SCIENCE FORUM (JOURNAL OF PURE AND APPLIED SCIENCES) 23 (2023) 700 - 708

Science Forum (Journal of Pure and Applied Sciences)

Journal Homepage: https://atbu.edu.ng/science-forum/

Physico-Chemical Properties of Well and Borehole Water of Bwarat Districts Of Lantang North Local Government Area

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ABSTRACT

The study was carried out to ascertain the quality of groundwater samples from well and boreholes in three villages of Bwarat District, Langtang North Local Government Area of Plateau State, using standard methods. Samples collected from six sites in each of the communities were analysed for pH, temperature, electrical conductivity, turbidity, anions (nitrates and fluoride) and heavy metals (Pb, Cd, Cr and Cu). Results obtained showed that the measured parameters were all within the permissible limits specified by World Health Organization and Nigerian Standard for Drinking Water Quality. The well and borehole water are suitability for domestic and other uses except for fluoride in wells and borehole samples from Lumum and Laka. It is therefore recommended that periodic assessment of the water quality within Bwarat district and other disadvantaged areas, lacking portable water supply in Plateau State should be conducted to prevent health risk to consumers.

ARTICLE INFO

Received 09 November 2023

Received in Revised Form 15 November 2023

Accepted 17 November 2023

Published 20 November 2023

Available online 20 November 2023

KEYWORDS

Water quality,
Contamination,
Ground water,
physico-chemical properties

INTRODUCTION

The importance of water to all living things has been established from time immemorial (WHO, 2011). As the next major support to life after air, water is a vital component of human existence and necessary for a sustainable economic development of an area. It has been estimated that over 170 million people in Nigeria depend on the fresh water in our rivers, lakes, streams and ground water supplies as sources of drinking water. Groundwater is the world's most extracted raw material, supplying approximately 31.5% of the world population with portable water (US EPA, 2015; Andrade et al., 2018). It is a very important source of portable water for both domestic and industrial uses in Africa, especially in Nigeria.

Groundwater as a source of drinking water has been preferred in the urban and rural areas due to its relatively better quality compared to surface water such as rivers. According to Ajibade, (2011), 90% of the population in Nigeria depends largely on hand dug wells and boreholes. Groundwater is referred to as borehole water when conveyed to the surface via a network of pumps (Obuekwe et al., 2021), and as well water when it is hand dug; and may be drawn by an electric submersible pump, a vertical turbine pump, a hand pump or a mechanical pump (e.g., from a water-pumping windmill).

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Access to safe drinking water is a basic human need and a fundamental human right that is crucial for poverty reduction. According to a report (United Nation, 2003), inaccessibility to portable water supply forces people to consume untreated water from rivers and ponds and it represents a high risk to their health. Although access to clean water may have improved over the last decades in most parts of the world, yet about 1.1 billion of the world population still lack access to safe drinking water, while over 2.6 billion worldwide lack access to adequate sanitation which causes water-borne diseases (Adebisi et al., 2016; Obuekwe et al., 2021).

Globally, 4 billion cases of diarrhea are reported every year causing 1.8 million deaths, out of which about 90% are children under five years of age (UNESCO, 2007). Many inhabitants of rural settlements therefore relied on groundwater often within a few meters of the surface, which they exploit by digging wells to be able to access clean water.

In spite of the numerous benefits of groundwater to human and national development, its quality has been compromised as a result of anthropogenic activities in our environment over the years. The indiscriminate disposal of wastes of all sorts on the soil and landfills has continued to threaten the quality of groundwater. Wastes buried underground and leachates from fertilizer/herbicdes applications can seep into groundwater, thus reducing its quality and adversely affecting such water for domestic, farm, municipal or industrial use (Amoo et al. 2021). Water borne diseases have be reported to be responsible for 80% of all illness or death in the developing countries and kill more than 5 million people every year (UNESCO, 2007), while an appreciable number of deaths are recorded in developing countries yearly as a result of water-related illnesses such as cholera, typhoid, hepatitis, diarrhoea (WHO, 2008).

