OCCURRENCE OF COLIFORM BACTERIUM IN BOREHOLES WATER

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ABSTRACT

To probe the quality of borehole water samples in Gombe Metropolis, water samples were collected from three wards including Pantami (ward A), Tudun Wada (ward B) and Jekada Fari (ward C). Physico-chemical and microbial analysis towards determining the quality of the water compared with Nigeria Standard for Drinking Water Quality (NSDWQ) and the World Health Organization (WHO) standard for were made. The mean values for temperature, pH, conductivity, total dissolved solids (TDS), hardness and chloride in the water sample were within the acceptable range of NSDWQ, except for turbidity and alkalinity. The water alkalinity was different across the wards and above the standards; A= 159.83 mg/L, B= 201.33 mg/L and C= 247.33 mg/L. *Enterobacter aerogenes* was the detected coliform in the water samples. Most of the physicochemical and microbial analyses conducted on the water samples were in accordance with the standard procedures. Thus, as a preventive measure to control the health threat associated with consumption of turbidity and alkaline water, the borehole water samples should only be used for bathing and washing. As well, the public should be provided with alternative water source for drinking and cooking purposes.

Keywords: Coliform, Borehole water, Physicochemical, Gombe metropolis.

INTRODUCTION

Groundwater is the most vital component of the hydrological cycle, as well, essential source of potable water in Africa. It constitutes about two thirds of the freshwater resources of the world. The water provides a reasonable and constant supply for domestic use, livestock and irrigation (Kumar, A. 2011; Calow *et al.*, 2011). In many arid and semi-arid areas of Africa, borehole water remains a means of coping with water deficiencies, more especially in areas where rainfall is scarce or highly seasonal and surface water is extremely limited (David, 2011). Borehole sample varied from 30m to 50m deep, but such can be found between 7 to 20m (Adekunle I. M. *et al.*, 2007). Evenly, the increasing population pressure and rising demand for food and other services has increased demand for water. This has bigger the reliance on groundwater resources in developing nations thereby creating challenges for the provisions of adequate quantity and quality water. However, borehole water development in under-develop and developing countries is seen as more amenable to poverty targeting than surface water, as well, low cost option (Kai and Jeroen, 2009).

In fact, water is not easily accessible to large sections of the global population which defines the central needs for borehole water resources. Presence of pathogenic bacteria in the such water is scientifically possible, because they survive long at underground and may have a life span of about 4 years. Equally, indiscriminate waste disposal, poor agricultural practices, pit latrines and graves near boreholes and poor well construction can contribute to borehole water contamination (Lu, 2004; McHenry, 2011). These account for the presence of coliform bacteria in borehole water (Adetunde, L. A. and Glover, R. L. K. 2010). Due to that, water contamination has increasingly become an issue of serious environmental concern after years of pollution (Akpoveta *et al*., 2011). These may serve as source of water borne or related diseases. Therefore, identifying the factors that affect domestic water quality is very important in management of available water resources. Determining the parameters of borehole water and its microbial community remain a welcome idea toward preventing the spread of water related diseases. In the present study, boreholes water samples were collected, characterized and further determine their quality based on presence of coliform bacterium.

MATERIAL AND METHODS

Borehole Water Sample Collection

The borehole water samples were collected from Gombe Metropolis, Gombe state, North-East Nigeria. Gombe lay approximately within latitude 10019/N and 11002/E. Three boreholes located at Pantami (ward A), Tudun wada (ward B), and Jekadafari (ward C) areas of the metropolitan were randomly selected for the analyses. The samples were collected using sterile plastic containers 750m1 at 2-weeks interval for a period of three months (April, May and June). Prior, to the sample collection, the taps were sterilized with flame and allowed to cool by running the water for about 1 minute. All the samples were kept in ice box and brought to Biological Sciences, GSU laboratory for physicochemical and microbial analysis.

