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Assessment of water quality status of borehole in calabar south local government area, Cross River State

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Abstract

In Nigeria, the inability of the government to provide potable and sufficient water to her increasing population has led to the indiscriminate sinking of boreholes by private individuals in order to meet the increasing water needs of the people. Sadly, water from these boreholes is pumped and sold to the people for drinking and household activities without any form of treatment. The study examines the physico-chemical and bacteriological parameters of boreholes in Calabar South, Cross River. Four functional boreholes in the area were used. Result showed that the borehole water samples were acidic with a mean pH value of 5.56; the values of total suspended solids (TSS) and turbidity was zero; indicating the absence of organic and inorganic solids. The conductivity of the borehole water samples varied with values ranging from 190 to 494µs/cm. Total hardness of the water samples ranged from 16.00 to 32.00mg/l below WHO 500 mg/l desirable limit. Bacteriological index showed that the four sampled boreholes had no coliform (total coliform) contamination; hence, water from these boreholes was suitable for consumption. In order to maintain the current quality status of borehole water in the area, regular monitoring by the authorities concerned as well as proper treatment of the water before making it available to the public were suggested.

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Introduction

In developing countries like Nigeria, lack of drinkable water is one of the most critical crises of human health as a result, rivers, streams, well and borehole waters are often used as supplement for the scarce pipe-borne water for drinking with little or no treatment. Drinking such water is harmful and may results in the outbreak of epidemics (Adesina, 1986). The supply of water in several cities in Nigeria is insufficient to meet the increasing water demands of her teeming population. The inability of the federal, state and local governments in Nigeria to provide potable and sufficient water to her increasing population has led to the indiscriminate sinking of boreholes by private individuals in order to meet the increasing water needs of the people (Ano & Okwunodulu, 2008). In Calabar South Local Government Area of Cross River State, the absence of potable water to every household has led to the proliferation of boreholes as a result of its high demand and lucrative nature. Sadly, water from these boreholes is pumped and sold to the inhabitants of the area for drinking and household activities without any form of treatment.

Environmentalists, geologists, geographers and scholars in different fields of studies have raised alarms on the indiscriminate sinking of boreholes in rural and urban areas (Ano & Okwunodulu, 2008; Adekunle, 2008; Ojo, 1995) due to numerous health implications; this is because in some areas, boreholes are located too near and downstream of soak away pits or adjoining landfills/waste dump sites. The quality of water from such boreholes cannot be guaranteed due to element contamination. Several studies have in the past been carried out to assess the water quality status of underground water (Ojo, 1995; Sangodoyin, 1991; Alexander, 2008; Jam et al., 1995; Ibe, and Okplenye, 2005; Chuchwu, 2008; Ano & Okwunodulu, 2008; Alexander, 2008; Sangodoyin, 1991; Adekunle 2008; Adamu and Adekiya, 2010; Yerima et al., 2008; Udom et al., 2002; Obiefuna and Sheriff, 2011) across the country and beyond, but in Calabar South, with the recent development in infrastructures and the subsequent increase in population and number of boreholes to meet the large unavailability of pipe-borne water, no documented and quantitative information is available on the quality status of boreholes in the area. Though, of recent, the Cross River State Water Board has tried to meet up with the water needs of people in the area, but inconsistence in water supply has made people to keep on patronizing private providers. It is on this background that this study assesses the water quality status of boreholes in Calabar South Local Government Area, Cross River State.

Material and methods

Study area

The study was conducted in Calabar South Local Governments Area of Cross River State, Nigeria between the 4th and 5th of August, 2009. Calabar South is located approximately between longitude 8° 19'E and 8° 21'E and latitude 4° 55'N and 4° 58'N. Owing to it latitudinal location, the area receives abundant and constant insulation. The maximum temperature is above 27 °C with a peak at about 35°C during January to February, the daily maximum and mean annual maximum temperature increase from the coastal temperature is 30 °C. The moderating influences in the coastal region are due to proximity to the sea. The mean daily maximum temperature does not fall below 10 °C except during hamattan, where variation exists. The vegetation of Calabar South is characterized by mangrove and rainforest ecosystems which form part of the rich fauna and flora of the state. The major engineers of economic growth in the area are farming, fishing and the public sector. Presently, the pace is set to rejuvenate a dynamic, purposeful and vibrant sector economy in the metropolis to complement the tourism drive of the state. The major sources of water for drinking in the area are pipe-borne water, borehole, rainwater and river.

