World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(Research Article)

Check for updates

Quality analysis of borehole water in federal polytechnic ado Ekiti hostels

O. O. OLADIPO *, T. O. LAYO-AKINGBADE and O. D. OSASONA

Department of Science Technology, Microbiology Unit, Ado Ekiti, Nigeria.

World Journal of Advanced Research and Reviews, 2023, 19(02), 436–442

Publication history: Received on 28 June 2023; revised on 07 August 2023; accepted on 10 August 2023

Article DOI: https://doi.org/10.30574/wjarr.2023.19.2.1589

Abstract

The quality of drinking water has always been a major health concern, especially in developing countries, where 80 % of the disease cases are attributed to inadequate sanitation and use of polluted water. This study was designed to evaluate the physicochemical and microbial analysis of drinking water of the hostels in the Federal polytechnic Ado, Ekiti state. Water samples were collected from the three hostels on campus. Physiochemical analysis, heavy metal analysis using Atomic absorption Spectrophotometer (AAS), and microbiological analysis were carried out using standard procedure. The Results of physico-chemical analysis indicated that mean values of Turbidity (6 NTU), Total Hardness (195 mg/L) and Fluoride 1.59 mg/L in water obtained from hand dug wells have exceeded the threshold limits recommended by regulatory authorities. The bacteriological analysis showed no growth on the eosin methylene plates indicating the absence of coliform bacteria in the three boreholes. Thus, the water is suitable for drinking. The total bacterial counts are within permissible levels that all the three boreholes. From the study, it was proven that the water is safe for drinking and other domestic purposes because the physiochemical and metal parameters are below the WHO permissible limit and pathogenic bacterial are absent in the sample water.

Keyword: Water-quality; Physiochemical; Heavy metals; Microbiological

1. Introduction

Water is the universal solvent capable of dissolving nearly all solutes, which is important to living and non-living things (Koda *et al.,* 2017). Water is a resource that can be used for a wide range of purposes, including household, industrial, commercial, hydroelectric power, transportation, recreation, and more. River water is crucial to the growth of nations. Water is extraordinarily abundant on the planet as a whole, but fresh potable water is not always available at the right time or the right place for human or ecosystem use (Ababiaka and Sule, 2011). Water quality is defined as the set of physical, chemical and biological characters that must be satisfied in order to ensure that the water supplied is safe for the consumer. Water pollution can cause adverse health effects for a representative number of people over predictable periods of time and is due to population growth, industrial development and urbanization (Awoyemi *et al*., 2014). In the recent past, expanding human population, industrialization, intensive agricultural practices and discharges of massive amount of wastewater into rivers have resulted in deterioration of water quality (Sale). The improper management of water systems may cause serious problems in availability and quality of water since water quality and human are closely related. For degradation of the quality of surface and groundwater, one of its origins is the direct discharge of contaminated water from domestic, industrial and agricultural sources into bodies of water (Falowo *et al*., 2017). Unfortunately, clean, pure and safe water only exists briefly in nature and is immediately polluted by prevailing environmental factors and human activities. Water from most sources is therefore unfit for immediate consumption without some sort of treatment. The industrial pollutants associated with organic matter, inorganic dissolved solids and other unwanted chemicals cause serious problems in the water quality (Mahaurpawar, 2015). Water related diseases continue to be one of the major health problems globally due to consumption of contaminated water (WHO, 2022). The high prevalence of diarrhea among children and infants can be traced to the consumption of unsafe water. The

* Corresponding author: O. D. OLADIPO

examination of microbiological river water quality according to technical standards is obligatory for use-related aspects such as for drinking water production, irrigation or recreation.

2. Material and methods

2.1. Study Area

Federal Polytechnic, Ado-Ekiti is located along Ado/Ijan Ekiti Road, Ado-Ekiti, Ekiti State, Nigeria. It contains three main hostel locations within the campus named Lagos Hostel, Annex hostel and Abuja hostel, Lagos hostel is mainly occupied by females, Abuja hostel is occupied only by males while Annex hostel is occupied by both genders.

