

Ketata, M, Gueddari M and Bouhlila R, (2011): Suitability assessment of shallow and deep groundwater for drinking and irrigation use in the El Khairat aquifer (Enfidha, Tunisian Sahel) Environmental. Earth Science

Kempster, P.L,VanVlient H..R,Kuhn A. (1997):The need for guideline to bridge the gap between ideal drinking water quality and quality which is practicably available and acceptable. Water SA23(2):163-167.

Mande, S.A Liu M, Dyaneye-Boundjou G.Z, Liu F, KamaleidinovaBawa M.L, and Chen H (2011): Hydro chemical investigation of ground contamination in an urban area of Beijing aquifer impact of irrigation with industrial waste. *Afr. j. Agric. Res*. (31) 6555-6562

Maspalma, G.A (2006): Analysis of banana (*Musa sapientum*) Fruits from sprouting to rotten stages. M. Tech Dissertation. Federal University of Technology Yola. Unpublished

Salminen, S, Playne M andYuanKun L (2004): Successful probiotic lactobacilli: human studies on probiotic efficacy. Handbookof Functional Dairy Products (Short C & O'Brien J, edition), pp. 13 –32. Boca Raton, FL.

Sandhu, S.E, Warren, W.J, Nelson, P (1979).:Magnitude of pollution indicator organisms in rural potable water. *Applied and Environmental Microbiology*, 37: 744-749.

Singleton, P (1999): Bacteria in Biology, Biotechnology and Medicine. Biddies Limited, Guildford and King's Lynn. 294-345.

Singh1, S, Mosley L.M. (2003): Trace metal levels in drinking water on Viti Levu, Fiji Islands. *S. Pac J Nat Sci*.(21):31–4.

Tebutt T.H.Y (1983): Principles of Quality Control. England: Pergamum, p.232. US Environmental protection Agency (USEPA) (1995): Guidelines for water supply 7th edition. New York: WHO press, pp.144 - 162.

World Health Organization (1996): Guidelines for drinking water quality, World Health Organization. (2), 23