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PHYSICOCHEMICAL AND HEAVY METALS ASSESSMENT OF SOME SELECTED BOREHOLE WATER IN DUTSE TOWN OF JIGAWA STATE

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ABSTRACT
Jigawa State of Nigeria is a state naturally blessed with arable land for both wet and dry farming. The irrigation farming activities have led to the increasing population of boreholes in the state. The perils associated with individual borehole water quality consumed are not well investigated. This paper therefore sought to assess the quality of some randomly selected boreholes water in the State using standard methods, with the view of determining the suitability of the water for domestic and agricultural uses. The study shows the following results for the five selected boreholes: temperature range of 30-32^{o}C, pH of 6.93−6.98, turbidity of 0.07−0.6(NTU), alkalinity of 11.8−30.67(mg/L), total dissolved solids(TDS) of 143−147(mg/L), total hardness of 0.93−8.1(mg/L), calcium hardness of 4.3−8.83(mg/L), magnesium hardness of 0.03−0.23(mg/L), conductivity of 176.63−853(μS/mL), chloride of 4.25−6.72(mg/L), lead (Pb) of 0.239−0.447(mg/L), cadmium (Cd) of 0.032−0.158(mg/L), zinc (Zn) of 0.01-0.11(mg/L), copper (Cu) of 0.0(mg/L), and iron (Fe) of 0.0-0.004(mg/L). Most of the parameters analyzed were found to be within the limits set by the World Health Organization's standard for drinking water. Hence the borehole water is of good quality for human consumption and other domestic and agricultural uses, although little treatment may be required to lower the lead and cadmium concentrations in all the boreholes.

Keywords: Biological contaminations, Borehole, Hardness, Magnesium, Turbidity, Water

INTRODUCTION

Water is an imperative commodity for human existence, and its significance to health and economic development of a nation cannot be overemphasized. Developing countries like Nigeria do not have full access to potable water for basic hygiene. This situation can result into so many health problems. Consumption of water contaminated by disease-causing agents (pathogens) or toxic chemicals can cause illness such as typhoid, diarrhea, dysentery, cholera, cancer, stomachache, skin diseases etc. Also, insufficient amounts of potable water for basic needs can lead to poor hygiene practices, which can be a precursor to eye and skin diseases (WHO/UNICEF, 2010).

Water is said to be potable when it is free from physical, chemical, and biological contaminations. Therefore, water quality is an important parameter which should always be checked before water consumption. Various regulatory bodies cross the globe have set quality standards for water to ensure efficient use of water for a designated purpose. Water quality analysis on the other hand is to measure the required parameters for a given sample of water and then compared with the set standard to check for conformity (Momodu, 2014). Human requires water for day to day activities such as drinking, washing, cooking, bathing, agriculture, and for industrial activities (Akpoborie *et al.*, 2008). The two major sources of water whose qualities are checked by scientists are ground water and surface water (Momodu, 2014).

Haruna *et al.,* (2008) and Okeola *et al.,* (2010) reported that generally ground water is more reliable and safe for domestic and agricultural irrigation applications than surface water which is mostly poor in quality due to contaminations. In a developmental research, Berthold (2010) established that wells and boreholes alter the natural flow field and cause heat and mass transfer between aquifers, rocks and surrounding atmosphere. Many authors (Sunnudo-Wilhelmy and Gill, 1999; Egwari and Aboaba, 2002; Lu, 2004) have associated the contamination of borehole water to human activities in careless waste disposal and landfills, wrong well construction, poor agricultural practices, siting of pit latrines and graves near boreholes etc.

Okuo *et al.*, (2007) in a study submitted that Groundwater bodies are susceptible to contamination from both natural and human activities. The prevalent reports on underground water pollution have increased in recent years and have now become an issue of great public concern (Amoo et al., 2018). This study therefore, seek to investigate the physical and chemical properties of some randomly selected borehole water residing within Dutse town of Jigawa State to assess the level of contaminations of the boreholes.

