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Research Paper

Evaluation of water quality parameters from five locations in Yobe State, Nigeria

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Water is one of the basic components of the biotic environment and all living organism's activities depend on it. For water to befit for the industrial and domestic usage, it needs to be handled with care to maintain its purity. The aim of this study is to qualitatively evaluate some physical, chemical and bacteriological parameters of water samples of rivers in Yobe State. Physiochemical parameters analyzed include; calcium, chloride, chromium, fluoride, iron, manganese, magnesium, nitrite, sulphate, and total hardness using atomic absorption spectrophotometer (AAS-DR2000), while Omega conductivity meter (CDH221) was used for the determination of total dissolved solid, conductivity and temperature. Turbidity was determined by absorptiometry method. Colour was determined by Platinum-cobalt (Pt-Co) method. PH was determined with litmus paper and compared on colour chart. The bacteriological assessment was conducted according to the membrane filtration method. Results of sample water from Gashua showed turbidity of 375.66±57.82 FTU, Chloride 8.36±0.31 mg/L. Colour (Pt-Co) obtained for Gashua 421.33±14.85, Geidam 499.66±35.70, Katarko 429.66±17.61. Geidam Manganese 12.17±1.75 mg/ L, Sulphate 72.33±2.05 mg/L. Damaturu Nitrate 33.2±2.25 mg/L. Bacteriological assessment showed Geidam and Katarko with 4.0CFU each respectively. These results could be attributed to the activities going on in this area with respect to the presence of large scale upland and irrigated farm land which may introduce leaching fertilizer into the river so also the presence of traditional potash mining sites. The results of the analysis of the five samples from various locations in Yobe State showed that the physical and chemical parameters of most of the water samples were within the acceptable limit of the WHO. While the bacteriological parameters determined exceeded the acceptable limits, suggesting that the water samples may be contaminated bacteriologically.

Key words: Water, sanitation, pollution, hygienic, pathogenic. W.H.O

INTRODUCTION

Water is the most abundant liquid on earth and covers three-quarters of the earth surface (David, 1982). Human activities and settlement hinge on the availability of water (Edmunds and Smedley, 1996). In man, three-quarters of the fluid are made of water, water forms the essential medium in which the chemical reaction of his cells proceed. It transports blood, it forms a pool for digestion, it also hold and help the transport of electrically charged ions that generate nerve signals and makes the human brain function possible (Alberts *et al*., 2002). Water carries away the wastes materials from the living system in form of excretory products, and runs its river course steadily to sea along a vast network. It is receptacle for sewage, it can be used to rinse away grime and toxic

chemicals or remove waste and heat from the body (Robert *et al*., 2005).

Water profoundly influences all molecular interaction in a biological system. Water is the major constituent of living matter and forms 50-90% of the weight of living organism's protoplasm.

The material of living cells consists of water solution of fats, carbohydrates, protein and similar chemicals, pure water is generally colourless that sustain life. The presence of organic matter modifies the colour of water (Bram, 1979).

Water is referred to as the most abundant chemical compounds that occur in three states: solid, liquid, and gas (Wilcock, 1983). The fact that this is a wet planet, so it is disturbing to realize that today more than a sixth of the world population have no access to safe drinking water (Chukwurah, 2003).

Naturally, occurring water exists in three main sources; sea, surface and underground water. Its occurrence is very immense with over seventy-five percent of the earth crust covered by water being so largely available, it enjoys extensive usage in all living processes. Its ability also remains stable in all three states of matter help to promote its use.

With these divine endowments, along with about seventy percent constituent in man, this universal solvent has continuously played a very active role in human survival (NIWASA, 2002). Water has remained one of the most important substances to man, in fact, our body is mainly water in our great strive to industrialization, it remains a necessity, however, its vast natural occurrence, water being universal solvent continuously dissolve all substances it comes across leading to ground water, also requiring treatment before attaining portable water quality (Muhammad, 2014).

