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ASSESSMENT OF THE QUALITY OF WATER FROM BOREHOLES AND HAND-DUG WELLS OF PERI-URBAN TOWNS IN SOUTHERN NIGERIA.

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ABSTRACT

This study assessed the quality of borehole and hand-dug wells water from three peri-urban towns in southern, Nigeria. Seventeen borehole and hand-dug well water samples were examined for physicochemical and bacteriological properties using standard analytical procedures. The results were compared with WHO permissible standards for drinking water. The results showed that physicochemical properties such as pH, turbidity, electrical conductivity, total dissolved solid, chloride, sulphate were within the accepted maximum allowable limits of WHO for drinking water whereas the bacteriological property such as total coliform was above the WHO accepted maximum allowable limits of WHO for drinking water. The high coliform count indicated faecal pollution and its usage domestically could be endangering to human health.

INTRODUCTION

Groundwater is a vital resource on which more than one-quarter of the world's population depends for drinking water (Hill, 2004). It is naturally replenished by surface water from precipitation, streams and rivers. It is not as susceptible to pollution as surface water but once polluted, restoration is difficult and long term (Henry and Heinke, 2005). Groundwater contamination occurs when surface pollutants, dissolved in water, percolate down through the soil, rendering the water unsafe and unfit for human use (Agbaire and Oyibo, 2009). How much pollutant reaches groundwater depends on soil type, pollutant characteristic and the distance to groundwater (Hill, 2004).

Today, anthropogenic activities are constantly adding industrial, domestic and agricultural wastes to groundwater reservoirs at alarming rate (Aremu et al., 2011) which subsequently alters the physicochemical properties of the water (Aremu et al., 2011; Ezeribe et al., 2012). Pollution processes, which introduce water-soluble chemicals and microorganisms via improperly built landfill and septic systems, occur in drinking water throughout the world which could possibly threaten human health. Determining the health effects of these contaminants is difficult, especially researching and learning how different chemicals react in the body to damage cells and cause illness (Hornsby, 2009).

The quality and accessibility of drinking water are of paramount importance to human health. In order to control the risks to public health arising from Pollution, systematic water quality monitoring and surveillance are required. Generally, most rural dwellers depend on groundwater as an available water source since it does not generally require treatment. The quality of this groundwater is not fully guaranteed and may be challenging to consumers who rely on them as a drinking source. Therefore, the objective of this study was to assess the physicochemical and biological quality of groundwater from sub-urban towns in Delta State, Nigeria.

MATERIALS AND METHODS

Description of study area

The study area covers three peri-urban towns of Abraka, Eku and Oviorie located in Ethiope East Local Government Area of Delta State. Abraka, a university town lies approximately on longitude 6^{o} 061E and latitude 5^{o}481N, Eku lies on longitude 6^{o} 05E and latitude 5^{o} 767N while Oviorie lies within the coordinates of longitude 5^{o}919E and latitude 5^{o}661N. The study area enjoys a tropical climate with well demarcated rainy and dry seasons. The dry season sketches from November to April while the rainy season is usually from May to October of every year.

Sample collection

A total of seventeen groundwater samples were obtained from boreholes (hereafter referred to as "BH") and hand-dug wells (hereafter referred to as "HD") in different locations in Abraka, Eku and Oviore towns in Delta State of Nigeria following standard water sampling procedure. Each sample was directly collected into factory fresh plastic bottles, with cap securely tightened. The containers used for collection and storage had been previously washed and rinsed with 5% nitric acid and then thoroughly rinsed with deionised water. After collection the samples were placed inside ice coolers for transportation to the laboratory where they were stored in the refrigerator at 4°C pending analysis.

Experimental Analysis

Physicochemical parameters of water samples were determined by standard analytical procedures (APHA, 1995). The pH of water samples was measured at the time of sampling with a pH meter previously calibrated with buffer solutions of pH 4 and 7 respectively. Conductivity was measured with a conductivity meter calibrated with potassium chloride solution. Turbidity was determined using turbidity meter. Total dissolved solid (TDS) was determined gravimetrically by evaporating a known volume of water to dryness in a preweighed crucible on a steam bath. The concentrations of sulphates (SO_4^{2-}) and chlorides (Cl^-) were determined spectrometrically while total coliform of samples was determined using multiple tube fermentation technique expressed as most probable number (APHA 9222C). General laboratory quality assurance measures were always maintained.

