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Water Quality Analyses: Evidence from River Gashua and Some Selected Groundwater Sources in Gashua, Nigeria

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ABSTRACT

The interface between surface water and groundwater is becoming more complex owing to the effects of climate change and anthropogenic activities these days. In this study, the physicochemical; pH, color, electrical conductivity, total dissolved solids, and turbidity while bacteriological parameters; total and fecal coliform of water samples from River Gashua and its surrounding wells in Gashua local government area of Yobe State were assessed. All the physicochemical parameters were analyzed using water quality standards. Fecal and total coliforms were assayed using the filter membrane technique. The results obtained from the physicochemical parameters of Boreholes (BH1, BH2, and BH3) and hand pump wells (HPW1, HPW2, and HPW3) are within the World Health Organization (WHO) standards. However, the river (R) water sample was found to have a high concentration in total dissolved solids, turbidity, and color than permissible standards. Bacteriological analysis revealed the presence of total and fecal coliform in the water samples; R, BH2, BH3, HPW1, HPW2, and HPW3. The findings indicate that there is a need to protect the quality of the river system. Therefore, it is recommended that government and other stakeholders should take appropriate and corrective actions to avert the continuous discharge of waste products into the river. Again, Yobe State Ministry of Environment should ensure that all public boreholes are routinely subjected to appropriate water assays to ascertain their suitability for human consumption.

INTRODUCTION

Over the years, the shortage of water resources has been as a result of a direct increase in development throughout the world (UNICEF, 2005; Bisi-Johnson *et al.*, 2017). According to Onabolu (2011), access to potable water and sanitation has been the main concern as 53% and 28% of people living in rural and urban areas respectively have got no access to improved water sources. Water Aids Nigeria (2016) reported that almost 57 million Nigerians have got no access to potable water while over 130 million people which form two-thirds of the entire population have got no access to suitable sanitation.

Water is a vital natural resource that sustains life on earth (Shallom *et al.*, 2011) as human beings

may endure survival for many weeks without eating, but cannot afford to do away with not drinking water for a few days due to the fact that water is needed to replace lost fluids via regular physiological activities (Shallom *et al.*, 2011; Iroha *et al.*, 2020). The utmost importance of water to life is ineffable owing to the fact that there is no human activity that can be done without the involvement of water (Obunwo and Oporum, 2013). According to Obunwo and Oporum (2013), water gives life and accomplishes many functions that have got no substitute.

Over the years, surface water quality has remained a solemn global issue most particularly in developing countries and those countries whose economy has been seriously ravaged (Shiklomanov

and Rodda, 2003; Amoo *et al.*, 2017). The quality of river water is deteriorating day in day out these days (Shiklomanov and Rodda, 2003). The increasing rate of water-borne diseases in developing countries has been associated with scarcity of infrastructure meant for operative treatment and distribution of water which has invariably accounted for the incidence of high morbidity and mortality rate recorded these days (Shallom *et al.*, 2011). An incredible expanse of consideration has been geared towards water pollution and the successive effects on the life of humans and animals (Odeyemi *et al.*, 2013; Iroha *et al.*, 2020).

According to Amoo *et al.* (2018), groundwater is employed for use by about 1.5 billion people in the world over. These authors reported further that the sources linked with the contamination of groundwater are numerous and the associated contaminants are many. As reported by Lehr (2002); Hassan *et al.* (2018), in case groundwater, gets polluted, it is pretty difficult, if not impossible, to restore it. These authors reported further that the threat posed by groundwater pollution has been on the increase owing to the disposal of waste materials indiscriminately and the extensive use of chemicals that are capable of polluting the environment by the industrial and agricultural sectors. According to Lenntech (2011), the slowness of groundwater in terms of flow and possessing of low microbiological activity naturally limit any form of self-purification. One of the feared penalties of rapid urbanization has been pinpointed as solid

waste management, a problem mainly in terms of environmental irritants coupled with health hazards and its associated outcome (Adewole, 2009; Hassan *et al.*, 2018). This research was however conducted with a view to assessing the quality of river Gashua, available hand-pump wells, and boreholes in close proximity to the river as these are the major sources of water depended on by the inhabitants of Gashua town.