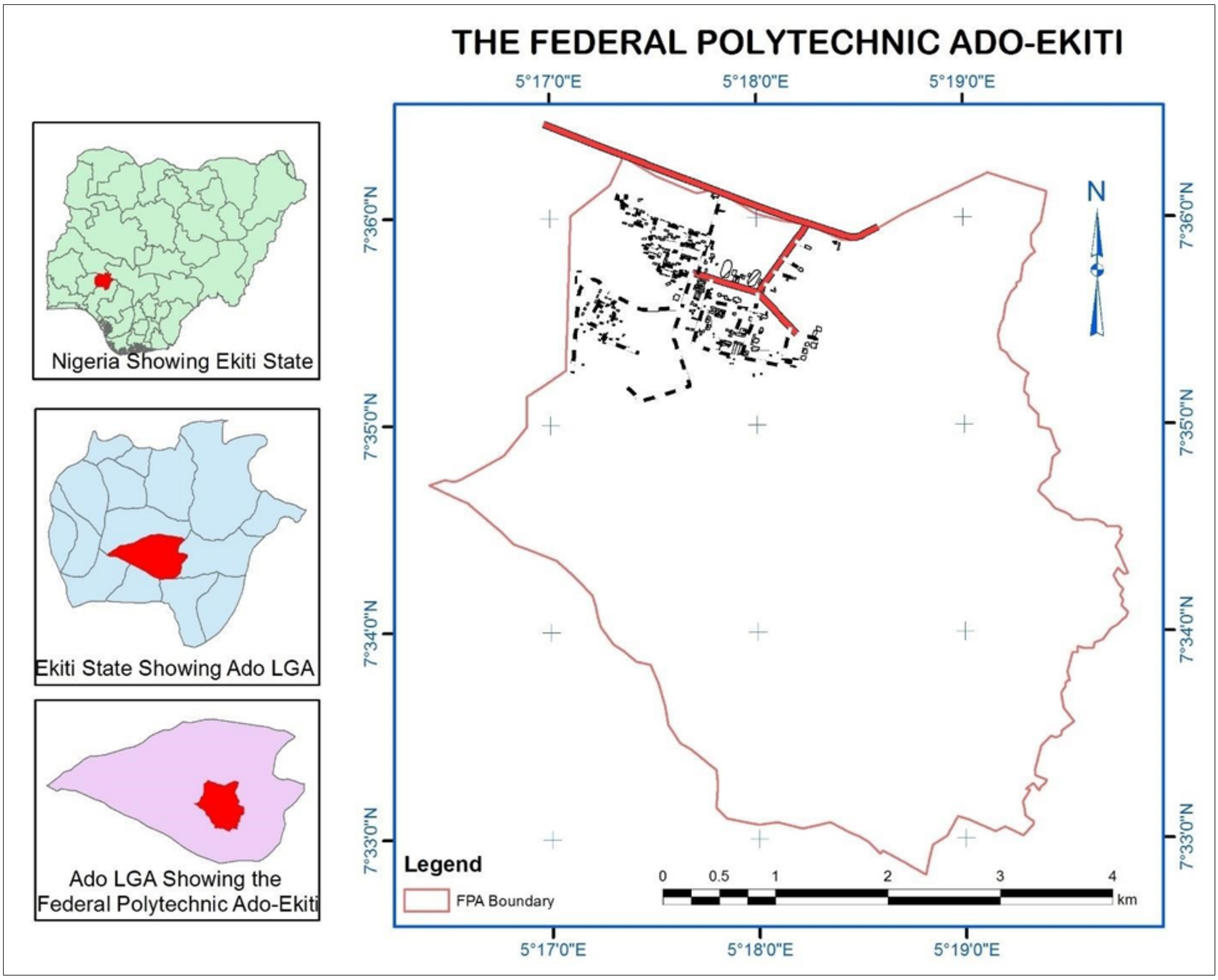

Figure 1 Map showing the study area

2.2. Sample collection

Water samples were collected from three points (one from each hostel) in pre-cleaned 1 litre capacity plastic bottles and immediately delivered to the Microbiology Laboratory of the Department of Science Technology, Federal Polytechnic Ado-Ekiti for analysis.

2.3. Physicochemical analysis of the water samples

The water quality parameters which include conductivity and pH were determined using the conductivity meter and the pH meter respectively. The classical titrimetric method was used for determination of acidity, alkalinity, total hardness, calcium hardness, magnesium hardness, chloride ions and sodium chloride levels of the water samples; while the total solids, total suspended solids and total dissolved solids were determined using the classical gravimetric methods. The spectrophotometric method was used in the determination of the phosphate and sulphate ions (Oko *et al.,* 2017).