Bwarat District in Lantang North local government area of Plateau States is one of the disadvantaged areas that do not enjoy portable water supply. Most dwellers there depend greatly on borehole and well water as an available water source. The qualities of this water generally are not guaranteed and at times may pose health problems to consumers who rely on them as a drinking source. The study therefore seeks to compare some physicochemical properties of groundwater in this area to the World Health Organization (WHO) and Nigerian Standard for Drinking Water Quality (NSDWQ) limits in order to ascertain its suitability for domestic and other use.

Materials and methods

Study Area

Langtang North Local Government, which was formerly known as Langtang Local Government before the year 1991 is essentially a merger of two geo-political entities of Plain and Hill Yergams (Taroks), consisting of five districts: Langtang, Gazum, Bwarat, Pil-Gani and the Resettlement Areas. Bwarat District consists of Laka, Limum, and Lohmak communities. Hand-dug wells and boreholes for communal use were identified in these communities. Wells and boreholes were selected from each community.

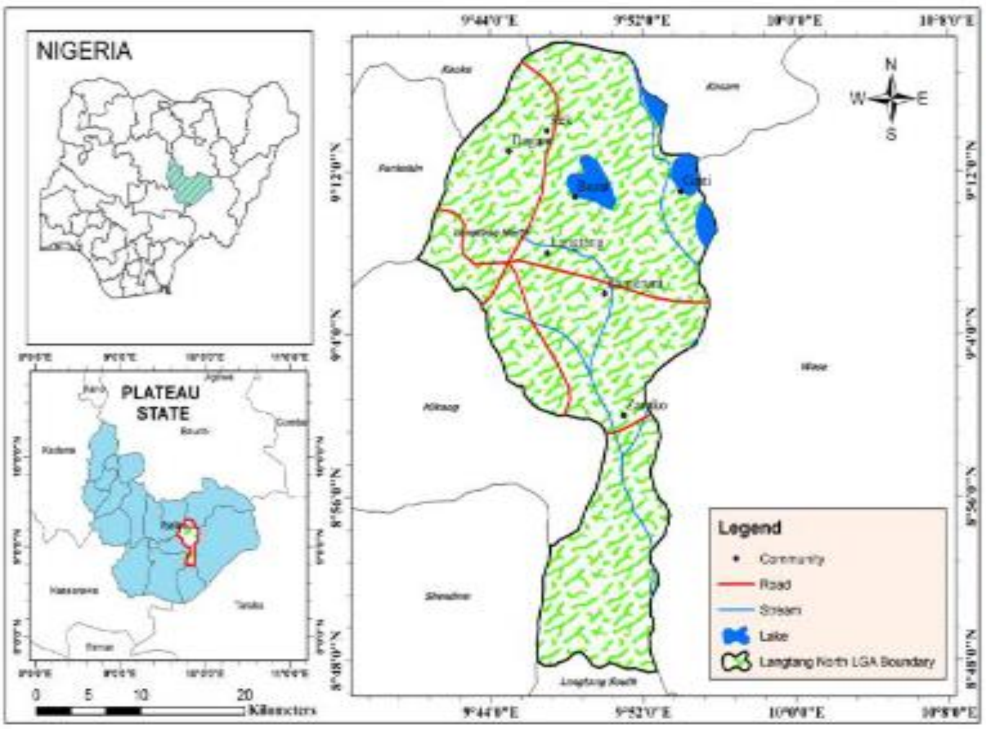

Figure 1 Map of Nigeria showing the study area

Sample Collection

Groundwater samples were consistently taken according to the standard procedures by (APHA, 2000) from different hand-dug wells and boreholes in houses around the three communities in Bwarat Districts of Lantang North local government. Samples were collected in plastic container

to avoid unpredictable changes in characteristic.

