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Quality Assessment of Borehole Water in-Terms of Selected Physicochemical Parameters in Maiduguri Urban Areas, Borno State, Nigeria

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ABSTRACT: In Nigeria, over 120 million peoples use boreholes as their main source of drinking water and in-view of the increasing volume of solid waste materials in Maiduguri, it has become exigencies to evaluate the quality of borehole waters in the city. The objective of this paper is therefore to evaluate some physicochemical characteristic of borehole water samples in Maiduguri urban areas Borno State, Nigeria using standard methods. Result obtained revealed that the pH of all the water samples was within the range of 6.5 to 8.5 as recommended limit by World Health Organization (WHO). Except for the pH of borehole water at Bulumkutu ward which is acidic (6.2). The pHs of all the water from the three wards were alkaline. The total dissolved solid and the electrical conductivity of water samples from the three wards fall within the limit of WHO, except water samples from Ngarannam (1100 mg/l) and (2220 uS/cm). The concentration of major ions (Na, Mg and K) fall far below the WHO recommended limit and thus the water can said to be excellent in terms of these elements. Except for Cl ion (262 mg/g) at borehole water in Gwange ward fall above the permissible limit by WHO. The study recommends performing regular testing of different water sources within the study area to ensure that commensurate attention given is maintaining a healthy population.

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Water is a precious natural resource that is indispensable to human life and ecosystems health. Water exists in two major sources; ground and surface water (Saminu *et al*., 2020). Boreholes and hand dug well constitute ground water sources while rivers, lakes streams are surface water sources (Ngozi *et al*., 2020). Water is no doubt one of the most essential needs of human beings, for drinking and other domestic purposes. Its presence or lack of it determines to a great extent the nature of the natural environment in which life and majority of our economic activities depend on (Akankpo *et al*., 2009). The quantity of water is significantly affected by domestic, industrial and agricultural activities (Makinde *et al*., 2015). Water is said to be potable if it is colourless, odourless, tasteless, as well as devoid of chemical and microorganisms contaminants (Abdulsalam *et al*., 2019). An estimated population of 1.5 billion people in sub-Saharan Africa depend on groundwater as source of drinking water. In Nigeria, over 120 million peoples use boreholes as their main source of water of drinking (Obioma *et al*., 2020). Groundwater is premium inherent resource that is crucial for human health, socio-economic progress, and functioning of ecosystem. Water dearth owing to fast growth of inhabitants and anthropogenic actions, the preeminence of groundwater is deteriorating in present days (Saminu *et al*., 2020). Possibility of

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groundwater infectivity on existing drought-prone condition, the rudely treated, spontaneous release of effluents of industry and municipal into the nearby streams and ponds. Temporary changing fotting of water and creation of the recharge water, hydrological and human factors, may cause unsteady changes in groundwater quality. Ascertain the quality is crucial before being use for various purposes such as drinking, recreational and industrial (Saminu *et al*., 2018). Therefore, the objective of this paper is therefore to evaluate some physicochemical characteristics of borehole water samples in Maiduguri urban areas Borno State, Nigeria.

MATERIAL AND METHODS

Study area: Maiduguri is the capital of Borno State founded in 1907 by the British colonial masters for administrative purpose it has long been the largest and dominant city in the north eastern region of Nigeria. It lies in the Sudan-Sahel transition zone, located between latitude 11^0 27^1 30 N and 11^0 33^1 N and longitude 13^0 2^1 3 E and 13^0 9^1 10 E with land mass of 550 square kilometers (Musa *et al*., 2019). It is the headquarters of Maiduguri Metropolitan council bounded in the north by Jere Local Government Area, in the south-West by Konduga Local Government Area and in the north by Mafa Local Government Area.

