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Quality Water Analysis of Public and Private Boreholes (A Case Study of Azare Town, Bauchi, Nigeria)

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ABSTRACT**:** *Analysis of public and private borehole water supply sources in katagun Local Government Area (Azare) of Bauchi State, Nigeria, was conducted in order to examine their qualities. A total of 10 water samples collected from 3 randomly selected private and 7 functional public boreholes in the area were analysed using standard analytical techniques and instruments. Most of the physicochemical parameters of samples from the two sources were within the acceptable limits of the World Health Organisation (WHO) for drinking water. E.coli for all samples was 0.00 except for A9 where the value is* 1×10^{-4} *which mean sample A9 have traces of bacterial. There was no growth of indicator organism in samples from the both boreholes. From the findings, it is recommended that both private borehole and public water supply in the area are safe for consumption except for sample A9 which need be properly treated before human consumption and other domestic purposes.*

Keywords: *Bauchi, Public borehole, private borehole, water Quality and WHO*

I. INTRODUCTION

The use of groundwater is of great importance to Bauchi (azare) inhabitants, as superficial water sources are lacking in the vicinity. Many boreholes have been drilled with an approximate depth of more than 80 m all over Azare town by state, local and members representing these areas. Although, due to increase in population, public water supply from these boreholes is very unstable, inadequate and unpredictable as supplies are often irregular due to lack of maintenance culture of the end users. Thus, the possibility of these may justify the purpose of this research. As a result, most of the people drilled their private boreholes. These boreholes are widely recognized since there is hardly pipe bore water within the vicinity and it becomes an important source of drinking water in the area. The increase in population due to migration from neighbouring states in the insurgence affected state in north eastern part of Nigeria which has also increase the volume of waste generated and consequent indiscriminate dumping of polluted water may enhance the infiltration of harmful compound into the ground water. The objective of the present study was to analyze and determine the overall physical, chemical and bacteriological quality of drinking water from public and private boreholes in Azare town Bauchi and the results was compared with the standard guidelines set by WHO. It should be noted, however, that there are no available literatures or researches that have been conducted on analysis of public boreholes in the identified area upon which the authors can lay their hands. This research would also provide an insight into the water quality of the boreholes in Azare town Bauchi state, Nigeria.

Many infectious diseases are transmitted by water through faecal oral contamination. Diseases due to drinking of contaminated water which leads to the death of five million children annually and make 1/6 of the world population sick (Shittu et al., 2008). Also, water may contain toxic inorganic chemicals which may cause either acute or chronic health effect. Acute effects include nausea, lung irritation, skin rash, vomiting and dizziness, sometime death usually occurred. Chronic effect, like cancer, birth defects, organs damage, disorder of the nervous system and damage to the immune system are usually more common (Erah et al., 2002). Inorganic chemicals like lead may produce adverse health effect which include interference with red blood cell chemistry, delay in normal physical and mental development in babies and young children, slit deficit in attention span, hearing and learning abilities of children and slight increase in blood pressure in some adults. Also, presence of excess nitrogen can be hazardous to health, especially for infants and pregnant women. Although, the sources of metal contaminants of the underground water are uncertain, it may likely be due to natural process and anthropogenic activities (Erah et al., 2002). In addition, rural water also have excessive amount of nitrite from microbial action on agricultural fertilizer, when ingested nitrite compete for oxygen in the blood (Oladipo et al., 2009).

II DESCRIPTION OF THE STUDY AREA

The study area is Katagum local government Area (Azare), metropolitan council is the capital of Katagum local government of Bauchi state, was created in 1978 by the federal government of Nigeria with headquarter at Azare, located in North eastern Nigeria. The town is located at 11°38'07"North 10°11'28" East (Google Earth, 2015). It covers more than 1,436 km^2 of different land area. The use of groundwater is of great importance to Azare inhabitants, as superficial water sources are lacking in the vicinity. Although, Lake Alau has been dammed up for that reason and serve as a reservoir for drinking water since the late 1980s (Rudiger, 2002). Many boreholes have been drilled to a depth of up to 80m all over KatagumAzare metropolis. Although, due to increase in population, public water supply from these boreholes is very unstable and unpredictable as supplies are often irregular. As a result, most of the residents drill their boreholes to a depth between 70m to 75m which are often called wash boreholes. These boreholes are widely recognized within the vicinity and it becomes an important source of drinking water in the area. This research would provide an insight into the water quality from boreholes in Azare Nigeria.