Sample collection and analysis

The procedure for data selection commenced with a reconnaissance survey to the area. This enabled functional boreholes to be identified. Functional borehole was conceptualized as one that is frequently in use with level of patronage (use) greater than 50 persons per day. Through this approach, 19 functional boreholes were identified, with their names written on pieces of paper after which 4 boreholes were randomly selected without replacement. Water samples were collected using ragolis plastic containers; before the collection of water samples, the boreholes were allowed to pump for 15 minutes so that water with a constant temperature and pH, representing that from the aquifer was collected. Water samples were collected at the borehole heads. Prior to sample collection, all plastic containers were rinsed thrice with the borehole water. After sampling, the containers were tightly covered to minimize oxygen contamination, and escape of dissolved gases; the samples were appropriately labeled and stored in a cooler of 4 ^{o}C, and immediately taken to the laboratory at the University of Calabar for analysis of physical, chemical and bacteriological parameters using standard methods (APHA, 1998). Results obtained from the laboratory analysis were represented using tables and averages, while analysis of variance (ANOVA) for significant variation in water quality among the sampled boreholes was determined using SPSS 17.0 for Windows.

Result and discussion

Information on the physico-chemical parameters of the water samples from the four boreholes is depicted in Table 1. The borehole water samples were acidic with a pH range of 5.46 to 5.62 and a mean value of 5.56. The acidic nature of borehole water could be attributed to the abundance of organic matter in the soil as well as the presence of tiny shale intercalations in the aquiferous coastal plain sand (Udom et al., 2002). The pH values are below the minimum desirable limits of 6.5 set by WHO (2006). The values of total suspended solids (TSS) and turbidity were zero; meaning that the water is harmless, in its natural state and ideal for human consumption. It further indicates the absence of organic and inorganic solids. Conductivity measures the ability of water to conduct an electric current and is used to estimate the amount of dissolved solids. It increases as the amount of dissolved mineral (ions) increases. The conductivity of the borehole samples varied with values ranging from 190 to 494μs/cm with a mean value of 324.25μs/cm. These values are within WHO's (2006) desirable limit of 1000 μs/cm for drinking water.

Table 1. Summary of physico-chemical parameters of borehole water samples[a].

Parameters	Range		Mean values	WHO (2006)
	Min	Max		
pH	5.46	5.62	5.5±0.03	6.5-8.5
TSS (mg/l)	0.00	0.00	0.00	-
Turbidity (FTU)	0.00	0.00	0.00	5
Conductivity(μs/cm)	190	494	324.2±66.1	500
NH_4 (mg/l)	0.00	0.00	0.00	-
NH_3 (mg/l)	4.66	5.01	4.8±0.08	50
SO_4 (mg/l)	9.56	24.85	16.2±3.3	400
Chloride (mg/l)	68.00	180.0	117±24.6	250
Total Hardness (mg/l)	16.00	32.00	26.30±3.7	500
Total coliform (MPN/100ml	0.00	0.00	0.00	0.00

[a] Values are means ± standard errors

Nevertheless, Ammonium (NH_4) value was 0.00mg/l for the four sampled boreholes, which indicates that all the boreholes are free of ammonium contamination. Nitrate (NO_3) ranged from 4.66 to 5.01mg/l with a mean value of 4.87mg/l and sulphate (SO_4) ranged from 9.56 to 24.85mg/l with a mean value of 16.28mg/l. The relatively low values of NH_3 and SO_4 are attributed to the location of boreholes far away from soak away pits and dumpsites; as the boreholes do not receive domestic and municipal wastes that could contain these elements (Adamu and Adekiya, 2010). The values of NH_3 and SO_4 are within WHO's desirable limits of 50mg/l and 400mg/l respectively. Chloride is an ion that may be associated with individual septic disposal system (ISDSS) and is present in all natural waters, usually in relatively small amounts. High concentration of chloride in water is known to cause no health hazard (Obiefuna and Sheriff, 2011). The value of chloride in this study was low and ranged from 68.00 to 180.00mg/l with a mean value of 117mg/l, which is below the maximum allowable concentration of 250mg/l (WHO, 2006). This value is harmless as such safe for drinking.