2.4. Analysis of Water Samples for Heavy Metals

Atomic absorption spectrophotometer (AAS) model 939 was used in determining heavy metals following the standard procedures of APHA (Kundu and Nag, 2018). Lead, Nickel, Chromium, Cadmium, and Arsenic. Atomic absorption spectrophotometer working principle is based on the sample being aspirated into the acetylene flame and atomized when the light beam of the AAS is directed through the flame into the monochrometer and unto the detector that measures the amount of light absorbed by the atomized element in the flame (Okoya *et al.,* 2011). Since metals have their own characteristic absorption wavelength, a source lamp composed of that element is used, making the method relatively free from spectral or radiational interferences. The amount of energy of the characteristic wavelength absorbed in the flame is proportional to the concentration of the element in the sample.

2.5. Isolation and Microbial Identification

Microbial isolation was performed from the water samples collected at the three hostels. The culture media used were, eosin methylene blue agar, mannitol agar, soyabean casein digest agar, cetrimide agar and nutrient agar. Isolation was performed by pour plate technique after performing the serial dilution of the sample. The cultures were incubated at 37˚C overnight. After the incubation time, a new isolation was made in the same culture media and the morphology was analyzed to identify the bacterial genera (Obiri-Danso *et al.,* 2009).

3. Results

The Physicochemical properties of the water samples at different sampling points are as presented in Table 1.

The pH of the water at the three sampling points was 7.18, 7.31 and 7.62 respectively and was slightly alkaline. The electrical conductivity was highest at sampling point 2 while the alkalinity had their highest record at point 2 respectively. The total suspended solids and dissolved solids ranged from 1.34-2.03mg/l and 74.60mg/l respectively. The lowest sulphate concentration was recorded at point 1, nitrate was at point 1 and point 2 at 0.10 mg/l each and chloride at point 2. The water hardness was between 80.60 and 106.22 representing points 2 and 1 respectively.

Table 1 Physiochemical analysis of Lagos hostel water

Parameters	Point 1	Point 2	Point 3	WHO permissible limit	NSDWQ
pH	7.180	7.620	7.310	6.5-8.5	6.5-8.5
EC(µS/cm)	108.500	155.700	146.200	250	1000
TDS(mg/l)	50.850	74.600	58.160	500	500
TSS(mg/l)	2.030	1.910	1.340	NG	10
Colour (Hazen Unit)	5.000	5.000	5.000	5.000	5.000
T.Hardness (mg/l)	106.220	80.600	91.270	300	500
T.Alkalinity(mg/l)	25.880	33.500	30.180	120	200
Turbidity(NTU)	1.350	1.850	1.520	5	5
DO(mg/l)	6.150	5.960	6.320	14	5
Chloride(mg/l)	7.120	4.660	5.304	250	250
Nitrate(mg/l)	0.100	0.160	0.100	50	50
Sulphate(mg/l)	0.113	0.180	0.212	250	100

Point 1 = Lagos hostel. Point 2 = Annex hostel, Point 3 = Abuja water, NG = No Guideline; NSDWQ, 2007 = Nigeria Standard for Water Quality

Table 1 and Table 2 shows the metal concentration of the hostels water source. The three sampling points; Chromium was between 0.47 mg/l and 0.8 mg/l 3, arsenic varied between 0.002 mg/l and 0.009 mg/l. Nickel was not detected from the three sampling points. Zinc varied between 0.230 mg/l – 0.328 mg/l at point 1 and 3 respectively, calcium ranges from 16.10-24.30 mg/l., iron has the highest value at point 3. All agars inhibited the growth of microorganisms except for Nutrient agar which supported growth of microbes from the three water points, all isolates are creamy, circular and smooth. Water sample from Point 3 had an average colony number of 51 while Point 1 and Point 2 had 45 each as shown in Table 3

Table 2 Metal analysis of sample water

PARAMETERS	Point 1	Point 2	Point 3	WHO standard	NSDWQ
Na(mg/l)	8.400	11.200	9.600	200	200
Ca(mg/l)	24.30	16.100	20.900	75	NG
K(mg/l)	10.500	7.200	5.500	12	NG
Fe(mg/l)	0.370	0.390	0.717	NG	0.3
Mn(mg/l)	0.380	0.207	0.346	0.5	0.2
Cu(mg/l)	0.190	0.202	0.185	0.500	1.0
Mg(mg/l)	3.510	4.160	3.610	50	20
Zn(mg/l)	0.230	0.310	0.328	3.0	3.0
Cd(mg/l)	0.001	0.002	0.001	0.005	0.003
Co(mg/l)	0.005	0.018	0.009	0.01	0.01
As(mg/l)	0.009	0.007	0.002	0.01	0.01
Pb(mg/l)	0.020	0.020	0.011	0.01	0.01
Ni(mg/l)	ND	ND	ND	0.02	0.02