MATERIALS AND METHODS

Study Area

Gashua is a community in Yobe State, North-Eastern Nigeria with coordinates 12°52'5" N and 11°2'47" E, with an average elevation of about 299 mm above the sea level (Saleh and Ahmed, 2019; Yuguda *et al.*, 2020). The geology of the area is consistent with the general geological setting, which is principally comprised of crystalline and sedimentary rocks underlain by basement complex rocks (Mandal, 2016; Abdullah *et al.*, 2018). River Gashua is the biggest river in the state and the river flows eastwards which later ends up in Lake Chad. The town is located a few kilometers below the convergence of the Hadejia and Jama'are Rivers downstream of the Hadejia – Nguru Wetlands (Ibrahim *et al.*, 2016), where the famous yearly Bade fishing and cultural festival takes place (Alhassan *et al.*, 2018). According to the 2006 census, the town has a population of about 12500 (Saleh and Ahmed, 2019; Yuguda *et al.*, 2020).

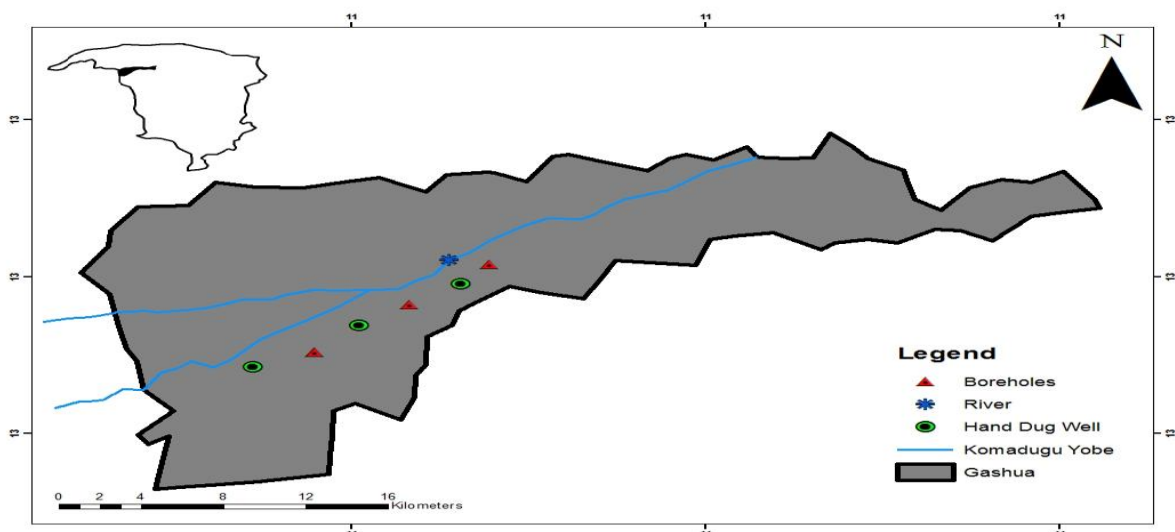


Figure 1. Location of the sampling points in River Gashua, Nigeria

Water Sampling

To investigate the interaction of surface water pollution with groundwater quality, one water sample was collected from the river (R) to represent the flow of River Gashua towards the outskirts of Gashua town as presented in Figure 1. Water samples were collected from three hand-pump wells (HPW1, HPW2, and HPW3) and three boreholes (BH1, BH2, and BH3) which are in close proximity to River Gashua. Field sampling was done in the middle of the dry season in February 2021. As done by Amoo *et al.* (2018); Adeleye *et al.* (2020), each sampling of 100mL of water samples was collected using random sampling. Water samples were collected in well-labeled sterile one-liter plastic containers. All the plastic containers were washed with non-ionic detergent and subsequently rinsed with de-ionized water before being used (USFDA, 2018). Before the final water sampling was done, the containers were rinsed three times with the river water and groundwater sources to be sampled at the point of collection. All samples were subsequently preserved with ice packs and transported to the laboratory (Ministry of Water Resources, Damaturu, Yobe State) for onward analyses.

Physicochemical analyses of the samples

All the water samples from each sampling point were subjected to physicochemical analyses ranging from pH, color, turbidity, total dissolved solid (TDS), and electrical conductivity (EC). These parameters were analyzed through the adoption of the standardized methods described by the American Public Health Association, APHA (2012).

Bacteriological analyses of the samples

The membrane filtration technique described by USEPA (2002) for the determination of total coliforms (TC) and fecal coliform (FC) were employed.

Data Analysis

Descriptive statistics in form of tables were used to abridge the variations in the physicochemical and bacteriological concentrations of the sampled water and sites coupled with their comparison with World Health Organisation (WHO) standards.