Table 2. Physico-chemical and bacteriological parameters of borehole water samples.

Parameters	Selected boreholes			
	Goldie (1)	Harcourt (2)	Atamunu (3)	Palm Street (4)
pH	5.46	5.58	5.62	5.56
TSS (mg/l)	0.00	0.00	0.00	0.00
Turbidity (FTU)	0.00	0.00	0.00	0.00
Conductivity (µs/cm)	256	494	357	190
NH_4(mg/l)	0.00	0.00	0.00	0.00
NO_3 (mg/l)	4.826	4.662	5.010	4.982
SO_4 (mg/l)	12.87	24.85	17.86	9.558
Chloride (mg/l)	90.0	180.0	130.0	68.0
Total Hardness (mg/l)	25.2	32.0	32.0	16.0
Total coliform (MPN/100ml	0	0	0	0

However, the total hardness of the water samples ranged from 16.00 to 32.00mg/l with a mean value of 26.30mg/l, and is below WHO 500mg/l acceptable limit, meaning the water is soft and foamy. This indicates that the boreholes are not harmful or corrosive and would not cause mutations as such; it is suitable for domestic consumption. Comparatively, the physico-chemical concentration of parameter obtained across the ground water samples varied spatially and significantly due to variation in the location of boreholes and human activities. The borehole in station 4 (Palm street) had the least concentration as such, was most potable for consumption, followed by station 1 (Goldie), station 3 (Harcourt) and then station 3 (Atamunu). Bacteriologically, the four sampled boreholes had no coliform indicating the absence of contamination. Irrespective of this, the ANOVA result implies that the physico-chemical parameters of the four boreholes do not vary ($F = 0.317$, $p>0.05$).

Bacteriological analysis (total coliform) of selected boreholes

Coliform are a family of bacteria common in soil, plant and animal. One can come in contact with these bacteria by eating or drinking (ingesting) soils on plants and in rivers. The presence of coliform in water indicates the possibility, but not the certainty that disease organisms may also be present in the water. When total coliforms are absent there is a very low probability of disease organisms being present in the water (Environmental Fact Sheet, 2008). Total or fecal coliform bacteria can be found in water contaminated by human and animal waste. The presence of only total coliform does not imply an imminent health risk but does require an analysis of all water system facilities and their operation to determine how these organisms entered the water system. However, bacteriological speaking, water from the four sampled boreholes were within WHO (2006) recommended guideline standard for drinking water. The guideline requires that water intended for drinking should not contain any pathogen or micro-organisms indicative of fecal contamination. Thus, the entire borehole water samples examined had no trace of fecal coliform or total coliform. The borehole used for the study may be deduced to be properly constructed with no cracks to give way to any form of contamination from runoff; also they are located far away from soak away pits. In conclusion, the bacteriological quality of the sample boreholes is ideal and suitable for drinking and domestic purpose.

Conclusion/recommendation

The result obtained shows that the quality status of boreholes in the area is not impaired or polluted in any way. The examined parameters across the four boreholes samples are within WHO's limits for drinking water, as no parameter individual or as a whole exceeded the maximum permissible limit. It therefore implies that the boreholes are potable and suitable for consumption. The bacteriological analysis shows that the borehole water is within WHO's recommended guideline for drinking water; hence water from the boreholes is suitable for consumption. However, to maintain their potable state/ suitability, regular monitoring should be ensured by the authorities concerned. Nevertheless, despite, the potable nature of water in the area, it should be adequately/ properly treated before making it available to the public.

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