Physiochemical analyses

pH, Temperature, Electrical Conductivity, Total Dissolved Solids and Turbidity of the well and borehole water samples were determined using standard methods for analysis of water (APHA, 1999; AOAC, 2000).

Digestion of Water Sample

The water samples taken were immediately digested after sampling according to standard procedures of the American Public Health Association (APHA, 2012).

Statistical Analysis

The SPSS version 12 was used to determine the mean, standard deviation and Pearson correlation coefficient of the data gathered at $P < 0.05$.

Results and Discussion

Determination of Physicochemical Parameters.

Tables 1 – 4 show the results of the physicochemical analysis of the water samples in comparison to the WHO standard and Nigerian Standard for Drinking Water Quality (NSDWQ) limits for drinking water while the correlation between physicochemical parameters and study metals are shown in Table 4.10-11.

pH:

The values of pH obtained in all the sampled hand dug wells in the various communities ranged from 7.31±0.02 to 7.61±0.02 (Table 1), with highest pH values recorded at Lohmark, while it was 7.47±0.07 – 7.57±0.02 for the borehole water samples. pH values obtained for borehole sample are not significantly different from those obtained for the wells water. The pH values of all the sampled hand dug wells and boreholes water tested were within the WHO and NSDWQ acceptable ranges of 6.5 to 8.5 Although the values indicated that most of the water samples were slightly basic, the consumers of the water are not at any health risk due to pH. Ilechukwu and Okonkwo (2012) reported pH of range of 6.38 to 8.42 and concluded that the consumers of such water in that pH range are not at any health risk due to pH. pH values obtained in this study are consistent with those reported in Ikeme et al., (2014); Abdulkadir et al., (2017); Popoola et al., (2019), Abugu et al., (2021), but were higher than values obtained for borehole in Gloria and Token (2015) and Obuekwe et al., (2021).

Temperature

The values of temperature (ºC) obtained for the well water samples ranged from 28.4±0.16 in Lohmak to 29.77±0.03 in Limun (Table 1). For the borehole water it was 28.96±0.15 – 30.20±0.04. Values obtained here are not significantly different from the range of 20-30 ^{0}C set by the WHO for drinking water. The relatively low sampling temperature recorded could be attributed to the time of collection of the samples which was in the morning. Nkansah and Ephraim (2009) reported low temperature in the physicochemical analysis of water in Ghana which they attributed to the time of sampling. The temperature ranges obtained in this study are consistent with those reported by Thilza et al. (2018) and Amoo et al. (2021). The temperature of drinking water is often not a major concern to consumers especially in terms of the quality. The quality of water with respect to temperature is usually left to the individual taste and preference.

Electrical Conductivity

The values of electrical conductivity obtained for well water (982.00±2.00 to 1006±2.00µS/cm) and Borehole water (950.7±2.89 to 1204±1.00µS/cm) in the various communities in Table 1 were well below the WHO and NSDWQ limits maximum permissible limit of 1000µS/cm for drinking water. Electrical conductivity gives an account of all the dissolved ions in solution and degree of salinity in water. Salinity affects the taste of water and this significantly affects the acceptability of water for consumption. The electrical conductivity values recorded from the samples do not have any potential health risk to the consumers.

Abugu et al. (2021) reported very low EC values (133 – 187µs/cm^{3}) compared to this study. The EC values obtained here are consistent with those reported in Onwughara et al. (2013), Abdulkadir et al., 2017, Popoola et al., (2019) and Abugu et al., 2021, but were higher than values obtained for borehole in Gloria and Token, 2015; Karpagam and Ramesh (2015) and Obuekwe et al., 2021. The high EC values may be attributed to the presence of salts diluted by the increased water volume from the recharge aquifers (Gloria and Token, 2015).