RESULTS AND DISCUSSION

Results of the physicochemical characteristics of the water samples from the river and its surrounding groundwater sources are presented in Table 1. The pH of water samples BH2 and BH3 had values of 6.31 and 6.46 which are below the WHO (2016) allowable limit (Figure 2).

Table 1. Physicochemical parameters of sampled water in the study area

	R	BH1	BH2	BH3	HPW1	HPW2	HPW3
pH	7.80	6.94	6.31	6.46	6.76	6.60	6.81
Turbidity (NTU)	8.06	0.13	0.07	0.12	2.73	1.82	2.04
EC (μS/cm)	824	402	253	352	372	502	487
TDS(mg/L)	721	101	83	89	158	124	207
Colour(Pt-Co)	21.8	1.12	4.0	2.34	7.13	6.21	8.01

R= River; BH= Borehole; HPW= Hand-pump well; EC= Electrical Conductivity; TDS= Total dissolved solid

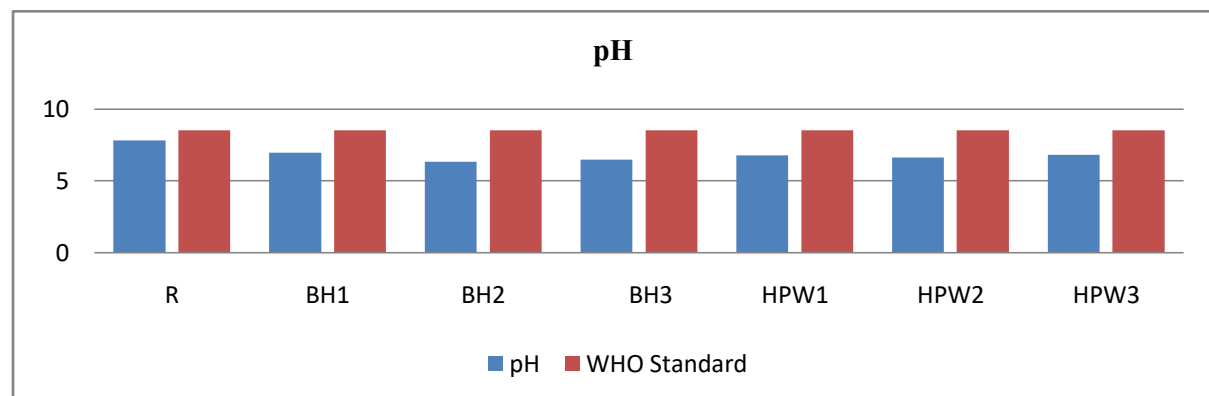


Figure 2. Comparison of pH between the water samples and WHO allowable limit

The results imply that the water is slightly acidic and the pH values of R (7.80), BH1 (6.94), BH3 (6.76), HPW1 (6.60), and HPW2 (6.81) are within WHO (2016) recommended limits set up for drinking water quality standard (Figure 2).

The pH values obtained in this current study are in line with the work of Badejo (2017) who recorded 6.9 - 7.67 in the same study area. These pH values are equally in conformity with the findings of Muhammad (2014); Omotayo *et al.*

(2017) in a similar study area. However, these results obtained in this study are contrary to Tadessa *et al.* (2018) who recorded 8.2 - 10.5 during the dry season in their study area.

The values of EC for the water samples fall between the ranges of 253.0 - 824.0 $\mu\text{S}/\text{cm}$. These values are within the allowable limits (1000.0 $\mu\text{S}/\text{cm}$) set by WHO. However, the river (R) sample has the highest (824.0 $\mu\text{S}/\text{cm}$) while BH2 has the lowest (253.0 $\mu\text{S}/\text{cm}$) as shown in Figure 3 below.