Drinking water that is safe and aesthetically acceptable is a matter of higher priority to the National Agency for Food and Drugs Administration and Control (NAFDAC, 2004). Drinking water that is certified fit for human consumption by NAFDAC, is expected to meet WHO Standard; to be free from physical, chemical substances and microorganisms in the amount that could be within acceptable limit.

It is a known fact that no single method of filtration or purification of water will eliminate hundred percent of the contaminant from our drinking water (Muhammad, 2014). Water samples can be screened using epifluorescence microscope with 4α-6-diamidino-2-phenylindole (DAPI) staining, the analyses including viable counts for Escherichia coli, intestinal enterococci, coliform bacteria and heterotrophic bacteria. In addition, total cell counts including both viable and nonviable bacteria, algae and protozoans may be assessed using (Von Hertzen *et al*., 2007).

There are physical, chemical and heavy metal parameter guidelines recommended by World Health Organization (WHO, 2005), National Administration for Food Drugs and Control (NAFDAC), and Standard Organization of Nigeria (SON, 2007). These are agency in Nigeria that regulates the quality of potable water. When the heavy metals exceed maximum permissible concentration for potable water, the water is said to be contaminated (Izah and Ineyougha, 2015). Water is life, it is vital to all forms of life on earth. Provision of fresh water to drink, for use in industry, agriculture and for the multitude of other purposes is necessity (UNESCO, 2012). The aim of this study is to qualitatively evaluate some physico-chemical and bacteriological parameters of water samples of some rivers in Yobe State.

MATERIALS AND METHODS

Station description

The stations were selected to capture the major towns from north to southern part of the state; Nguru is located in the far north west, Geidam far north east Gashua and Damaturu randomly selected due to the activities in those areas, Katarko was located in the southern part of the state. The state was purely a pastoral agriculture, Nguru, Gashua and Geidam were connected with same river route which finally emptying its content into Chad basin. Damaturu- Katarko are also connected with the same river source. The study was conducted between June-September, 2016. The major economic activities in these areas are; Land mining for Potash at Nguru, Gashua and Geidam. While in Katarko area Gypsum and other precious stone mining activities are common in this area.

Water sampling

The water samples were collected in sterilized plastic containers from five different locations for this study. The sample was quickly transferred to the laboratory and kept till analysis (WRC, 2000).

METHODS

Analyses of parameters from water samples were carried out using atomic absorption spectrophotometer (AAS-DR2000). For calcium, chloride, chromium, fluoride, Iron, manganese, magnesium, nitrite, sulphate, and total hardness. Turbidity was determined by absorptiometry method. Colour was determined by Platinum-cobalt (Pt co) method. pH was determined with litmus paper and compared on colour chart. While total dissolved solids, electrical conductivity and temperature were determined using Omega conductivity meter (CDH221) (WRC, 2000).

Preparation of culture Media and analysis of bacteriological parameters

52 g of MacConkey agar was suspended in 1 litre (1000 ml) of distilled water. It was brought to a boil in order to dissolve

completely for fifteen (15) min at 121°C. 2ml was poured into five sterile Petri plates. The surface of the gel was dried before inoculation. Inoculation Method for Colony Count:

Membrane filter method

10 ml of water sample was used for this segment; the water was vortexed and filtered onto a membrane filter using a sterile filtration compartment according to method as described by Dagne *et al*. (2005).

A forcep was dipped into alcohol and burnt off excess drops; the forcep was used to take absorbent membrane pad from the package and placed on sterilized agar plate, touching the pad only at the very edge. 2.0 ml of the prepared media was pipetted onto the absorbent membrane pad and drained off any excess. The forcep from alcohol were taken again and burnt off excess drops.

The membrane filters was taken from the package and place it side up on support screen of filter apparatus. The funnel was carefully set onto the base and fixed into place. The sample was added to filtration funnel. The plate was incubated in an incubator at 35°C for 24 h. The plates were then checked for bacteria colony growth (Dafour *et al*., 1981; Camberra, 2005; Dagne *et al*., 2005).

Determination of total coliform

After the samples were incubated at a temperature of 35°C for 24 h, the plates count was taken for each of the samples.