Point 1 = Lagos hostel. Point 2 = Annex hostel, Point 3 = Abuja water, ND= Not Detected, NG = No Guideline; NSDWQ, 2007 = Nigeria Standard for Water Quality

Table 3 Morphological characteristics of isolates

Sample	CFU/g	N1	N2	C1	C2	E1	E2	M1	M1
Point 1	45×10^3	Cream, circular, smooth	Cream, circular, smooth	NG	NG	NG	NG	NG	NG
Point 2	45×10^4	Cream, circular, smooth	Cream, circular, smooth	NG	NG	NG	NG	NG	NG
Point 3	51×10^2	Cream, circular, smooth	Cream, circular, smooth	NG	NG	NG	NG	NG	NG

N=Nutrient agar. C=Cetrimide agar, E=Eosin Methylene Blue agar, M=Mannitol Agar, NG=No Growth

4. Discussion

A summary of the results of physico-chemical analyses is presented in Tables 1. These values were placed alongside Nigeria Standard for Water Quality (NSDWQ) and World Health Organization (WHO) guideline values (SON, 2007, WHO, 2008). The colour, odour, and taste of these water samples are unobjectionable. These fall within the standard that is acceptable to international bodies like W.H.O and NSDWQ. Odour in water is usually caused by volatile substances associated with organic and inorganic chemical materials such as algae and hydrogen, respectively (Okoya *et al.,* 2020). The pH values in the water points under study ranges from 7.18-7.62 which indicated slightly alkaline (near neutral) nature of the ground waters and are well within the limits of NSDWQ and WHO for various uses, including drinking, and that of pH of most natural waters (Oko *et al.*, 2017). Point 2 with the latest pH value and Point 1 with the least pH at 7.128. It is, therefore, desirable since low pH corrodes the pipe and causes acidosis (which results in peptic ulcer) while high pH may cause incrustation and also affects the mucous membrane. Dissolved Oxygen (DO) is the amount of oxygen dissolved in water. It takes the advantage of the fact that the heavier the organic matter content of the water, the greater the expected growth of aerobic organisms in it and the less the oxygen content of it after growth. The DO in this study ranges from 5.96 to 6.32 mg/L. This range did not show any organic pollution or thermal pollution as the values were within the permissible limit of WHO, however slightly higher than NSDWQ value of 5. A higher DO indicates better water quality (Olusola *et al*., 2017). This showed that the boreholes were not densely organic matter packed; otherwise, it would have been consumed to an extent during microbial decomposition. The sources of conductivity may be an abundance of dissolved salts due to poor irrigation, minerals from rainwater run-offs, or other discharges. Electrical conductivity is a measure of the Total dissolved solids (TDS) of a water body. TDS and conductivity are closely related in the sense that the more salts are dissolved in the water, the higher the value of the conductivity. In this study, the highest mean TDS value of 74.6 mg/l (Point 2) had the corresponding highest mean conductivity of 155.7µs/cm. The low conductivity values of the samples implied that the dissolved salts were minimal. Total dissolved solids affect the taste of our water. The low level of conductivity could be attributed to the low level of total dissolved solids. The two parameters (TDS and conductivity) which ranged from 50.85- 74.60 and 108.5 – 155.70 respectively fell within the limits of WHO recommendations (Koda *et al.,* 2017).

Turbidity is the material in water that affects the transparency or light-scattering capacity of the water. It is the reflection of the total suspended solids or particles contained in water. The low level of turbidity could account for the reason why the entire appearance of the water samples was very clear and having no odour (Olusola *et al.,* 2017).