Water sample collection: Water samples were collected from boreholes from the four (4) wards Shehuri south, Ngarannam, Bulumkutu and Gwange of Maiduguri Metropolis. Water samples were collected into polythene bottles prewashed with detergent diluted HNO_3 and distilled de-ionized water. The samples were labeled and transported to the laboratory stored at 4^{0C} to avoid possible alteration of the original properties of the samples before the commencement of the analysis.

Determination of pH: The determination of pH of the water samples was carried out in-situ using digital pH meter standardized with buffer 4.7 and 9 respectively. The pH meters electrode was dipped into 100 cm^3 of water sample and the reading was recorded. The procedure was repeated for the other samples (APHA, 20005).

Total dissolved solid (TDS): This test was performed using a conductivity of the meter. The automated menu of the conductivity meter was switched onto total dissolved solid. A volume of 100 cm^3 of the sample was poured into the beaker and the electrode which is part of the conductivity was introduced into the sample. The result of the total dissolved solid of the sample was shown on the display were noted (APHA, 2005).

Electrical conductivity (EC): The electrical conductivity of the water samples was carried out using conductivity meter. The meter electrode was dipped into 20 ml of the water samples until a stable reading was recorded (APHA, 2005).

Determination of chloride: This test was performed to determine the total chlorine content of the water sample using the HACH Test Kit Model (N66/66F/66T). A colour viewing tube was filled to the 5 ml mark with the water sample. Also another viewing tube was filled to the 5 ml mark with the water sample. The clippers were used to open one DPD Total chlorine reagent powder pillow, and the content was emptied inside the water sample. It was gently switched to achieve a homogenous solution, allowed to stand for three minutes and the results were recorded (Ademorati, 1996).

Determination of other elements: Elemental analysis of the water samples were carried out using appropriate certified and acceptable international procedures outline in the Standard Method for the Examination of Water and Wastewater (APHA, 2005). Sodium (Na), magnesium (Mg) and potassium (K) were analyzed by Atomic Absoption Spectrometer (AAS) Model A. Analyst 400.

RESULTS AND DISCUSSION

Result of this study shows that pH of the water samples were generally within the 6.5 to 8.5 as recommended by WHO (table 1). pH is a significant factor that impacts many biological and chemical processes.

The findings reveal a peri-neutral pH range of 7.0 to 7.6 in Ngarannam (7.4), Shehuri south (7.4) and Gwange (7.6) respectively, but the pH of sample from Bulumkutu ward (6.2) is acidic.

Acidity increases the capacity of the water to attack geological materials and leach toxic materials into the water making it potentially waste for human consumption. In a similar study by Ebong *et al*., (2018) reported that the pH of boreholes water sampled from different points in Mgboushimini was within the range of 4.31 to 4.73. Kolo *et al*., (2009) reported similar PH value of 6.1 from boreholes water sampled from Bulumkutu ward of Maiduguri. Also Alex *et al*., (2015) reported the PH of groundwater in Eliozu community; Part Harcourt was within the range of 5.5 to 8.0. These reports are consistent with the findings of this study.

Table 1: Physicochemical Parameters of the Water Samples

Wards	PH	TDS (mg/l)	EC (µS/cm)
Shehu south	7.4	186	460
Ngarannam	7.0	1100	2230
Bulumkutu	6.2	152	440
Gwange	7.6	112	300
WHO Limit	6.5 to 8.5	500	1000

Source: Data from field

Findings reveals (table 1) total dissolved solid (TDS) of the water samples from the three (3) locations were within the values recommended by WHO, Shehuri south (186 mg/l), Bulumkutu (152 mg/l) and Gwange (112 mg/l) respectively, while that of Ngarannam (1100 mg/l) exceeded limit set by WHO was consistent with the findings of Faleh *et al*., (2020). When the total dissolved solids in water are high, it reduces the water clearness which contributes in reducing photosynthetic activities, probably lead to increase in temperature of the water. Also the taste of drinking will be affected if the total dissolved solid exceed WHO limit of 500 mg/l (Adesakin *et al*., 2020).