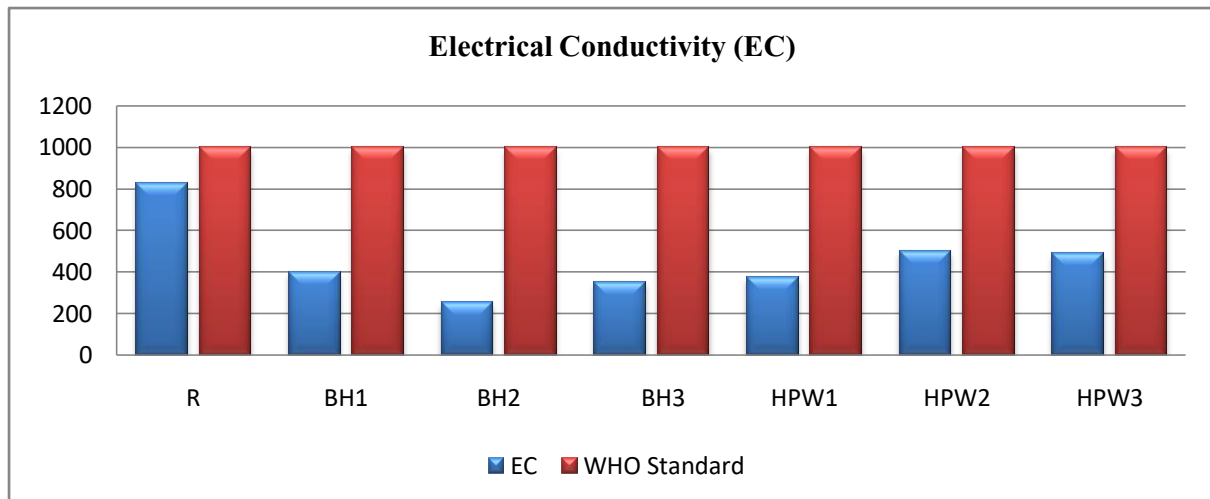


Figure 3. Comparison of EC between the sampling points and WHO allowable standard

In contrast to this current study, Onwughara *et al.* (2013) reported an EC (9.32 $\mu\text{S}/\text{cm}$) in their study which is below the recommended limit set by WHO. These results are also in disparity with Tadessa *et al.* (2018) who reported EC values ranging between 171.2 $\mu\text{S}/\text{cm}$ - 1592.6 $\mu\text{S}/\text{cm}$ in

their study area. The values of total dissolved solid (TDS) of the water samples are between the range of 83 and 207 mg/L (Figure 4). These values are within the allowable limits set by WHO (2016), with the exception of R (721 mg/L) that exceeded the range (Figure 4).

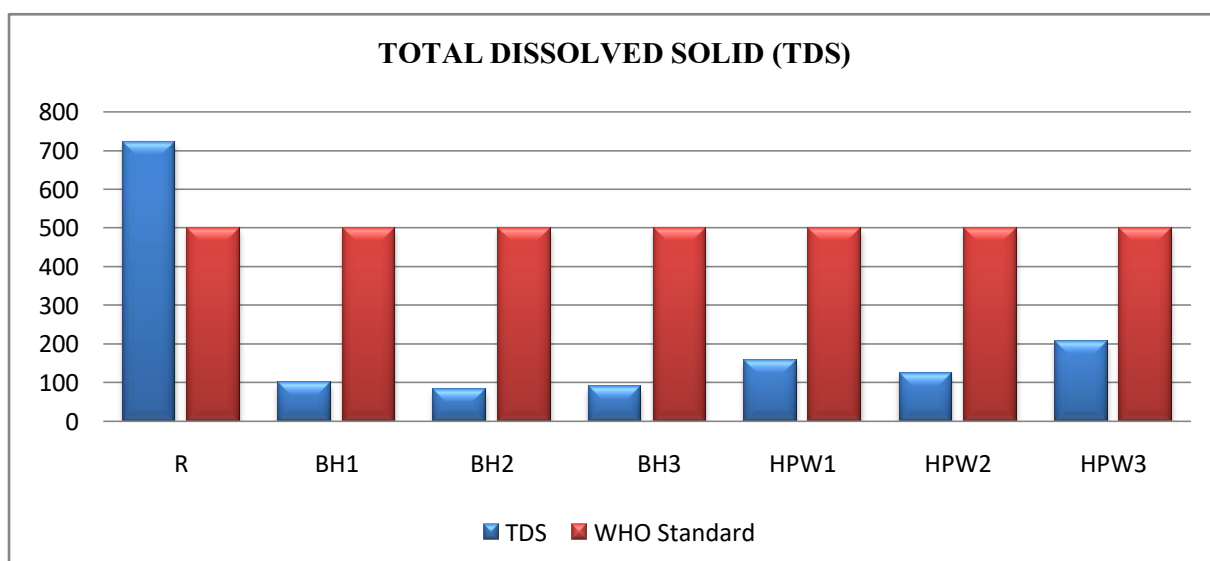


Figure 4. Comparison of TDS between the sampling points and WHO allowable limit

The detection of high TDS in the water sampled from the river can be connected with low water levels, indiscriminate discharge of domestic sewage and industrial wastewater into the river body coupled with the agricultural activities going on in the river banks. The turbidity values of the

sampled water ranged from 0.07 to 8.06 NTU (Figure 5). These results fall within the standard limit (5.0 NTU) set by WHO (2016) with the exception of the river (R) 8.06 (NTU) that is above the recommended limit (Figure 5).