III MATERIAL AND METHODS

3.1 Location of Sampling Points

The water samples were collected from 10 boreholes from each of the wards selected within the case study area. These boreholes; most of them being the major sources of drinking water to the residents are mostly publically owned. The names of the wards, notations and coordinates of sampling points are shown in the table 1 below

Table 1; location and notation of sampling points

Sample notation	Location	Coordinates
A1	OdojiAzare	11°40'53"N, 10°11'24"E
A2	Matsango	11°16'59"N, 10°24'0"E
A3	Bidawa	11°40'53"N, 10°11'23"E
A4	Fatara	11°40'16"N, 10°13'40"E
A5	Kujuru	11°38'40"N, 10°16'29"E
A6	Misau Road	11°29'7"N, 10°19'2"E
A7	Hadejia Road	11°41'33"N, 10°11'11"E
A8	State lowcost	11°39'59"N, 10°11'0"E
A9	Bokki	11°40'4"N, 10°11'37"E
A10	Kano road	11°49'37"N, 10°11'0"E

Source; field work 2015

3.2 Sample Collection

The water samples were collected in 2-liter plastic containers each. Each of the containers was thoroughly rinsed with the water before they were filled and covered with an air tight cover. Each of the containers was labelled after collection of the sample and the name of the ward from which it was collected was recorded. The coordinates of each sampling point was also recorded. The collected samples were delivered to the laboratory within 1 hour 30 min of collection in a cooler containing ice blocks.

IV RESULTS AND DISCUSSION

4.1 Physicochemical Analysis

The water samples were analysed for temperature, colour, turbidity, pH, total dissolve solid, electrical conductivity, total alkalinity, magnesium, nitrate, sulphate, phosphate and nitrite as describe by FAO (1997a). The result of physicochemical parameters of the samples was expressed in their different units of measurement which include (temperature, colour, turbidity, electrical conductivity, total dissolved solids, hardness, dissolved oxygen, nitrite, nitrate, pH, sulphate, phosphate, calcium and magnesium). Table 2 shows the physicochemical analysis results of the ten boreholes in the study area.

Table 2: physicochemical and biological results of private and public borehole

S/N	Parameters	*A1	•A2	•A3	•A4	*A5	*A6	•A7	•A8	•A9	•A10
1	Temperature(°C)	28.00	26.00	25.00	26.00	25.00	26.00	27.00	26.00	26.00	26.00
2	Turbidity (NTU)	4.00	0.00	1.00	4.00	1.00	3.00	1.00	2.00	1.00	1.00
3	TDS(mg/l)	431.0	313.0	533.0	262.0	169.0	247.0	744.0	447.0	464.0	142.0
4	pH(mg/l)	6.800	6.800	6.800	6.800	7.000	6.800	6.800	6.800	6.800	6.800
5	Colour(pt/co)	2.500	1.400	0.200	1.300	1.000	2.000	0.400	0.700	0.600	0.240

6	Electrical conductivity	874.0	421.0	839.0	415.0	253.0	426.0	1129.0	680.0	709.0	220.0
7	Total hardness	0.220	1.270	1.050	1.420	0.000	0.000	0.900	1.600	1.300	1.870
8	Magnesium(mg/l)	0.100	0.670	0.490	0.640	0.000	0.000	0.460	0.860	0.350	0.910
9	Calcium(mg/l)	0.120	0.600	0.500	0.780	0.000	0.000	0.500	0.800	0.950	0,960
10	C.O.D(mg/l)	3.400	2.000	1.166	3.880	2.330	1.550	2.330	3.100	5.050	1.160
11	Sulphate (mg/l)	6.200	1.200	0.000	4.000	3.000	5.000	0.120	0.000	2.510	2.000
12	Phosphate(mg/l)	1.260	0.016	0.258	0.960	0.760	0.640	0.970	0.860	0.280	0.250
13	Nitrogen(mg/l)	3.200	2.600	1.800	4.500	0.900	2.000	3.600	2.400	1.800	4.200
14	Nitrate(mg/l)	0.240	0.800	8.200	1.600	3.000	9.000	6.800	0.500	0.900	18.40
15	Total coliform Count(cfu/100l)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	E.Coli(mg/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00

