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Water Quality Assessment of Selected Boreholes in Federal University Dutse Campus North-West, Nigeria

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Abstract
The present study was conducted to assess the physicochemical and bacteriological quality of water sampled from different boreholes on the campus of Federal University Dutse. Water samples were collected from six (6) different boreholes. Physicochemical parameters; pH, Electrical conductivity (EC) and temperature were measured in-situ. pH, EC and temperature ranged from 6.53¬7.80, 422.0¬690µ/cm and 31.0¬33.0°C respectively. Turbidity, total hardness and nitrite (NO_2) were found to be in the range of 0.01¬41.2NTU, 51.3¬102.6mg/L and 0.001¬0.06mg/L respectively. Bacteriological analysis also revealed the presence of E. coli in four (4) of the assessed boreholes. Upon comparison with water quality standards of World Health Organisation (WHO) and Nigeria Standard for Drinking Water Quality (NSDWQ), it was found that some of the parameters were above the permissible standards for potable water that is fit for human consumption. It is therefore recommended that all stakeholders entrusted with water quality management should be actively involved in ensuring that all public serving boreholes are subjected to appropriate water quality tests with a view to ascertaining its quality so as to adequately advise on its consumption status. Water quality inspectors should be sent on regular basis to the tertiary institutions in the state for routine check-up.
***Keywords**: Borehole, Escherichia coli counts, Groundwater, Water quality*

INTRODUCTION

Water is the most significant nutrient that is indispensable to the survival of humanity because it is involved in all body functions and makes up about 75% of total body weight (Shryer, 2007; Mack and Nadel, 2011; Offei-Ansah, 2012). About 60% percent of human body is water as life began in water and life is nurtured with water (Amoo *et al*., 2018). Despite the need to ensure sufficient water quality, one of the biggest developmental challenges these days is ensuring sufficient water quality (Gundry *et al*., 2003). The need for water in the day to day activities of man includes; cooking, washing, drinking and for industrial activities (Akpoborie *et al*., 2008). The two major sources of water whose quality are assessed by scientists are surface water and ground water.

It has been reported by Haruna *et al*. (2008); Okeola *et al*. (2010) that surface water is generally poor in quality, while ground water is more reliable for domestic and agricultural irrigation needs. Berthold (2010) submitted that boreholes and wells change the natural flow field and create a path that opens up an additional possibility of heat and mass transfer between rock, aquifers and surrounding atmosphere. Many authors (Sunnudo-Wilhelmy and Gill, 1999; Egwari and Aboaba, 2002; Lu, 2004) have attributed the contamination of borehole water to indiscriminate waste disposal, poor agricultural practices, poor well construction, proximity of septic tanks to boreholes, siting of pit latrines and graves near boreholes.

The widespread reports on pollutants in groundwater have increased in recent years and have resulted to augmented public concern about the quality of groundwater. Groundwater bodies are prone to contamination from both anthropogenic and natural activities (Okuo *et al*., 2007). The seepage of waste buried underground such as pit toilets or leachate from fertilizer applications can produce deleterious effects on ground water quality especially in and around Federal University Dutse, as it is one of the areas in Dutse that has been long known as agricultural area. Strikingly, the persistent nature of some chemicals used for farming can possibly leach and contaminate the ground water. It is against this backdrop that this study was conducted to assess the level of some selected physicochemical properties and *E. coli* counts in some selected boreholes in Federal University Dutse with view to comparing the results of the assessed parameters with acceptable standards.

MATERIALS AND METHODS

Study Area

The study was conducted on the campus of Federal University Dutse North western, Nigeria. Dutse is the capital city of Jigawa state and has latitude of 11°42'8.46" N and longitude of 9°20'2.46" E (Peel *et al.,* 2007). Federal University Dutse is characterized by extensive open grasslands with few scattered stunted trees as shown in Figure 1. Neem trees and eucalyptus have naturalized in the school campus to the extent of replacing the original native trees (Ikem *et al.,* 2002). The soil is sandy at the top and compact at depth with often hard pans (Peel *et al.,* 2007).