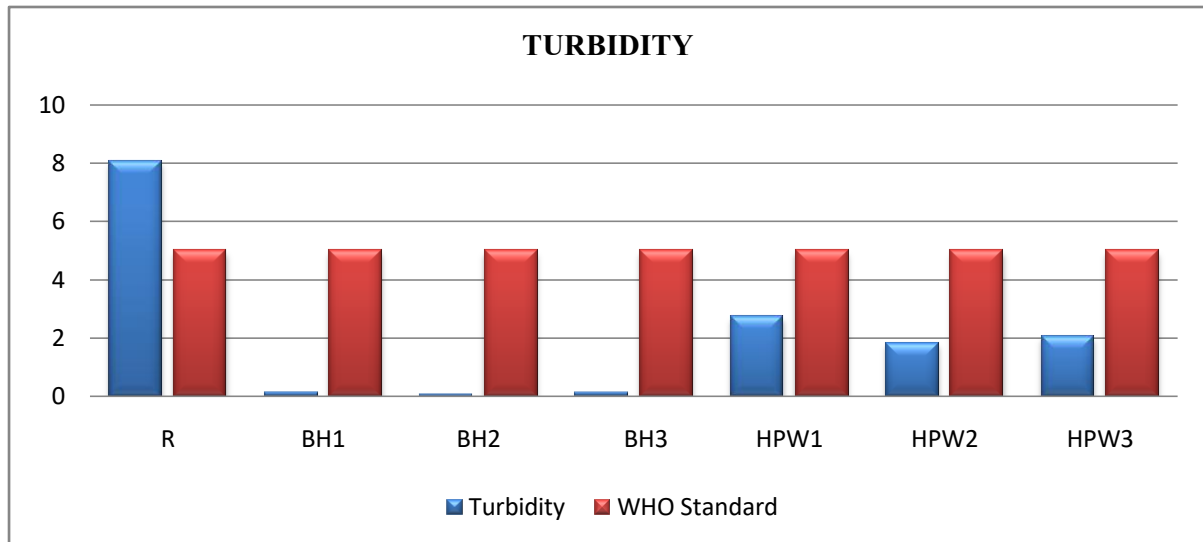


Figure 5. Comparison of Turbidity between the sampling points and WHO allowable limit.

This finding is in line with Muhammad (2014); Tessema *et al.*, (2014); Amoo *et al.* (2018) that reported high values of turbidity of the water samples analyzed in their own study area. The color of all the water samples fell within the WHO (2016) limit (15 Pt-Co) (Figure 6). The obtained values range between 1.12 - 8.01 Pt-Co with the exception of R (218) that had a high value (Figure 6). The obtained results are in agreement with Omotayo *et al.* (2017) who conducted their research in a similar study area.

The results of the total coliform count in all the sampled water are presented in Figure 7. These results have clearly revealed that the total coliform counts range from 0 cfu/100mL to 3 cfu/100mL, with a river (R) that recording the highest bacterial count (3 cfu/100 mL). The results obtained from the river (R) are in agreement with Omotayo *et al.* (2017) in a similar study area. While BH1, BH2, and BH3 recorded no total coliform count indicating that water derived from the three boreholes is safe for human consumption.