Total Dissolved Solids

The values of the total dissolved solid (mg/l) obtained in the sampled water ranged from 0.68±0.58 to 8.3±0.58mg/l for well water and 0.00±0.00 to 6.67±1.16mg/l for the borehole samples (Table 1). These values were observed to be lower than the 500 mg/l threshold for TDS by WHO and NSDWQ. Values for TDS reported in this work are lower than those in Gloria and Token, 2015, Abubu et al. (2021)

Table1 Mean values of physicochemical parameters for well water and Borehole samples compared in the study sites

Parameter	Limun	Laka	Lohmak	WHO	NSDWQ 2007
		Hand Dug Well Water			
pH	7.31±0.02	7.55±0.01	7.61±0.02	6.5-8.5	6.5-8.5
Temp.(ºC)	29.77±0.00	28.70±0.10	28.40±0.16	20-30	-
Electrical Conductivity (µS/cm)	1066.00±2.00	996.67±1.68	982.00±2.00	1000	≥1000
Turbidity (NTU)	2.83±0.77	10.03±0.95	2.00±1.00	5.000	≤10.00
Total Dissolved Solids (mg/l)	2.00±1.00	8.30±0.58	0.68±0.58	500.0	500.0
Nitrate	17.24±0.45	15.76±0.21	21.50±3.53	50.0	50.0
Fluoride	2.20±0.03	4.22±0.03	1.19±0.04	1.5	
		Bore Hole Water			
pH	7.47±0.07	7.49±0.03	7.57±0.02	6.5-9.5	6.5-8.5
Temp.(ºC)	30.20±0.04	29.10±0.10	28.96±0.15	30.0	-
Electrical Conductivity (µS/cm)	1204.00±1.00	964.3±1.53	950.7±2.89	1000	≥1000
Turbidity (NTU)	1.67±0.58	0.00±0.00	3.00±1.00	5.0	≤10.00
Total Dissolved Solids (mg/l)	0.667±1.16	0.00±0.00	0.33±0.5	500	500.0
Nitrate	15.36±0.56	15.00±1.54	19.57±0.08	50.0	50.0
Fluoride	7.24±0.02	4.74±0.04	1.12±0.08	1.5	

Turbidity

Turbidity values in the study locations ranged from 2.00±0.10 to 10.03±0.95NTU for well water and from 0.00±0.00 to 3.00±1.00NTU for the boreholes (Table 1). Turbidity is an indication of the clarity of water. The turbidity values as recorded in all the Hand dug wells and boreholes sampled were below the WHO 2006 maximum permissible limit of 5NTU except for well water in Laka with the turbidity value of 10.03±0.95 NTU, though this value is not significantly different from the NSDWQ limits. The turbidity of the water investigated therefore do not have any potential health risk to the consumers residing in Limum and Lohmak except those in Laka. However, the significant values obtained in Laka hand dug wells analyzed signified a possible clay and groundwater interaction in some aquifers which is capable of influencing the clarity of the water. Tiimub *et al.,* 2012, reported turbidity of 0.59-23.3 in underground water analysis and attributed it to clay and underground water interaction. Except for turbidity level in Laka, Popoola et al., (2019), Amoo et al. 2021; Abubu et al. (2021) reported similar levels of turbidity. Higher turbidity values were recorded for wells (30 – 71 NTU) and boreholes (23 – 34 NTU) by Abdulkadir et al. (2017). Turbidity provides protection for organisms and this can seriously impede the efficiency of disinfection WHO (2011)

Fluoride

Fluoride values obtained ranged from 1.19±0.04 in Lohmark to 4.22±0.03 in Laka for well water and 1.12±0.08 in Lohmak to 7.24±0.021mg/l for borehole water in Limun (Table 1). The levels of fluoride in the water samples from the well and boreholes in Lumum and Laka were far above the recommended limits by WHO and NSDWQ of 1.5. Gloria and Token (2015) reported zero levels of fluoride in all their borehole water samples in Abonnema. The higher levels of fluoride in water in the water samples from the well and boreholes in Lumum and Laka may be due to the presence of fluoride compounds in the water such as hydrofluoric acid (HF), sodium fluoride (NaF) and uranium haxafluoric (UF 6). Although fluoride is known to prevent early stage tooth decay, high concentration in drinking water and food could result in mottled teeth in children (Ezeribe et al., 2012).