* = Private Borehole source; field work 2015
• = Public Borehole

The mean temperature of the private borehole water samples was 26.33°C while that of the public was 26°C. Turbidity mean value of 2.66 NTU and 1.43 NTU were obtained for private and public borehole water samples respectively. The mean value of electrical conductivity for the private source was 517.66 µs/cm and that of the public were 603.43 µs/cm. Total dissolved solids mean value of 282.33mg/l was recorded for private source while 415 mg/l was obtained for public borehole water samples. The mean pH of private and public borehole water samples stood at 6.86 and 6.8 respectively. Hardness level for the private source was 0.073mg/l while that of the public was 1.344mg/l. The mean concentration of chemical oxygen demand (COD) in private borehole water samples was 2.426mg/l whereas 2.668mg/l was for the public source. The mean value of the inorganic (nitrate, sulphate, phosphate, calcium, and magnesium) were 4.08mg/l, 4.733mg/l, 0.89mg/l, 0.04 mg/l, 0.033 mg/l respectively for the private borehole water samples, while those of the public were 5.314mg/l, 1.40 mg/l, 0.51 mg/l, 0.73, 0.63 mg/l respectively for the same inorganic. Physicochemical and biological quality of raw water is important in the choice of the best source and the treatment needed. The range, mean values and standard deviation of all the various samples were computed from the raw data obtained from the field.

The result presented in Table 2 indicate that the temperature of the water samples at the time of the analysis ranged from 25°c to 28°C, with water samples from A1 having the highest temperature of 28°C, while A3 and A5 had the lowest temperature of 25°C (Table 2). The result of the water samples show the temperature of the samples is within acceptable limit as prescribe by WHO. None of the samples had objectionable colour. From the result obtained for turbidity shows a range of 0.0 – 4.0 NTU with a mean value of 2.35 and 1.5 NTU for public and private borehole respectively which is within the allowable limit of 5.0 NTU suggested by WHO as shown in (Table 2). Turbidity water is usually cloudy and prevents visibility of the glass containing it. Thus, the slightly turbid water indicates the presence of total suspended solids. Water sample from A1 and A4 had the highest turbidity of 4 NTU, while A3 had the lowest of 0.00 NTU.

The result for the total dissolved solid of the samples was found to be within the WHO standard, except for A5 which is way above the WHO Standard. a high concentration of dissolved solid is usually don't have health hazard. The total dissolve solid ranged from 142- 744 mg/L with A7 having the highest of 744 mg/L and A10 is having the lowest of 142 mg/L. The TDS is the term used to describe the inorganic salt and small amount of organic matter present in solution or water. The principal constituents are usually calcium, magnesium, sodium and potassium cation, carbonate, hydrogen carbonate, chloride, sulphate and nitrate anion (WHO, 1996). The presence of TDS in water may affect its taste (WHO, 1996). It has been reported that drinking water with extremely low concentration of TDS may be unacceptable because of its flat insipid taste (WHO, 1996; Bruvold and Ongerth, 1969). The turbidity of all water samples used in this study is in agreement with WHO standard. Water turbidity is very important because high turbidity is often associated with higher level of disease causing microorganism, such as bacteria and other parasites (Shittu et al., 2008).

The result for the pH of all the samples was found to be within the range of which shows the samples to be neutral and within the specified WHO standard (Table 2) The WHO standard for pH of drinking water is within the range of 6.5-8.5 while that for bathing water is within the range of 6.0 – 9.0 respectively. All the samples had 6.8 except for A5 which had 7.0. Calcium ions of the water source ranges from 0.12 – 0.96 mg/l. The WHO standard gives a limit of 75mg/l. From the result obtained, all the sources are within the range if compared with the WHO guideline of 75mg/l. Private boreholes had the lowest value of 0.00-0.12mg/L while public borehole ranges from 0.5-0.96 mg/L Calcium ions is present in all natural water and are often refer to as hardness factor. Hardness is the ability of water to cause precipitation of insoluble calcium salt of higher fatty acid from soap solutions. All the ten water samples recorded low magnesium concentrations, which agree with the magnesium ion concentrations and within WHO maximum acceptable limits for drinking (150mg/l). It ranges for both private and public boreholes from 0.10-0.91mg/L. private borehole had the lowest values compare to the public boreholes. Like calcium ion, no evidence of adverse health effect specifically attributed to magnesium in drinking water has been established. However, undesirable effects due to the presence of magnesium in drinking water may be its ability to render water hard. Magnesium is washed from rocks and subsequently ends up in water.