MATERIALS AND METHODS

Study Area

Five different locations within Dutse town of Jigawa State were selected at random for the study. These locations are: Gida-dubu, Tukur-site, Yalwawa, Garu and Federal University Dutse (FUD) with the latitude and longitude as follows 11^{o}71'24.17" N and 9^{o}36'32.43" E, 11^{o}69'03.66" N and 9^{o}32'95.11" E, 11^{o}70'20.35" N and 9^{o}35'39.69" E, 11^{o}71'25.57" N and 9^{o}36'34.05" E, and 11^{o}70'78.14" N and 9^{o}36'67.48" E respectively.

Water sampling and collection

Random sampling technique was used in selecting the water samples; the town was divided into five regions (Gida-dubu, Takur-site, Yalwawa, Garu and FUD). In each region, one borehole was selected at random. The water samples were collected from the selected boreholes into pre-washed 2 liters polythene containers (Tukura et al., 2012) and labeled as depicted in the Table 1.

Table 1: Selected boreholes and labels

Location/Samples	Label
Tukur-site borehole water	B1
Yalwawa borehole water	B2
Gida-dubu borehole water	B3
Garu borehole water	B4
FUD	B5

The samples were transported to the laboratory within 12 hours of sampling and preserved for analysis. The physicochemical parameters such as temperature, pH, turbidity, total dissolved solid (TDS), electrical conductivity, total hardness, calcium hardness, magnesium hardness, chlorides and alkalinity were determined according to standard methods as established by APHA (2012). For the heavy metals analysis, the samples were first digested to remove organic impurities present and also to prevent interference in the analysis. Concentrated nitric acid was used to digest the samples. The digested samples were analyzed for the presences of lead (Pb), cadmium (Cd), Zinc (Zn), Iron (Fe), and Copper (Cu). Using atomic absorption spectrophotometer. The concentrations of such heavy metals were calculated using the standard calibration plot of each metal as employed by Momodu and Anyakora (2010).

RESULTS AND DISCUSSION

The results are segmented into two parts, the physicochemical analysis and heavy metal analysis. Tables and graphical representations are used to show the results.

Physicochemical analysis

The results of the physicochemical analysis of the five selected borehole water samples are presented in table 2 below. The comparison of the analyzed physicochemical properties of the water samples and World Health Organization's standard are depicted in bar charts as can be seen in figure 1 – 9.

Table 2: Physicochemical analysis results for the selected borehole water

Parameter	Sample B1	Sample B2	Sample B3	Sample B4	Sample B5	W.H.O Standard
pH	6.98	6.97	6.93	6.93	6.93	6.5 – 8.5
Temperature (^{o}C)	30	31	30	32	32	-
Turbidity (NTU)	0.6	0.07	0.26	0.2	0.1	5
Total Dissolved Solid (mg/L)	143	147	140	145	143	120
Alkalinity (mg/L)	19.67	11.8	30.67	14.97	24.97	120
Total Hardness (mg/L)	0.93	9.07	4.43	6.03	8.1	500
Calcium Hardness (mg/L)	5.92	8.83	4.3	6.0	8.0	200
Magnesium Hardness (mg/L)	0.03	0.23	0.13	0.03	0.1	150
Electrical Conductivity (μS/mL)	176.63	848.33	848.33	853	637.7	1000
Chloride (mg/L)	4.87	4.63	4.25	5.63	6.72	250