Determination of Escherichia coli

The same procedure was used as that of total coliform, except that there was temperature adjustment to (45°C).

Statistical analysis

The samples were recorded in triplicate and the mean obtained and presented as MEAN ± SEM. ANOVA test was conducted and the significance level was taken at (α=0.05).

RESULTS

Physicochemical parameters determined were; calcium, chloride, chromium, fluoride, Iron, manganese, magnesium, nitrite, sulphate, total hardness, total dissolved solid, conductivity, temperature, Turbidity, Colour and pH (Table 1). The bacteriological assessments carried out are total coliform and Escherichia coli; the result was presented in the (Table 2).

DISCUSSION

The physico-chemical and bacteriological parameters were compared with the World Health Organization (WHO, 2005) standard in order to assess the quality of water from five different locations in Yobe State. Physical parameters determined revealed that, the values for the total dissolved solids were within the WHO acceptable value of 1,500 mg/L, for all the five samples. However, water containing more than 500 mg/L total dissolved solids is not considered desirable for water supplies for drinking purposes. Electrical conductivity which is a measurement of water electrical current is directly related to the concentration of dissolved ions in the water, the value falls within the limit of WHO standard. Conductivity of the samples were on the lower side 0.06-0.23 Ms/Cm when compare with the finding of Enetimi *et al*., (2016) with 423.53 – 2033.56 µhmoscm^{-1}

Damaturu and Nguru water temperatures are higher compared with the rest samples; this may be the influence of the hot wind which is blowing across northwest direction. The temperature of the samples falls within the range of 26.83°C-31.35°C may be the outcome this of the nature of the climatic condition of the State. This result agrees with the finding of Muhammad, (2014). Turbidity of the samples is higher 29.33-375.66 FTU when compared with WHO acceptable limit of 5 FTU.

The colour of the sample is much higher when compared with WHO limit of 15 Pt-Co. The obtained value range between 41.66-499.66Pt-Co. Turbidity is mostly caused by the presence of suspended particles such as clay, silt, finely divided organic and inorganic matters make water to become muddy. Also, industrial waste and growth of algae may affect water turbidity. The turbidity of the samples as well as color, exceeded the World Health Organization standard values. Actually, coloration of water is caused by the presence of some metallic salts, organic matter, and the dissolved material present (Law, 2005).

The pH range of (6.00-6.83) were obtained in five locations of the state were consistent with work of Enetimi *et al*., (2016) with the value of 6.73-6.87 pH. The P^H values of samples falls within the acceptable values of World Health Organization standard except Geidam which had pH of 6.83. Calcium: 0.63-1.23 mg/L and magnesium, 0.16±0.01-0.87 mg/L were lower when compared with 250mg/L the acceptable limit, but lower than the result of Enetimi *et al*., (2016) 4.04 – 6.20mg/kg (calcium), and 4.77 – 6.12 mg/kg (magnesium). Chlorides obtained were higher with values range of 8.36-24.66 mg/L which is above the WHO acceptable value of 1.5 mg/L. Chromium; obtained for the locations are; 0.03 mg/L for Damaturu,0.14 mg/L Gashua,.44 mg/L Geidam,0.082 mg/L Katarko, and 0.05 mg/L Nguru. Damaturu and Nguru samples value are within normal, while Gashua, Geidam and Katarko are above the acceptable value of 0.05 mg/L. Fluoride: 0.00-1.4 mg/L, value is less than the recommended value of 50 mg/L. Iron; the value obtained range between 0.17-3.16±0.12mg/L,

Table 1. Physicochemical properties of sample river water in five locations in Yobe State.