Nitrate can reach both surface water and groundwater because of agricultural activity (including excess application of inorganic nitrogenous fertilizers and manures), from wastewater disposal and from oxidation of nitrogenous waste products in human and animal excreta, including septic tanks (Where latrines and septic tanks are poorly sited, these can lead to contamination of drinking-water sources with nitrate) (Lin *et al.,* 2022). The guideline value (50 mg/litre) for nitrate is based on the occurrence of methaemoglobinaemia, or blue-baby syndrome, in bottle-fed infants caused by excess nitrate/nitrite exposure of infants up to approximately 3–6 months of age (WHO, 2007). All the boreholes sampled recorded values lower than the recommended values of both WHO and NSDWQ. The low level of Nitrate gave an indication that the groundwater is not contaminated with nitrate, either by agricultural run-offs, dumping of refuse or from wastewater (Talabi and Kayode, 2019).

Total alkalinity (mg/l) for all the water points sampled in this study was low and low alkalinity according to the tabulation of total alkalinity and its cultural significance, where- 0-9 is strongly acidic; 10-50 is very low alkalinity; 50-200 is high alkalinity; 211-500 is optimum.

Hard water requires more soap and synthetic detergents for home laundry and washing and contributes to incrustation and scaling in boilers and industrial equipment (Oyebode *et al.,* 2019). La Dou (2004) suggested that 0-60 mg/L is soft; 61 – 120 mg/L as moderately hard; 121 – 180 mg/L as hard; and 180 mg/L as very hard ($CaCO_3$). The Total alkalinity and Total hardness of the water samples at 25.88 – 33.50 and 80.6 – 106.22 respectively agreed with the standards of WHO and NSDQW for drinking water (SON, 2007 and WHO, 2008).

All other heavy metals analyzed like nickel, cadmium, chromium and arsenic were all below the permissible limit's standard set by WHO and SON for drinking water. The low levels of heavy metals recorded in the study can be attributed to less anthropogenic activities that occur in the area such as dredging and the influx of waste and wastewaters into the water body. The level of Lead ranged from 0.011 – 0.020 mg/L which is below permissible limit of WHO as reported in this study causes no health problems like cancer, anaemia etc. (Triantafyllidou *et al.,* 2021). The concentration of nickel was not detected from all sample points. The value of Arsenic is below the WHO guideline of 0.01 mg/L for drinking water and have no potential risk (Ayandiran *et al.,* 2022). Long term exposure to arsenic can lead to the formation of skin lesions, internal cancers, neurological problems, pulmonary disease, peripheral vascular disease, hypertension and cardiovascular disease and diabetes mellitus (Adereti *et al.,* 2017).

A total of four media were used which include nutrient agar, mannitol salt agar, Eosin methylene blue agar and cetrimide agar. Growth was only observed on the nutrient agar plates from the three water points, all isolates are creamy, circular and smooth. Water sample from Point 3 had an average colony number of 51 while Point 1 and Point 2 had 45 each. The absence of growth on other growth media indicated that the water is free from feacal coliforms and other pathogenic organisms.

The concentration of total coliform and faecal coliform obtained from the water samples is below WHO standard of 10MPN/100 mL and 0MPN/100 mL respectively for drinking water (WHO, 2008). Akubuenyi *et al* (2013) specified that potable drinking water should be devoid of total coliform in any given sample.

5. Conclusion

It can be concluded that the water from the three boreholes are portable for drinking. The physicochemical and heavy metal analysis have a little effect on the quality of water from the sites of sampling. The absence of feacal coliforms and pathogenic bacteria indicates that water points are safe for drinking.

It is recommended that appropriate regulatory agencies and routine checks should be carried out on the existing boreholes to ascertain their quality level of the water periodically. This will ensure that that incidence on contamination is noticed earlier for remedial action to be taken

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Ababiaka, T.O. & Sule, I.O. (2011). Bacteriological assessment of selected borehole water samples in Ilorin Metropolis. International Journal of Applied Biological Research. 2(2): 31- 37

[2] Adereti K.F, Awotoye O.O, Adebola S. I., and Akinpelu B.A (2017). Assessment of heavy metal concentration in soil and leaves of tree species around a scrap metal recycling factory in ileife, osun state, Nigeria. Journal of Research in Forestry, Wildlife & Environment, Vol. 9(1). 23-33.

[3] Akubuenyi, F. C., Uttah, E. C. & Enyi-Idoh, K. H. (2013). Microbiological and Physicochemical Assessment of Major Sources of Water for domestic Uses in Calabar Metropolis, Cross River State, Nigeria. Transnational Journal of Science and Technology, 3, 31.

[4] Awoyemi, O.M., Achudume, A.C., and Okoya, A.A (2014). The Physicochemical Quality of Groundwater in Relation to Surface Water Pollution in Majidun Area of Ikorodu, Lagos State, Nigeria. American Journal of Water Resources, 2(5). 126-133.