Nitrate

In Table 1, Nitrate values (mg/l) obtained were 17.24±0.45, 15.36±0.56 and 21.50±3.53 for hand dug wells in Limun, Loka and Lohmark respectively. The minimum value of 15.00mg/l was obtained from borehole at Laka while the maximum value of 19.57 mg/l was obtained from Lohmark. These values are below the WHO and NSDWQ recommended limits of 50mg/L. The low nitrate levels recorded in the water samples may be due to reduce anthropogenic activity which could involve nitrate (Amoo et al. 2021). Nitrate values in the current study is higher than those recorded for wells in Amoo et al. (2017), Amoo et al. (2021) and Obuekwe et al. (2021)

Heavy metal concentration in the groundwater

Although the concentrations of the heavy metals studied in the various water samples varied as per site, the mean concentrations of Cu < 0.1mg/l, Pb < 0.004mg/l, Cd < 0.008mg/l (except in Lohmark) and Cr < 0.03mg/l in the hand-dug and borehole waters samples in the three study locations were lower than the WHO and NSDWQ limits of 1.5mg/l, 0.01mg/l, 0.03mg/l and 0.05mg/l for Cu, Pb, Cd and Cr respectively. This is an indication that the water from these two sources may not have been impacted by anthropogenic activities in these areas. The water therefore may be safe for consumption in terms of the metals studied so far.

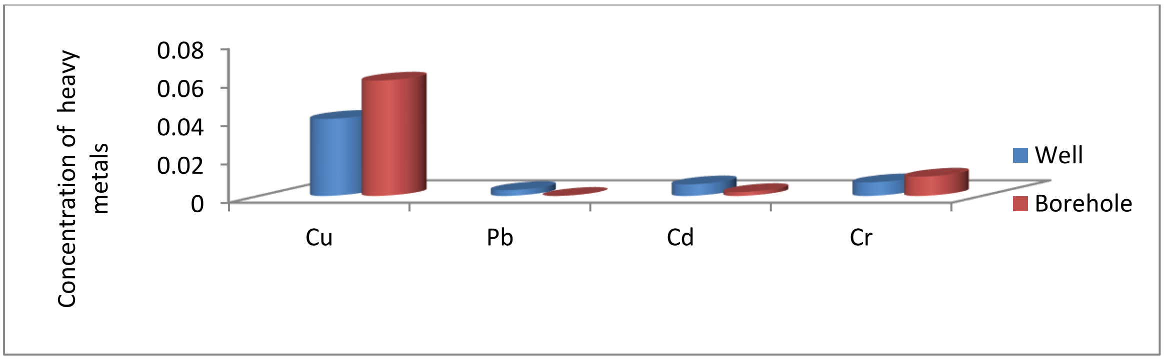

Figure 1 Heavy metal concentrations in wells and borehole water samples compared in **Limun**