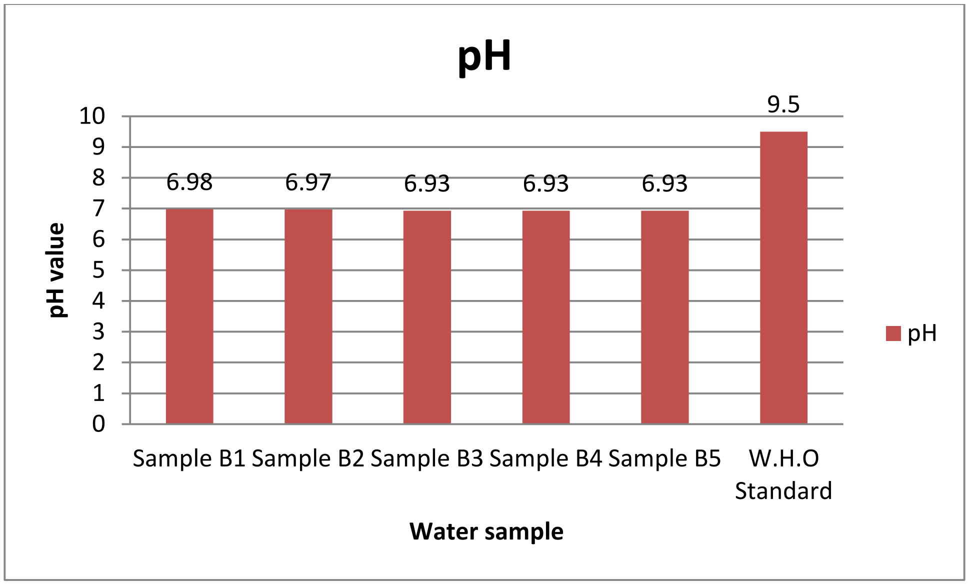

Fig. 1: pH values for the selected borehole water samples and WHO standard.

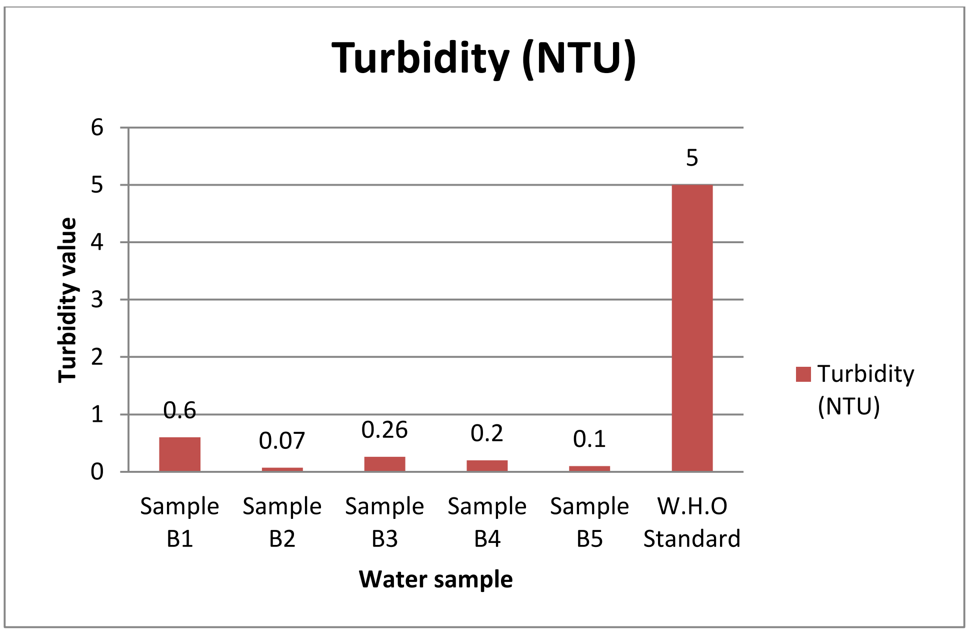

Fig. 2: Turbidity values for the selected borehole water samples and WHO standard.