[5] Ayandiran, T. A., Fawole, O. O., & Dahunsi, S. O. (2018). Water quality assessment of bitumen polluted Oluwa River, South-Western Nigeria. Water Resources and Industry, 19, 13-24.

[6] Falowo, O.O., Akindureni, Y., and Ojo, O (2017). Irrigation and Drinking Water Quality Index Determination for Groundwater Quality Evaluation in Akoko Northwest and Northeast Areas of Ondo State, Southwestern Nigeria. American Journal of Water Science and Engineering, 3(5).50-60.

[7] Koda, E., Miszkowska, A., and Sieczka A. (2017). Levels of Organic Pollution Indicators in Groundwater at the Old Landfill and Waste Management Site. Appl. Sci. 7(6). 638.

[8] Kundu A. and Nag S.K (2018). Assessment of groundwater quality in kashipur block, Purulia district,West Bengal. Applied Water Science, 8(33).

[9] La Dou, J. (2004). Current Occupational and Environmental Medicine. United States of America, Mc Graw-Hill, pp 241- 534.

[10] Lin, L., Yang, H., & Xu, X. (2022). Effects of Water Pollution on Human Health and Disease Heterogeneity: A Review. Frontiers in Environmental Science, 10. doi:10.3389/fenvs.2022.880246.

[11] Mahaurpawar, M (2015). Effects of heavy metals on human health. Int. J. Res.-Granthaalayah. A knowledge Repository. pp. 1-7.

[12] Obiri-Danso, K., Adjei, B., Stanley, K. N. & Jones, K. (2009). Microbiological quality and metal level in wells and boreholes water in some peri-urban communities in Kumasi, Ghana. African Journal of Environmental Science and Technology, 3(1), 059-066.

[13] Oko, O.J., Aremu, M.O., and Andrew C (2017). Evaluation of the physicochemical and heavy metal content of ground water sources in bantaji and rafin- kada settlements of Wukari Local Government Area, Taraba State, Nigeria. Journal of Environmental Chemistry and Ecotoxicology, 9(4). 43-53.

[14] Okoya, A.A., Asubiojo, O.I., and Amusan, A.A (2011). Trace element concentrations of soils in ife -ijesa area Southwestern, Nigeria. Journal of Environmental Chemistry and Ecotoxicology, 3(7). 173-179.

[15] Okoya, A.A., Elufowoju, M.A., Adepoju, K.A., and Akinyele, A.B (2020). Seasonal assessment of the physico-chemical properties of surface water and sediments in the vicinity of a scrap metal recycling industry in Southwestern Nigeria. Journal of Environmental Chemistry and Ecotoxicology, 12(1). 24-31.

[16] Olusola A., Adeyeye, O., and Durowoju, O (2017). Groundwater: quality levels and human exposure, southwest Nigeria. Journal of Environmnetal Geography, 10 (1-2), 23-29.

[17] Oyebode, O.J., Adebanjo, A.S., and ND-Ezuma, S. R (2019). Conditions of available sources of water for domestic use in selected communities in ado-ekiti, Ekiti State, Nigeria. African Journal of Environmental Science and Technology, 13(2). 84-90.

[18] SON, Nigerian standards for drinking water quality (NSDQW) (2007). Industrial standards. Nigerian standard for drinking water and wastewater. SON, 554, 1-30..

[19] Talabi, A.O. and Kayode, T.J (2019). Groundwater Pollution and Remediation. Journal of Water Resource and Protection, 11, 1-19.

[20] Triantafyllidou, S., Burkhardt, J., Tully, J., Cahalan, K., DeSantis, M., Lytle, D., & Schock, M. (2021). Variability and sampling of lead (Pb) in drinking water: Assessing potential human exposure depends on the sampling protocol. Environment International, 146, 106259.

[21] WHO (World Health Organization) (2007) Nitrate and nitrite in drinking-water- Background document for preparation of WHO Guidelines for drinking-water quality, Geneva, Author.

[22] WHO (2008). Guidelines for Drinking-water Quality, Incorporating 1st and 2nd Addenda, Volume 1, Recommendations (3rded). WHO: Geneva, Switzerland.

[23] WHO (2022). Guidelines for drinking-water quality: Fourth edition incorporating the first and second addenda.