Parameters	Damaturu	Gashua	Geidam	Katarko	Nguru
pH	6±0.16	6.33±0.53	6.83±0.12	6.53±0.41	6.51±0.08
Temperature (°C)	31.35±0.15	28.23±0.49	27.36±0.28	26.83±0.16	30.43±0.49
Total Dissolved Solid (mg/l)	0.121±0.0	0.04±0.0	0.04±0.0	0.04±0.0	0.041±0.0
Electrical Conductivity (Ms/Cm)	0.23±0.004	0.07±0.01	0.06±0.004	0.08±0.008	0.09±0.001
Turbidity (FTU)	29.33±12.35	93±6.96	375.66±57.82*	76.66±5.01	83±4.41
Colour (Pt co)	41.66±8.19	421.33±14.85*	499.66±35.70*	429.66±17.61*	54.66±5.71
Calcium (mg/ L)	0.90±0.16	0.64±0.01	0.63±0.02	0.63±0.04	1.23±0.16
Chloride (mg/ L)	19.13±18.57	8.36±0.31*	23.43±0.79	23.3±0.12	24.66±3.85
Chromium (mg/l)	0.03±0.01	0.14±0.01	0.44±0.26	0.082±0.26	0.05±0.00
Fluoride (mg/ L)	1.4±0.12	0.00	0.00	0.00	0.00
Iron (mg/ L)	0.17±0.01	3.16±0.12	3.10±0.14	2.36±0.05	1.4±0.32
Manganese (mg/ L)	0.21±0.01	2.06±0.12	12.17±1.75*	1.43±0.12	0.06±0.01
Magnesium (mg/l)	0.27±0.01	0.22±0.01	0.16±0.01	0.28±0.01	0.87±0.08
Nitrate (mg/ L)	33.2±2.25*	2.4±0.32	6.46±0.26	4.03±0.12	4.33±2.49
Sulphate (mg/ L)	27.46±1.22	27.5±1.08	72.33±2.05*	15.16±0.62	37.66±21.31
Total hardness mg/L	0.95±0.01	0.88±0.01	0.83±0.01	0.93±0.03	0.89±0.04

Samples were recorded in triplicate and the mean obtained and presented as Mean ± SEM. *significantly difference ($p<0.05$).

Table 2. Bacteriological parameters of water sample from different areas in Yobe State.

Parameters (CFU/100ml)	Damaturu	Gashua	Geidam	Katarko	Nguru
Total Coliform	1	3	2	4*	00
Escherichia coli (E. coli)	3	1	4*	1	00

*Significantly difference ($p<0.05$).

Damaturu location have the least value, while the rest locations have their value above the acceptable value of 1.0 mg/L. Iron being one of the major components of mineral element found in abundance on the earth, occurs naturally in some groundwater. The value of iron in Gashua, Geidam, Katarko and Nguru samples were above the acceptable limit. These could cause change in colour and taste of water. Manganese; the result record ranges from 0.21-12.17 mg/L with Geidam having the highest value. Nitrate; gives 2.4-33.2 mg/L this is higher than the finding of Enetimi *et al*., (2016) 2.43-4.57mg/kg (nitrate), the result from all the locations are lower than 400mg/L which is WHO acceptable value. Sulphate; 27.46-72.33 mg/L this is higher than WHO acceptable value of 0.05 mg/L, also higher than the result of Enetimi *et al*., (2016) 1.30-4.20 mg/kg (Sulphate). Total hardness: 0.83-0.95 mg/L is less than the acceptable value of 50 mg/L.

The bacteriological total coliform and the Escherichia coli presence in various water samples exceed the acceptable standard values of World Health Organization. These may lead to cases of diarrhea, cholera, fever, and stomach pain in the area. This finding agreed with EL-Ishaq *et al.* (2013), which reported the bacteriological analysis from the same state but different locations Izah and Ineyougha, (2015) review of the microbial quality of potable water in Nigeria, their study found out that the microbial load often exceeds the WHO and FAO Food and Agricultural Organization (FAO) allowable limit of 1.0 $x10^2$cfu/ml for potable water and SON maximum permissible level of 10cfu/ml for total coliform.

Conclusion

The results of the analysis of the five samples from various locations in Yobe State, showed that the physical and chemical parameters of most of the samples were not in agreement with the world health organization standard values. The bacteriological parameters determined did not meet the acceptable values suggesting that the waters samples were contaminated, bacteriologically. The suggestion is that any source of water should be treated before consumption and for other domestic use.

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