Sulphate concentrations found concentration ranging from 0.0 – 6.2 mg/l in ground waters. Private borehole had the highest value of 6.2 mg/L and public boreholes had the lowest of 0.00 mg/L. all the samples from the study area are within the WHO standard. Sulphate occurs naturally in many source waters after contact with particular mineral deposits and rocks strata. The concentrations normally found in drinking water do not represent a risk to health. The values obtained from all the samples in the study area are all within the WHO standard. Phosphate content for private source is the highest which ranges from 0.64 – 1.26 mg/l while public source is the lowest which ranges from 0.016-0.97 mg/L. The WHO standard gives a limit of 10 mg/l. All the ten water samples record little total hardness content, they ranges from 0.0-1.87mg/l. Hardness was recorded most for public boreholes with private having very insignificant value of hardness. The WHO standard gives a limit of 61-120mg/l, from these study, all samples are within the WHO maximum acceptable limits for drinking water.

This study shows that nitrate in all the samples are within the WHO standard except for A10 which is way above the recommended standard which record value of 18.4 mg/L. A1 record the lowest which is 0.24 mg/L and the standard by WHO is 10 mg/L. Nitrate in water is undetectable without testing because it is colourless, and tasteless. A water test for nitrate is highly recommended for household with infants, pregnant woman nursing mother or elderly people. These groups are most susceptible to nitrate or nitrite. The nitrite of water samples indicates the quality of non-filterable particles it contains. About 10mg/l was recommended by WHO as the acceptable standard for potable water

4.2 Bacteriological Analysis

The total bacterial count is the number of colours visible under a magnification of 6-8 which have developed under defined conditions. It provides a measure of the degree of contamination of the water by micro-organisms and especially sudden bacterial invasions. Bacteriological characteristics of the water samples were determined using multiple tube fermentation method (most probable number) for enumeration of both total coliform count and differential *Escherichia coli* count. This analysis was carried out on all the 10 water samples in the public health laboratory during the month of August. The chemical oxygen demand (COD) concentration in all the ten sources was significantly within the WHO standards of drinking water which ranges from1.16-5.05 mg/L as against 10 mg/L for standard. Electrical conductivity results range from 220-1129. The result for the total coliforms of all the samples was found to be zero the standards which show all the boreholes are not polluted. Coliforms occur naturally in soil and in the gut of humans and animals. Thus, their presence in water may indicate contamination. Total coliform bacteria are not likely to cause illness, but their presence indicates that your water supply may be vulnerable to contamination by more harmful microorganisms. In water, coliform bacteria have no taste, smell, or colour. They can only be detected through a laboratory test. The summary of results for *E*.coli (table 2) shows that the bacteriological contamination in the water samples is within the range of 0.00. The WHO guideline stated that drinking water should have no Bacterial contamination. The water sample from Bokki ward (A9) appears to have the highest bacterial contamination with $1x10^{-4}$ colonies/100ml. The*E.coli coli* form bacteria with several other heterotrophic bacteria which made them unfit for human consumption. The presence of *E.coli* in water meant for drinking is generally unaccepted

V CONCLUSION

The importance of access to quality water is very essential to human consumption, with the increase in population in Azare town and rise in human activities, there is need to check the quality of water the public consumes which can constitute major health problems. This study recorded slight high number of *E*.coli in water samples analyzed in Bokki ward (A9), thus making it unsafe for drinking and require further treatment. Therefore, there is an urgent need for awareness to be created about the present situation of this particular borehole. The remaining samples from other wards are safe for drinking as they are within the recommended limit by WHO standard for drinking water.

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