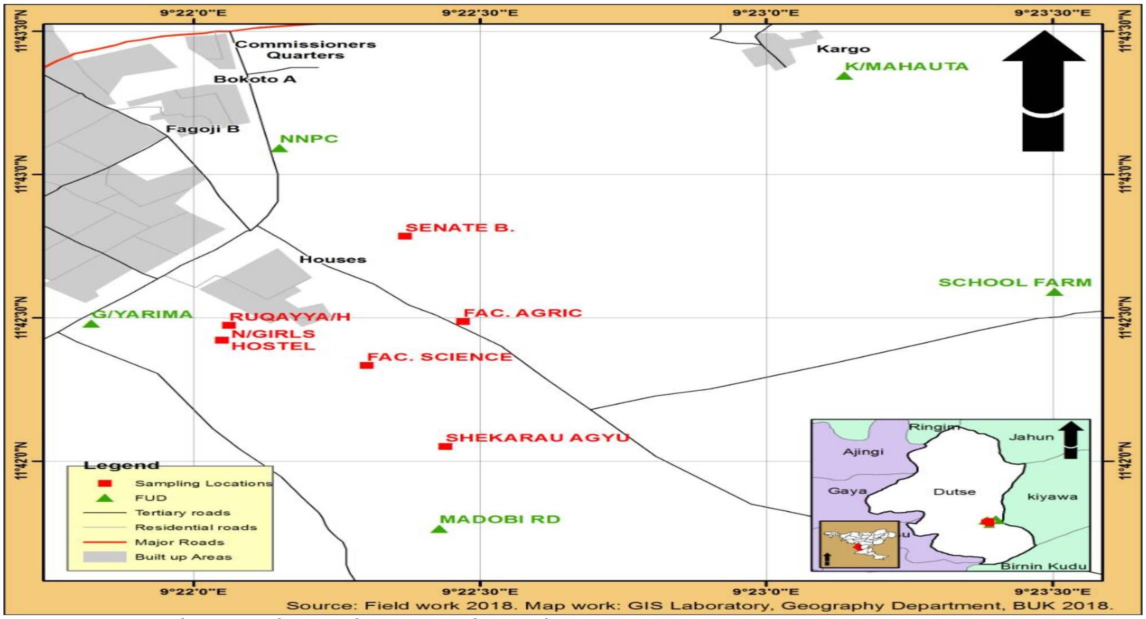

Figure 1: Map showing the study area and sampling points.

Water Sampling

In an attempt to investigate the extent of groundwater contamination, six (6) sampling points (boreholes) designated as BH_1, BH_2, BH_3, BH_4, BH_5 and BH_6 were selected within the University campus (Fig 1, Table 1). Field sampling was done at the beginning of wet season in May, 2018. Water samples were singly collected in sterile one (1) litre plastic containers and prior to collection as part of our quality control measures, all the bottles were washed with non-ionic detergent and rinsed with de-ionized water prior to usage (USFDA, 2018). Before the final water sampling was done, the bottles were rinsed three times with distilled water at the point of collection. Each bottle was labeled according to sampling location while all the samples were preserved at 4°C and transported to the laboratory.

Table 1: Location of sampled boreholes and acronym assigned to each

Location of borehole	Acronym
Ruqayya Hall	BH_1
Aminat Hall	BH_2
Shekarau Angyu Hall	BH_3
Faculty of Science	BH_4
Faculty of Agriculture	BH_5
Senate Building	BH_6

BH= Borehole

Physicochemical Analyses

All the water samples were analyzed for the following physicochemical parameters; pH, temperature, turbidity, nitrite (NO_2) and total hardness. The analyses of the water were carried out in accordance with standard analytical methods described by APHA (2012).

