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Assessment of Drinking Waters Quality Collected from Boreholes in Afe Babalola University Ado-Ekiti (ABUAD)

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Abstract. The quality of drinking water is dependent of its source(s) and means of collection. The water available for drinking in the study area is accessible through groundwater exploration. This research was carried out to determine the quality of water from the selected boreholes within the university and checked by the World Health Organization (WHO) drinking water standards for the various parameters considered. Samples were gotten from seven (7) of the sited boreholes and various physico-chemical parameter tests such as turbidity test, conductivity test, pH test, copper test, manganese test, chloride test, sulphate test, chromium test, nitrate test and cadmium test and bacteriological tests as total plate count, total coliform count and faecal coliform count were carried out following due procedure, precautions and the results analyzed. The results show that most samples were satisfactory for the tests carried out while only two (samples from Behind Admin and Engineering) were unsatisfactory in turbidity while one sample (sample from Back of College 2) was unsatisfactory in the cadmium test. WQI showed that the water samples had excellent qualities except for that from Back of College 2 which had poor quality and is unsuitable consumption.

1 Introduction

Groundwater is one of the most important sources for drinking water and domestic activities in Africa. It is likely to be less affected than surface resources by climate variability, higher temperatures, evaporation and contamination. While the people of Ado Ekiti have access to various water sources for their domestic usage, the most sought and reliable source of drinking water is the groundwater accessed through borehole (Oyebode et al., 2019). It is the cheapest of the reliable drinking water sources. Studies carried out by Odeyemi et al. (2013) and Oyebode et al. (2019) showed that other water sources in Ekiti are exposed too much more contamination including physical, chemical and bacteriological. The quality of water tells a lot about the wellbeing of the consumer and also indirectly influences economic productivity. Afe Babalola University Ado-Ekiti (ABUAD) is the most growing Nigerian university in recent times, having a population of over 9000 people. Majority of students and academic staff members prefer to drink water from packaged water in sachets and bottles because of lack of confidence in the purity level of the borehole waters in the institutions. Water supplied through boreholes in ABUAD for so long has been perceived as unhealthy for drinking by staff and students and this perception has led to the limited use and has created an inconvenience financially as students of the university have to spend money on the purchase of drinking water daily. This has also affected the environment in a lot of ways because plastic sachets and bottles are found in excess as a part of waste generated in the university. It is for this reason that this research is being carried out. This study was embarked on to begin the needed periodic assessment of the quality of groundwater in this area.

2 Materials and Methods

2.1 Study area and Sampling sites

The study area is ABUAD, a young private university having a population of about 11 000 people. It is located in eastern part of Ado-Ekiti along Ijan road, Ado Ekiti, Ekiti State, Nigeria, lying on area of about 130 ha within latitude 7°35′59.16″ and 7°36′31.32″ N and longitude 5°18′6.61″ and 5°18′37.56″ E. This research was carried out on water

Figure 1. Study area with boreholes location (© Google Maps 2018).

Table 1. Method for testing parameters.

Parameter	Test Method
Turbidity (NTU)	Turbidimeter
pH	pH meter
Electrical Conductivity (µS/cm)	Conductivity meter
Nitrate (mg/L)	Spectrometric method
Sulphate (mg/L)	Gravimetric method
Chloride (mg/L)	Photometric method
Parameter	Test Method
Cadmium (mg/L)	Atomic Absorption Spectroscopy
Manganese (mg/L)	Atomic Absorption Spectroscopy
Chromium (mg/L)	Atomic Absorption Spectroscopy
Copper (mg/L)	Atomic Absorption Spectroscopy
Total Plate Count (cfu)	Culture Media
Total Coliform Count (MPN/100 mL)	Most Probable Number Method

samples taken from seven of the boreholes sited in ABUAD. ABUAD has a geology that is of basement complex, igneous rock of South-Western, Nigeria (Ogungbemi et al., 2013; Oyegoke et al., 2015; Oladimeji and Ogungbemi, 2013; Ogundana and Talabi, 2014) comprising of crystalline basement rocks which include coarse grained charnokite (the most abundant in Ado Ekiti), fine grained granite, medium grained granite and porphyritic biotite, medium grained granite and quartzite as its lithological rock units (Oyegoke et al., 2020). Its climate is tropical with distinct wet and dry seasons that are associated with the prevalence of maritime south westerly monsoon winds from the Atlantic Ocean and the dry continental north easterly harmattan winds from the Sahara Desert having abundant rainwater between May and October with substantial rainwater deficit between November and April (Oyegoke et al., 2020).

Physico-chemical parameters tests as well as bacteriological tests were carried out on the collected water samples from the boreholes according to the procedures outlined by the World Health Organisation standards for drinking water (WHO, 2004, 2006, 2008). The physico-chemical tests include turbidity test, electrical conductivity test, pH test, copper test, manganese test, chloride test, sulphate test, chromium test, nitrate test and cadmium test and the bacteriological tests include total plate count, total coliform count and faecal coliform count. Water quality Index (WQI) was used to analyse the parameters tested in the groundwater samples collected.