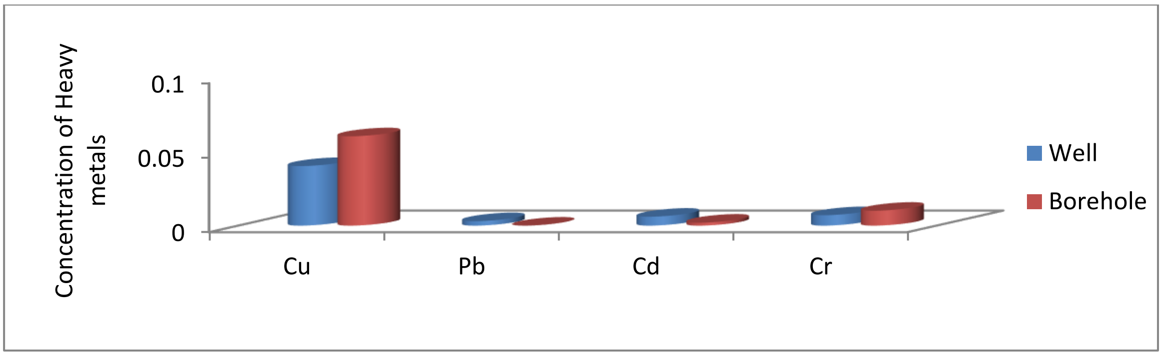

Figure 2 Heavy metal concentrations in wells and borehole water samples compared in **Laka**

Cu levels in the borehole water samples this study are consistent with those reported by Gloria and Token (2015) in Abonnema Community of Rivers State. Although Pb was not detected in their study, the ranges of mean concentration of Cr (0.006-0.008mg/l), Cu (0.00 - 0.06mg/l) and Cd (0.001-0.009mg/l) reported in Abugu et al. (2021) for borehole samples for drinking purpose in Gwagwalada area council Abuja were in consonant with those observed in this study. Similar values for Cd (0.0010–0.0030 ppm) and Pb (0.0002–0.0026ppm) were recorded in well water samples and in some of the borehole samples in Kashere metropolis (Abdulkadir et al. 2017). While Popoola et al (2019) reported higher levels of Pb and Cu in their work compare to this study, their reported levels of Cd and Cr are consistent with the current work.

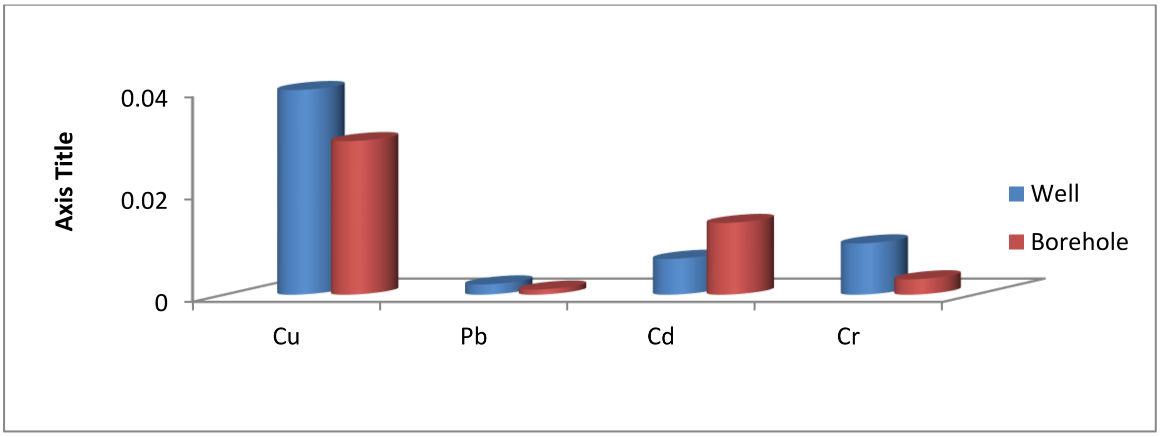

Figure 3 Heavy metal concentrations in wells and borehole water samples compared in **Lohmak**

Conclusion

All studied physicochemical parameters in groundwater from three villages of Bwarat District were within WHO and NSDWQ standards for drinking water, except for fluoride in wells and borehole samples from Lumum and Laka. Assessment of water quality in the study areas indicates therefore that the water sampled is suitable for drinking and other domestic purposes. Water quality assessment, including microbial analysis should be carried out on hand dug wells and boreholes in the study area at least two or three times every year to ensure that the incidence of contaminations are noticed earlier for remedial actions to be taken.

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