Physicochemical analyses of the Water Samples

Physicochemical parameters of the collected water samples were determined using standard methods as earlier described by Agbaire P.O. and Oyibo P.1 (2009). pH was determined using the pH meter model 3510, Temperature using mobile thermometer, Turbidity with turbidity meter, conductivity using HANA model H19835 meter and total dissolved solid using HANA model H19-143. Chloride, total hardness and alkalinity were determined by titration (Efe S.I., 2005).

Determination of Coliform Bacteria

Bacteriological characteristics of the water were determined as describe by Bezuidenhout et al., (2002). Standard analysis followed were ‘presumptive’, ‘confirmed’, and ‘completed’ tests. In presumptive test, most probable number of multiple tube technique were used for coliform enumeration. Confirmed test; eosein methylene blue (EMB) agar plates were used to determine the heterotrophic bacteria and incubated at 35°C for 24hrs. In presumptive test, colonies were confirmed by gram staining and each plate were given positive or negative score which marks the test complete.

RESULTS

Characteristics of the Boreholes Water

Physicochemical properties determination result of the boreholes water collected from the different parts of Gombe metropolitan are summarized in Tables 1. The mean and standard deviation of the water temperature recorded are; ward A 31^{o}C+12.19, ward B 30°C ±12.10 and ward C 30°C ±12.10 for the three consecutive months (Apj May and June). Likewise, the mean pH, hardness and TDS values are within the acceptable ranges recommended by NSDWQ and WHO. Turbidity analysis indicated that the borehole water samples from ward A and B are suitable for human consumption except for ward C, as its turbidity values exceeded the maximum allowable limit recommended by the national and international drinking water regulatory authorities. In case of conductivity and chloride, they were also within the acceptable range (Table 1). However, the conductivity values were higher compared what was reported by Aremu *et al*., (2011) on streams and boreholes water. This may be due to differences in geochemical conditions and soluble ions in the different locations. The alkalinity values of all the water samples was above the stipulated limit (Table 1) as reported by Magit, 2002 and Chris, W.P. (2012). This again confirmed the slightly acidic nature of water samples collected. Hence, water from these boreholes requires some level of treatment to attain the required WHO and NSDWQ standard.

Table 1: Physicochemical parameters of the examined boreholes water compared with that of NSDWQ and WHO

Parameters	Wards			Standard	
	A	B	C	NSDWQ	WHO
Temperature (^{0}C)	31.3 ±12.19	30 ± 12.10	30 ± 12.10	27.0-28.0	30^{0}C
pH	6.52 ± 0.78	6.62 ± 0.51	6.16 ± 0.17	6.5-8.5	6.5-8.5
TDS (mg/L)	243.17 ± 53.05	189.16 ± 33.85	165.53 ± 29.94	500 mg/L	1500 mg/L
Turbidity (mg/L)	1.42 ± 0.09	2.3 ± 0.57	8.09 ± 0.80	5 Mg/L	5 Mg/L
Conductivity (µS/cm)	684.3 ± 107.80	277.6 ± 25.81	300 ± 56.89	1000 (µS/cm)	1000 (µS/cm)
Alkalinity(mg/L)	159.83 ± 14.86	201.33 ± 26.30	247.33 ± 30.00	120 mg/L	100mg/L
Chloride (mg/L)	159.63 ± 14.35	172.16 ± 9.06	183.33 ± 10.75	250 mg/L	250 mg/L
Hardness (mg/L)	107.55 ± 25.12	103.66 ± 19.30	245.66 ± 55.25	300 mg/L	500 mg/L

Most probable number (MPN) per 100mL of sample at 95% confidence limits for various combinations of both positive and negative result are tabularized in Table 2.