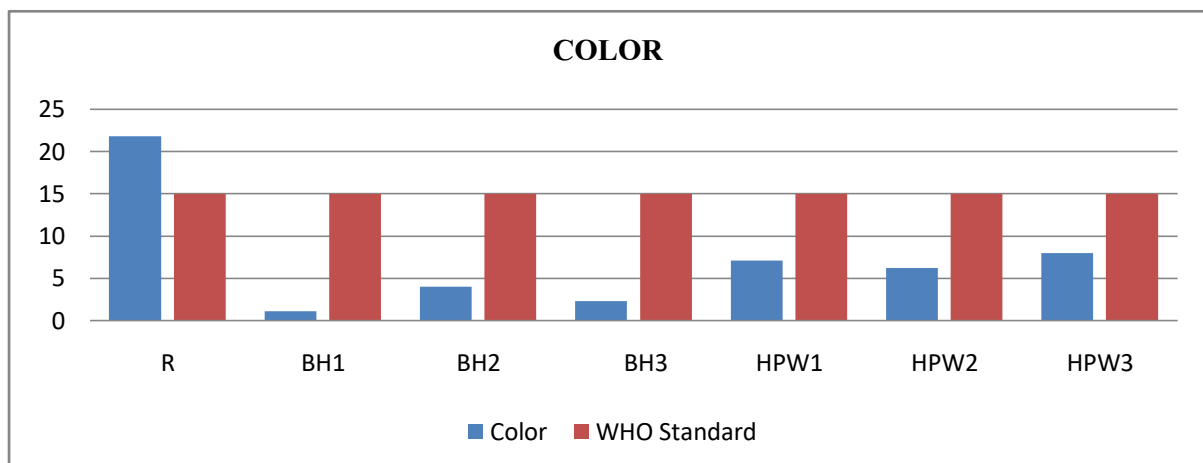


Figure 6. Comparison of colour between the sampling points and WHO allowable limit

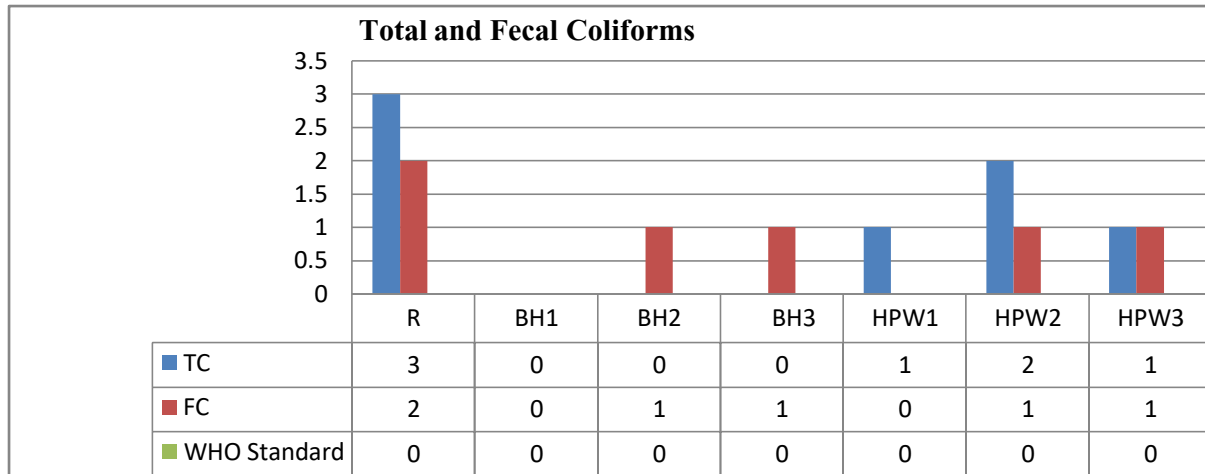


Figure 7. Comparison of fecal and total coliforms between the sampling points and WHO standard

It can also be seen from Figure 7 that four (4) samples (R, HPW1, HPW2, and HPW3) have not met with the WHO standard for drinking water which emphasizes the absence of coliform count in drinking water. The presence of fecal coliform counts recorded in five samples (R, BH2, BH3, HPW2, and HPW3) in this current study is in agreement with Amoo *et al.* (2018); Hassan *et al.* (2018); Adeleye *et al.* (2020) who detected bacterial counts in the boreholes of their respective study areas.

CONCLUSION

Based on the results of the parameters analyzed in this current study, it can be concluded that there are variations between different sampling locations and the physicochemical parameters (pH, color, turbidity, total dissolved solid, and electrical conductivity) analyzed. All water sampled is within the WHO permissible limit, with the exception of a river that had values above WHO water quality permissible limits. However, regarding the bacteriological assessment of the water samples, only one borehole (BH1) revealed zero coliforms count indicating its safety for drinking. Owing to the findings in this study, it is recommended that Environmental pollution control and Yobe State Ministry of Environment should ensure that all public boreholes (Hand-pump or Electrical pump) are routinely subjected to appropriate water assays with a view to ascertaining their suitability for human consumption. In addition, strict legislation and stringent standard practices should be enforced to prevent the indiscriminate disposal of untreated effluents into surface water and the environment.

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