Electrical conductivity (EC) is an appropriate tool used in assessing the purity of water. Findings show that the electrical conductivity of boreholes water from Shehuri south (460 (µS/cm)), Bulumkutu (440 (µS/cm)) and Gwange (300 (µS/cm)) were within the permissible set by WHO. The results of the present study were consistent with findings of Olubanja *et al* (2019). Borehole water from these sites was suitable for domestic use, irrigation and other purpose. Electrical conductivity value obtained from Ngarannam ward (2230 (µS/cm)) was above the permissible limit set by WHO, it was consistent with the findings of Faleh *et al*., (2020).

Table 2: Concentration (mg/L) of elements in the water samples

Ward	**Cl**	**Na**	**Mg**	**K**
Shehuri South	94	46	26	8
Ngarannam	32	27	31	13
Bulumkutu	84	31	42	7
Gwange	262	20	5	40
WHO limit	250	200	120	

Source: Data from field

The study reveals (table 2) concentration of chloride (Cl) in the water samples from three wards were within the value recommended set by WHO, Shehuri south (94 mg/l), Ngarannam (32 mg/l), Bulumkutu (84 mg/l) respectively, was consistent with the study of Akpoveta *et al*., (2020) and Ngozi *et al*., (2020), except that of Gwange (262 mg/l) above the permissible value set by WHO consistent with the findings of Efe *et al*., (2005). Chloride is useful in maintaining acid-base balance in the body and significant anions found in water. However, when it becomes excess in drinking water, it might cause dropsy. Chloride contaminates the groundwater through sewage and industrial effluents as well as saline intrusion. Findings reveals (table 2) concentration of sodium (Na) in all the water samples from the four wards were within the limit recommended set by WHO, Shehuri south (46 mg/l), Ngarannam (27 mg/l), Bulumkutu (31 mg/l) and Gwange (20 mg/l) respectively. The results of present study was consistent with the findings Faleh *et al*., (2020) but inconsistent with the findings of Saminu *et al*., (2020). Sodium affects the taste of water and the taste threshold concentration of sodium in water depends on the associated effects related to the temperature of the solution. Health effects related to overdose of sodium chloride include vomiting, nausea, convulsion, cerebral effects pulmonary oedema and muscular twitching. Hallenbeck *et al*., (1981) reported the presence of high level of sodium in drinking water and its relationship with high blood pressure.

The concentration of magnesium (mg) in all the water samples (table 2) from the four wards were within the recommended limit set by WHO, Shehuri south (26 mg/l), Ngarannam (31 mg/l), Bulumkutu (42 mg/l) and Gwange (5 mg/l) respectively. The results obtained in this study were consistent with the findings of Bitrus and Ibratim (2017) and Saminu *et al*., (2020) but inconsistent with the findings Faleh *et al*., (2020). There are no severe health danger in consuming water with elevated magnesium levels, except for diarrhea and irregular bowel disease. There's no guidance for potassium (K) given set by WHO. Findings reveals concentration of potassium (K) in all the water samples from the four wards (table 2), Shehuri south (8 mg/l), Ngarannam (13 mg/l), Bulumkutu (7 mg/l) and Gwange (40 mg/l) respectively. The results of the study was consistent with the findings of Kolo *et al*., (2009) but inconsistent with the findings of Faleh *et al*., (2020). K in couple with alters the osmotic pressure and the status of blood acidity. Normal values of K/Na, gives protection against heart diseases; however, higher ratio in drinking water is associated with increased incidence of hypertension (Tukura *at al*., 2013).

Conclusion: This study investigated the level and degree of purity of the boreholes water in Maiduguri urban areas and all parameters determined were found. The borehole water were found to be safe in the parameters studied except for total dissolved solid and electrical conductivity were the exceeded recommended limits in Ngarannam ward, and chloride was above the recommended limit in Gwange ward. It is therefore recommended that commensurate measures be taken to ensure proper treatment of water to safeguard the health of population.

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