RESULTS AND DISCUSSION

The result of the physicochemical and biological properties of the borehole, ring well and normal wells samples along with the World Health Organization (WHO) recommended standard for drinking water are presented in Table 1.

Water quality parameters, including pH and TDS are important quality parameters that serve as controlling variables because they strongly influence the behaviour of many other constituents (Weiner, 2007).

pH measures the concentration of hydrogen ion in water. The mean pH values ranged from 6.6 ± 0.2 to 7.8 ± 0.6 for BH samples and from 4.81 ± 0.16 to 6.05 ± 0.10 for HD samples. pH values obtained for HD waters are indicative of slight acidity of the water, which are subsequently lower than the WHO recommended limits (6.50 – 8.50) for drinking water. Consumption of acidic waters could have adverse effect on the digestive and lymphatic systems of humans (Chinedu et al. 2011). The values of pH obtained in this study for BH are within the WHO recommended values for drinking water. Similar values have been reported in the literature (Nduka et al., 2008; Agbaire and Oyibo, 2009; Nkansah et al., 2010; Ilechukwu and Okonkwo, 2012; Ezeribe et al., 2012; Chukwu and Nwanchukwu, 2013). Being an indicator of the chemical state in which environmental species will be found (Weiner, 2007), an alteration of the chemical forms of toxic species (which might be present) by increased solubility (e.g. of toxic metals) is less likely to occur; this is because solubility occurs at extreme pH values of acidity and alkalinity.

Turbidity measures suspended matter in water. It is usually caused by suspended particles which can be as a result of phytoplankton in water, making the water cloudy and hazy (Chinedu et al. 2011). For BH, the mean turbidity values obtained ranged from 1.60 ± 0.82 to 4.80 ± 1.31 NTU whereas the mean turbidity for HD ranged from 1.61 ± 0.37 to 4.21 ± 1.58 NTU. The turbidity values obtained for BH are lower than the WHO recommended values of 5 NTU. The values obtained for HD are comparable to those obtained by Ezeribe et al. (2012). The higher turbidity values for HD may be due to the presence of clay, silt, finely divided organic matter, plankton and other microscopic organisms (Durance, 1986; Ezeribe et al., 2012).

Electrical conductivity measures water's capacity for carrying electrical current and is directly related to the concentrations of ionized substances in the water (Jayalakshimi et al., 2011). From the result, the mean electrical conductivity obtained ranged from 25.30 ± 15.80 to 46.10 ± 7.10 μS/cm for BH and 59.80 ± 18.20 to 250.97 ± 126.30 μS/cm for HD. In some cases, these electrical conductivity results could serve as the total dissolved solids in water. The values are similar to those obtained for boreholes and hand-dug wells reported by Agbaire and Oyibo (2009), Ezeribe et al. (2012) and Ilechukwu and Okonkwo (2012) but are within the WHO permissible level.

The mean TDS obtained in this study ranged from 3.70 ± 1.90 to 13.40 ± 12.10 mg/L for BH water and 31.69 ± 17.76 to 133.00 ± 86.00 mg/L for HD water. The values obtained for BH are higher than those reported by Agbaire and Oyibo (2009) but the values are however lower than those reported by Ezeribe et al. (2012) and the WHO specification limits of 500 mg/L for drinking water. Carbonates, bicarbonates, chlorides, sulphates, phosphates and nitrate salts are thought to be major contributors to the high TDS values recorded for HD samples. However, while drinking water with TDS>1200mg/L may not taste good and may have a laxative effect (Weiner, 2007), the results obtained in this study can be thought to be acceptable, considering the upper limit of 1000 mg/L for TDS in drinking water.

Chlorides in natural waters such as well water result from the leaching of chloride containing rocks and soil with which the water comes in contact with (Ezeribe et al., 2012). In this study the mean chloride concentration in BH ranged from 3.60 ± 2.70 to 4.90 ± 2.40 mg/L while the mean Cl^- for HD ranged from 9.10 ± 6.67 to 22.22 ± 0.21 mg/L. These values reported in this study are lower than those reported by Ezeribe et al. (2012) and WHO recommended limit.

Sulphates occur naturally in water as a result of leaching from gypsum and other common minerals (Shrinivasa and Venkateswaralu, 2000). The values of sulphates obtained for BH ranged from 1.86 ± 0.10 to 3.50 ± 1.10 mg/L and 3.09 ± 0.71 to 18.75±7.51 mg/L for HD. The values are far below the WHO recommended limit. Similarly, water conditions which could favour the formation of H_2S from sulphates are absent, considering the fact that the concentration obtained is less than 60 mg/L (Weiner, 2007).