Presence of Coliform in Boreholes Water

Occurrence of infectious bacterium in the samples, particularly, *Enterobacter aerogenes* was shown in Table 3. The bacteriological analysis revealed it was only *Enterobacter* coliform bacteria are present in the three-borehole water. Particularly, the percentage of *Enterobacter aerogenes* prevalence in the month of June was high with a value of 13 % for each of ward (A, B, C). the water samples from all the three wards contained feacal Coliform as WHO and NSDWQ recommend no feacal coliform should be found in any water meant for drinking. Coliform bacteria are described and grouped based on their common origin or characteristics, as either total or faecal Coliforms. The total group includes faecal Coliform bacteria such as *Escherichia coli* (*E. coli*), as well as other types of Coliform bacteria that are naturally found in the soil. Faecal Coliform bacteria exist in the intestines of warm-blooded animals and humans, and are found in bodily waste, animal droppings, and naturally in soil. Most of the faecal Coliform in faecal material comprised of *E. coli*, and the serotype *E. coli* 0157:H7 known to cause serious human illness (Health Canada, 2011).

Table 2: MPN mean value per at 95% confidence limits for the various combinations of positive and negative results

Month	Sample	No. of tubes giving a positive reaction		MPN (100ml)	95% confidence limits	
		1 of 50ml	5 of 10ml		Lower	Upper
April	Ward A	1	3	9	2	21
	Ward B	1	5	18	-	-
	Ward C	1	5	18	-	-
May	Ward A	0	3	4	1	11
	Ward B	1	5	18	-	-
	Ward C	1	2	6	1	15
June	Ward A	1	5	18	-	-
	Ward B	1	5	18	-	-
	Ward C	1	5	18	-	-

Table 3: Presence and prevalence of *Enterobacter aerogenes* bacterium in the water samples

Months	Ward	No. of sample infected	Prevalence Percentage %
April	A	4	8
	B	6	13
	C	6	13
May	A	3	7
	B	6	13
	C	3	7
June	A	6	13
	B	6	13
	C	6	13
		46	**100**

DISCUSSION

Temperature value primarily indicates good water quality, as it influences pH, alkalinity, acidity and dissolved oxygen (DO). The temperature values recorded in the present research has meet up with that of the WHO standard for drinking water and the NSDWQ, except for ward A. Thus, this might unfavorably retard dissolution of oxygen and therefore, could intensify odor due to anaerobic reaction (Chris, W.P. 2012). Low pH water is regarded as acidic, soft and corrosive due which could leach to metals such as copper, iron, lead, manganese and zinc from pipes and fixtures. This also cause damage to metals pipes and brings about aesthetic problems such as a metallic sour taste. Therefore, the waters might contain elevated levels of toxic metals, with which could be detrimental to human health (Akpoveta O.V., 2011).

Turbidity is caused by suspended matter or impurities that interfere with the clarity of water bodies. These impurities may include clay, silt, finely divided inorganic and organic matter, soluble coloured organic compounds, and plankton and other microscopic organisms. Excessive turbidity in drinking water, apart from being aesthetically unappealing, may also present a health threat by providing food and shelter to pathogens Bodoczi, A. (2010). TDS is the term used to describe the inorganic salts and small amounts of organic matters present in water solution. The principal constituents are usually calcium. magnesium, sodium, and potassium cations and carbonate, bicarbonate, chloride, sulphate and nitrate anions (Aremu *et al*, 2011). The hardness of drinking water is determined largely by its content of calcium and magnesium. It is expressed as the equivalent amount of calcium carbonate that could be formed from the calcium and magnesium in solution (Itah, A. Y. and Akpan, C. E. 2005).

The bacteriological analysis revealed it was only *Enterobacter* coliform bacteria are present in the three-borehole water. The percentage of *Enterobacter aerogenes* prevalence in the month of June was high with a value of 13% for each of ward (A, B, C) (Egwari L., and Aboaba O.O. 2002). Water samples from all the three wards contained feacal Coliform as WHO and NSDWQ recommend no feacal coliform should be found in any water meant for drinking (Bodoczi, A. 2010). Based on bacteriological analysis, therefore, one may conclude that borehole water samples from all the three wards should be treated properly before usage by boiling or use of disinfectant.

CONCLUSION

Different borehole water from Gombe Metropolitan were determine for coliform presence. The assessment of the water compared with standard as recommended by WHO and NSDWQ was achieved and within the acceptable range. Even though, it is advised to and necessary to treat water from borehole before consumption to prevent the spread of water borne diseases to ensure that the health of the community is protected.

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