Bacteriological Analysis

The choice of assaying for *E coli* in this current study is in line with Ahmed (2003) that reported coliform bacteria as indicator organisms which reveal microbiological quality of surface and ground waters. About nine (9) ml of sterile distilled water was transferred into each of the five (5) universal bottles, using a sterile 1ml pipette. One (1) ml of the thoroughly mixed water sample from the conical flask was transferred into the first universal bottle and mixed making 10^{-1} dilution. Another one (1) ml sterile pipette was used to transfer one (1) ml of the water from 10^{-1} dilution bottle to second universal bottle and mixed making 10^{-2} dilution. This procedure was repeated in the remaining three (3) bottles making 10^{-3}, 10^{-4} and 10^{-5} dilution respectively. Colonies of faecal coliform (*Escherichia coli*) were isolated, inoculated and identified by adopting the methods described by Santra (2014); Nishith and Chakraborty (2014); Baveja (2013).

Data analysis

Results of laboratory analyses were subjected to statistical analysis using Microsoft Excel. Descriptive statistics in form of tables and bar charts were used to summarize the variations in the physicochemical parameters of the sampled water and sampled sites.

RESULTS

The results of the physicochemical attributes of the water samples derived from all the boreholes are presented in Table 2.

Table 2: Physicochemical parameters of sampled water in the study area

	BH_1	BH_2	BH_3	BH_4	BH_5	BH_6
Temperature(^{0}C)	32	31	31	32	33	32
pH	7.02	7.78	7.80	7.25	7.35	6.53
Turbidity (NTU)	3.43	0.02	41.2	0.01	0.01	51.3
EC (µS/cm)	596	592	690	467	624	422
Total hardness(mg/L)	85.5	85.5	85.5	68.4	102.6	51.3
Nitrite(mg/L)	0.001	0.01	0.05	0.01	0.06	0.06

BH= Borehole; EC= Electrical Conductivity

The results obtained as regards comparison of the physicochemical properties of the sampled borehole water with regulated standards are presented bar charts below:

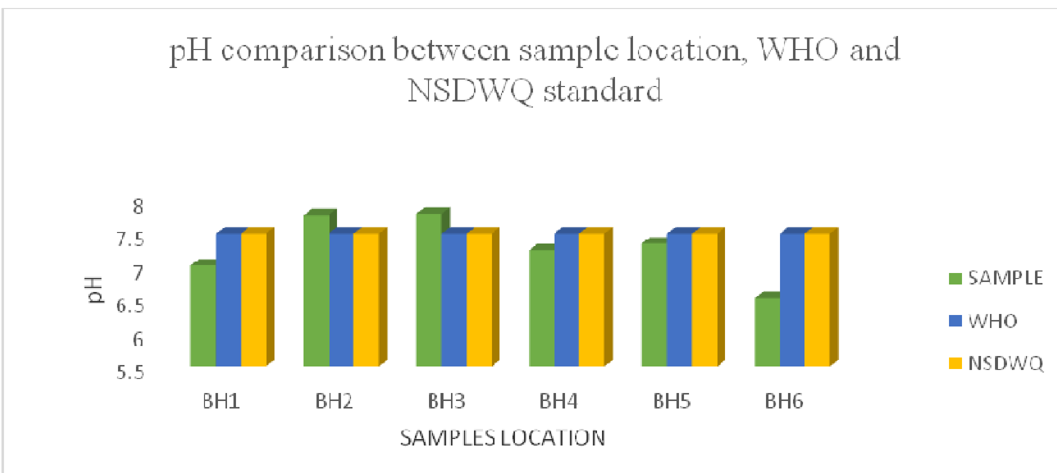

Figure 2: Comparison of pH between the sampling points and water standards

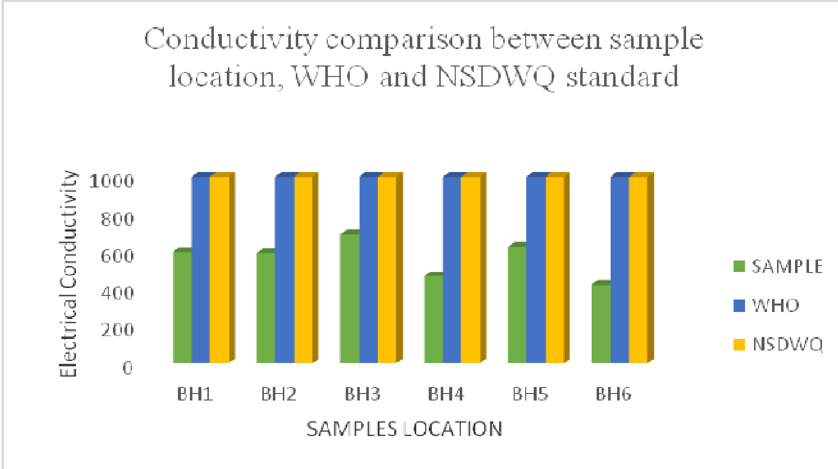

Figure 3: Comparison of Electrical conductivity (EC) between the sampling points and water standards

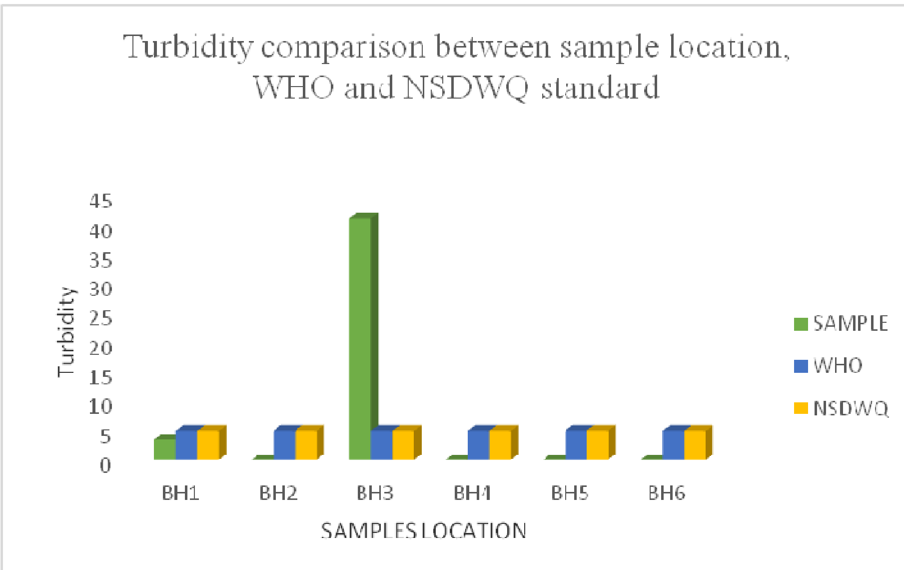

Figure 4: Comparison of Turbidity between the sampling points and water standards