Detecting and preventing faecal contamination is of prime importance in drinking water systems. This is because faecal wastes contain enteric pathogens (disease-causing organisms such as bacteria, virus and protozoan) (Weiner, 2007). The mean total coliform recorded in this study for BH ranged from 8.00 ± 4.00 to 15.00 ± 6.00 MPN (most probable number) while in HD wells, it ranged from 8.00 ± 5.00 to 12.00 ± 10.00 MPN. BH in Abraka had the highest mean total coliform compared to the others. None of the samples complied with the WHO standards for coliforms in drinking water as values obtained were higher than the WHO standards of zero MPN per 100 mL. According to WHO (2004), drinking water can be graded into four categories depending on their MPN value. Water with MPN of zero is excellent, MPN of 1-3 is satisfactory, MPN of 4-10 is suspicious and MPN above 10 is unsatisfactory. Water with MPN greater than 3 is not suitable for drinking (WHO, 2004). Areas with higher coliform count were observed to have the presence of latrines and septic tanks (sewage system). Toilet units are designed to discharge waste water into ground subsurface (Offodile, 2002). Therefore the high coliforms obtained in in the present study may be an indication that the water samples were feacally contaminated (Ajayi and Akonai, 2005). Faecal-contaminated water is a common cause of gastrointestinal illness, including diarrhea, dysentery, ulcers, fatigue, and cramps. It also may carry pathogens that cause a host of other serious diseases such as cholera, typhoid fever, hepatitis A, meningitis, and myocarditis (Weiner, 2007).

CONCLUSION

This work has presented the levels of some physicochemical and bacteriological properties of borehole and hand-dug wells in Abraka, Eku and Oviorie in Delta State, Southern Nigeria. The result showed that the physicochemical properties such as pH, turbidity, electrical conductivity, total dissolved solid, chloride and sulphate levels were within the accepted maximum allowable limits of WHO for drinking water whereas the bacteriological property such was above the WHO accepted maximum allowable limits of WHO for drinking water. The study reveals that the quality of groundwater is fit for domestic and drinking purposes, it need some degree of treatments to minimize the bacteriological contaminations. Hence, it is suggested that these waters are not much suitable for drinking purpose.

Therefore, environmental agencies should sought for ways to clean up the sources of water and the environment and improve on the quality of drinking water in these areas to avoid outbreak of drinking water related disease in Abraka whose inhabitants are already at risk.

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Table 1: Physicochemical and bacteriological properties of borehole and hand-dug wells from Abraka, Eku and Oviorie.

	BOREHOLE			**HAND-DUG WELL**	
	Abraka	Eku	Oviorie	Eku	Oviorie
pH	6.61±0.20 (4.98-8.20)	7.82±0.63 (5.67-9.10)	7.46±0.10 (5.41-7.84)	4.81±0.16 (4.51-5.00)	6.05±0.10 (5.49-6.13)
Turbidity (NTU)	1.60±0.82 (1.2-2.70)	4.80±1.31 (3.34-5.10)	4.23±1.60 (4.10-4.95)	4.21±1.58 (2.39-5.25)	1.61±0.37 (1.21-1.96)
EC (µS/cm)	25.30±15.8 (12.10-64.00)	29.70±7.13 (15.56-47.34)	46.1±7.10 (24.25-89.72)	59.80±18.20 (32.00-97.00)	250.97±126.3 (36.90-569.00
TDS (mg/L)	13.40±12.10 (6.57-33.92)	8.20±0.70 (7.20-9.34)	3.70±1.90 (3.11-5.81)	31.69±17.76 (16.96-51.41)	133.0±86.0 (19.56-301.57
Cl^- (mg/L)	4.10±3.30 (3.33-10.00)	4.90±2.40 (3.87-5.62)	3.60±2.70 (2.76-5.88)	9.10±6.67 (3.33-16.66)	22.22±0.21 (5.85-46.65)
SO_4^{2-} (mg/L)	1.86±0.10 (1.42-2.78)	1.90±0.70 (1.27-2.12)	3.50±1.10 (3.25-4.23)	3.09±0.71 (2.27-3.58)	18.75±7.51 (2.10-48.29)
Total coliform (mg/dl)	15.00±6.00 (6.00-18.00)	8.00±4.00 (3.00-16.00)	8.00±4.00 (3.00-16.00)	12.00±10.00 (7.00-18.00)	8.00±5.00 (2.00-16.00)

*WHO (2004)