2.2 Water Quality Index

The weighted arithmetic index method was used to determine the WQI of groundwater from the selected locations. Thirteen physico-chemical parameters i.e. Turbidity, pH, EC, Cu^{2+}, NO_3^-, SO_4^{2-}, Cl^-, Cd^{2+}, Mn^{2+}, Cr^{2+}, TPC, TCC, and FCC were used to calculate WQI. The formula to calculate the WQI is given as (Yisa and Jimoh, 2010; Tyagi et al., 2014):

$$q_i = \frac{C_i}{S_i} \cdot 100 \tag{1}$$

Where, q_i, C_i, and S_i indicate quality rating scale, concentration of ith parameter, and standard value of ith parameter respectively.

$$\text{Relative weight, } w_i = \frac{1}{S_i}; \tag{2}$$

$$\text{and WQI} = \frac{\sum w_i q_i}{\sum w_i} \tag{3}$$

3 Result and Discussion

The results of the various parameter tests that were carried out on the collected samples are as presented in Table 2. Results in Table 2 when compared with the WHO standards for drinking water (WHO, 2004, 2006, 2008; Gray, 2008) show that, water samples taken from all boreholes except for those at Engineering (1.24 NTU) and Behind Admin (1.16 NTU) are of values greater than the set standard of 1 NTU in turbidity, samples from all the boreholes fall within the standards for pH of drinking water which between 6.5–8.5 and the electrical conductivity of 1000 µS/cm. Copper ions detected in the samples fall within acceptable limit of 2.00 mg/L by standard, the amount of nitrate contained in the samples falls within acceptable limit of 50.00 mg/L by standard, sulphate of the samples falls within acceptable limit of 100.00 mg/L by standard, the chloride ions in the samples fall within acceptable limit of 250.00 mg/L by standard, cadmium ion was only detected in the borehole at the Back of College 2 (0.004 mg/L) and was in an amount exceeding the acceptable limit of 0.003 mg/L by standard, the manganese ions in the samples fall within acceptable limit of 0.5 mg/L by standard, chromium ion was only detected in the samples from boreholes at WEMA Hostel, Main Gate, Amphi-Theatre, and Engineering, and were in amounts within the acceptable limit of 0.05 mg/L by standard. Total Plate Count results revealed

Table 2. Quality parameters for samples from boreholes.

Samples		WEMA Hostel	Main Gate	New Female Hostel	Back of College 2	Amphi-Theatre	Engineering	Behind Admin	WHO standards
Turbidity (NTU)		0.56	0.62	0.8	0.59	0.48	1.24	1.16	1
pH		7.56	7.29	7.7	8.36	7.22	7.74	8.24	6.5–8.5
Electrical Conductivity	(µS/cm)	582.1	316.7	212.1	587.2	204.4	285.1	419.2	1000
Copper (mg/L)		< 0.01	0.04	< 0.01	< 0.01	< 0.01	0.03	< 0.01	2
Nitrate (mg/L)		0.02	0.01	0.01	0.02	0.04	0.22	0.01	50
Sulphate (mg/L)		10.57	0.62	0.83	0.5	0.14	0.26	0.44	100
Chloride (mg/L)		92	68.03	57.82	80.03	32.41	5.4	71.08	250
Cadmium (mg/L)		Not Detected	Not Detected	Not Detected	0.004	Not Detected	Not Detected	Not Detected	0.003
Manganese (mg/L)		0.06	0.09	0.04	0.07	0.06	0.06	0.08	0.5
Chromium (mg/L)		< 0.001	< 0.001	Not Detected	Not Detected	< 0.001	< 0.001	Not Detected	0.05
Total Plate Count (cfu)		0	0	0	0	0	0	0	Not Detectable
Total Coliform Count (MPN/100 mL)		0	0	0	0	0	0	0	Not Detectable
Faecal Coliform Count (cfu/mL)		0	0	0	0	0	0	0	Not Detectable

Table 3. Water Quality Index.

SN	Groundwater Location	WQI value	Water quality status
1	WEMA Hostel	0.2384	Excellent water
2	Main Gate	0.2852	Excellent water
3	New Female Hostel	0.2846	Excellent water
4	Back of College 2	124.77	Poor quality water
5	Amphi-Theatre	0.2079	Excellent water
6	Engineering	0.4342	Excellent water
7	Behind Admin	0.4423	Excellent water

that all the water samples contained no aerobic bacteria, Total Coliform Count results and analysis revealed that samples contained no coliform colonies, Faecal Coliform Count results and analysis revealed that all the borehole samples contained no coliform colonies.

This conforms to earlier study done by Adeosun and Omietimi (2020) on some parts of Ado-Ekiti where they found physico-chemical parameters of impurities to be insignificant. Although, other studies done in this region showed significant contaminants level, but they were on shallow well. Not much has been done on groundwater accessible through borehole.

4 Conclusions

The results and analysis of the physico-chemical quality parameters of the water samples from the seven boreholes taken for this study in ABUAD revealed that, all water samples when compared with the permissible limits presented by WHO standard are

satisfactory in pH, electrical conductivity, nitrate, sulphate and chloride; are satisfactory in examined heavy metal constituents except for that from borehole at Back of College 2 which was unsatisfactory in cadmium ion constituent. Turbidity level was within the limit for acceptability for samples from all boreholes except for those at Engineering and Behind Admin which will therefore need to be coagulated, filtered and disinfected before drinking. Investigation with Water Quality Index (WQI) calculation showed that all water samples were excellent quality except for samples collected at Back of College 2 which showed poor quality.

Results and analysis of the Total Plate Count, Total Coliform Count and Faecal Coliform Count revealed that there is no form of bacteriological contamination in all the borehole samples.

Water from the boreholes in ABUAD can generally be regarded as been good and fit for drinking and for domestic use while further investigation should be conducted on that at the Back of College 2.

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