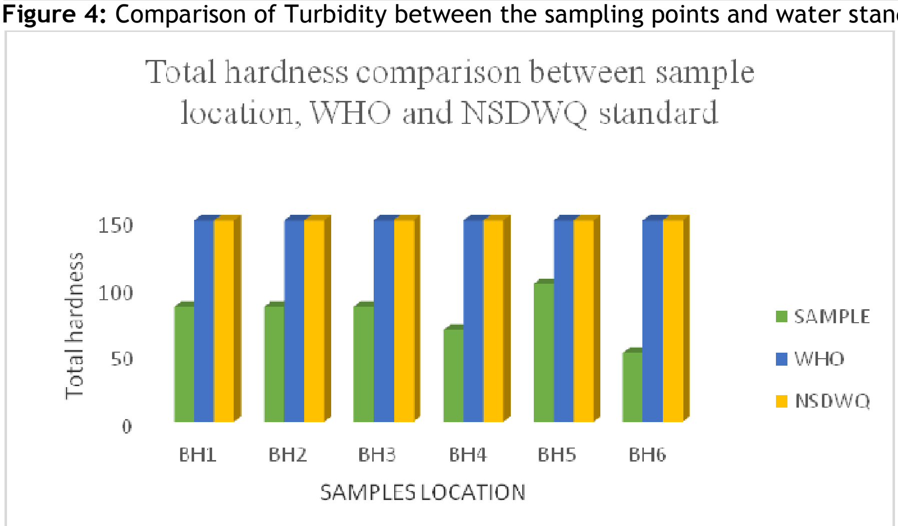

Figure 5: Comparison of Total hardness between the sampling points and standards

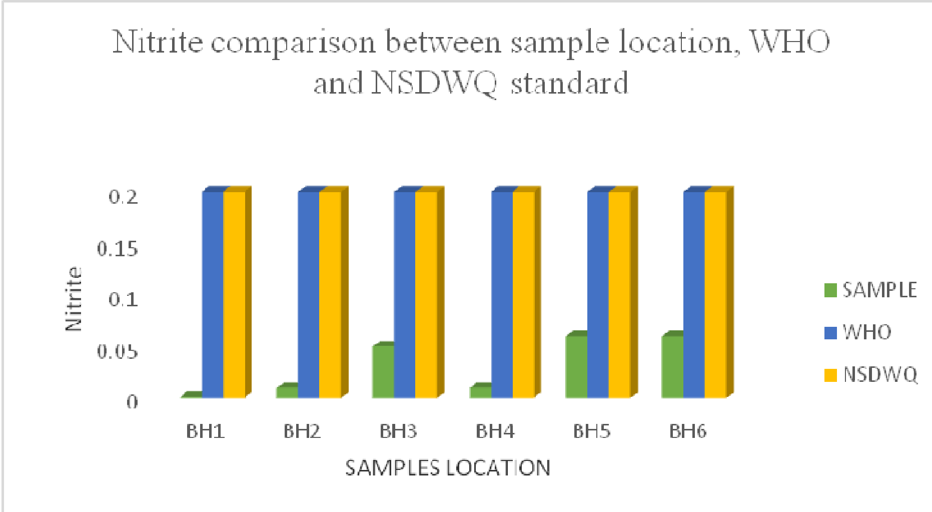

Figure 6: Comparison of Nitrite (NO_2) between the sampling points and water standards

The results of bacteriological parameters obtained from the conduct of water assay are presented in Table 3 below.

Table 3: *E. Coli* counts in all the sampled water from the boreholes (reciprocal of dilution =10^5)

Borehole	*E coli* count (cfu/ml)
BH_1	0
BH_2	$4.0x10^5$
BH_3	$1.6x10^6$
BH_4	$1x10^5$
BH_5	$9x10^5$
BH_6	0

DISCUSSION

In this study, temperature was found to be in the range of 31¬33 ^{0}C (Table 2). At all sampling points, it was also discovered that temperature did not vary between the sampling stations. Similar temperature differences obtained in this current study have been reported by Mohammad *et al*. (2015).

In this study, the pH values of the sampled water range from 6.53¬7.80 which are within the allowable limits (6.5¬8.5) set by WHO and NSDWQ (Figure 2). However, these results have clearly revealed that the water sampled from BH_6 is slightly acidic while the rest are all slightly basic. These results are in concord with the study conducted by Bello and Bichi (2013) that reported pH values ranging from 6 to 9 in their study.

The overall mean values of EC for the sampled water are between the range of 422.0-690.0 µS/cm (Figure 3). These values are within the allowable limits (1000.0 µS/cm) set by WHO and NSDWQ. However, BH_3 has the highest (690.0 µS/cm) while BH_6 has the lowest (422.0 µS/cm) (Figure 4). In contrast to this current study, Onwughara *et al*. (2013) reported an EC (9.32 µS/cm) in their study which is way below the recommended limit set by NSDWQ.

The mean turbidity values of the sampled water range from 0.01 NTU to 41.2 NTU (Figure 4). All the water samples fall within the standard limit of 5.0 NTU set by WHO and NSDWQ with the exception of BH_3 (41.2 NTU) that is above the recommended limit for any potable water fit for human consumption. This finding is in line with Tessema *et al*., (2014) that reported high values for the mean turbidity of water samples used in their study. Similarly, the present study revealed that all the mean values of turbidity, except that of BH_3 are below the desired value indicated by WHO and NSDWQ (Figure 4). According to WHO (2011), turbidity in distribution systems can occur because of the disturbance of sediments and biofilms but it is also from the ingress of dirty water that emanates outside of the system. This author further reported that turbidity can seriously impede the efficiency of disinfection by providing protection for organisms thereby necessitating the utmost need to ensure the removal of particulate matter before disinfection in the treatment plant. The mean values for total hardness ranged from 51.3–102.6 mg/l (Figure 5).

These values are below the desirable drinking water standards (150.0–500.0 mg/l) set by WHO. Some studies on surface water quality have found very low mean values for water hardness (Ibrahim *et al*., 2009). However, it has been reported that total hardness is not considered of health concern at levels found in drinking water (WHO, 2011).

Based on the results presented in Figure 6, the water samples have got mean values ranging from 0.001 mg/l to 0.06 mg/l which are way below the recommended limit (50 mg/l) set by WHO (2011) for potable water. These results are contrary to the reports of Palmuleni and Mercy (2015) that reported a mean value (4.19 mg/l) while Onwughara *et al*. (2013) reported a mean value (19.6 mg/l) in their respective studies. However, it is important to state that low level of nitrite recorded in this current study may be attributed to the less anthropogenic pollution experienced in the study area over the years.

The results of *E coli* count in all the water sampled from the boreholes are presented in Table 3. These results reveal that the faecal coliform counts range from 0 cfu/ml to 1.6×10^6 cfu/ml, with BH_5 recording the highest bacterial count (9×10^5 cfu/ml), while BH_1 and BH_6 recorded no bacterial count indicating that water derived from the two boreholes is safe for drinking. This clearly indicates that only BH_1 and BH_6 conform to regulated standards in terms fitness of potable water meant for human consumption. It can be seen from Table 2 that four (4) samples; BH_2, BH_3, BH_4 and BH_5 have not met the WHO standard for drinking water which stringently emphasizes absence of coliform count in drinking water. The presence of *E. coli* counts recorded in four boreholes (BH_2, BH_3, BH_4 and BH_5) in this current study is in agreement with a similar study by Hassan *et al*. (2018) who detected bacterial counts in sampled borehole water. Generally, *E. coli* is among the most pathogenic microorganisms and their presence in drinking water may cause so many health problems like food poisoning, urinary tract infections, pyogenic infections, septicemia and diarrhoea (Baveja, 2013).

CONCLUSION

Based on the results of the parameters analysed in this current study, it can be concluded that that there are variations between different sampling locations and the physicochemical parameters; pH, turbidity, total hardness, electrical conductivity and nitrite levels analysed. Again, turbidity level in one of the samples of water was above acceptable limits during the conduct of this study. However, regarding the bacteriological assessment of the water samples, only two boreholes revealed zero coliform count indicating its safety for drinking.

Owing to the results generated from this study, it is recommended that the management of Federal University Dutse and other stakeholders in water management such as Environmental pollution control and ministry of environment, Jigawa state should ensure that all public serving boreholes are subjected to appropriate water quality tests with a view to ascertaining its quality so as to adequately advise on its consumption status. Water quality inspectors should be sent on regular basis to the tertiary institutions in the state for routine check-up. Proper drainage and sewer systems should be constructed in the study area to ensure proper disposal of hazardous liquid waste, thereby preventing seepage into the groundwater. In addition, strict legislations and stringent standard practices must be enforced to prevent the indiscriminate disposal of untreated effluent into the environment.

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