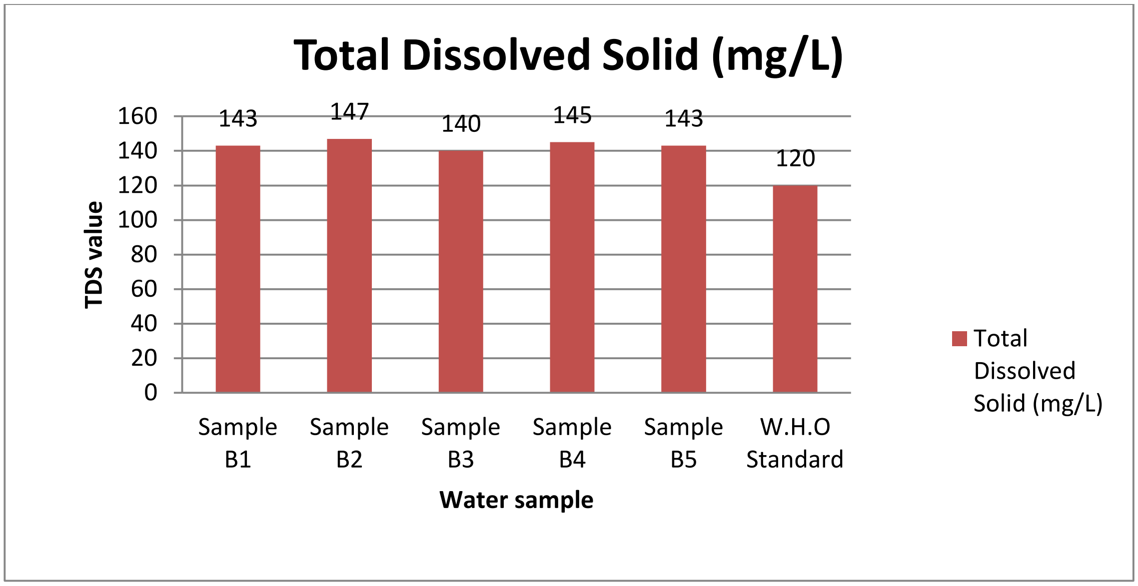

Fig. 3: TDS values for the selected borehole water samples and WHO standard.

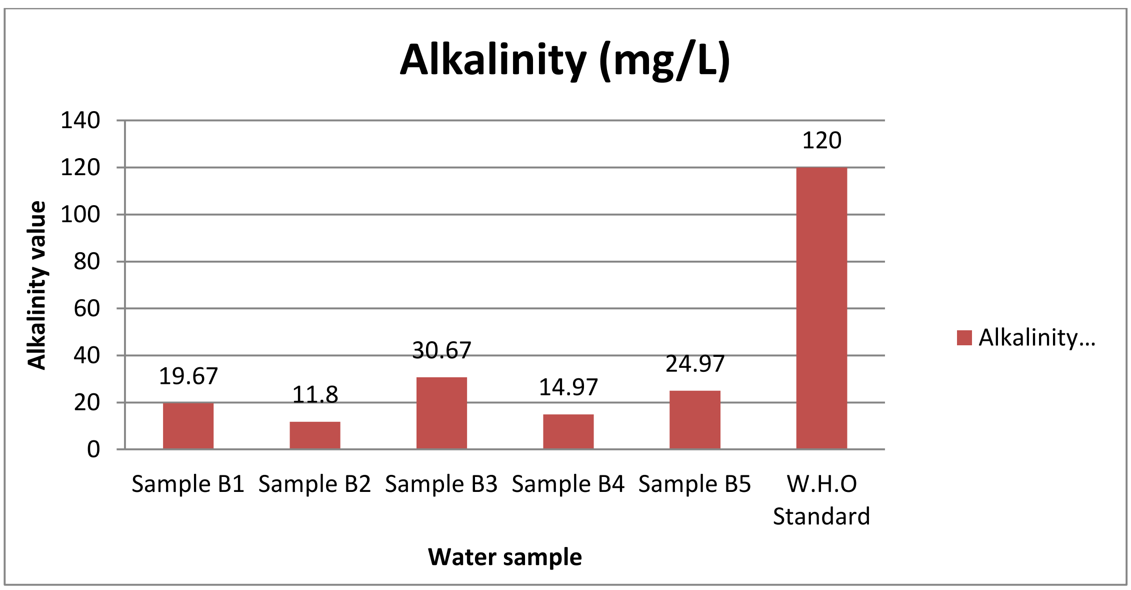

Fig. 4: Alkalinity values for the selected borehole water samples and WHO standard.

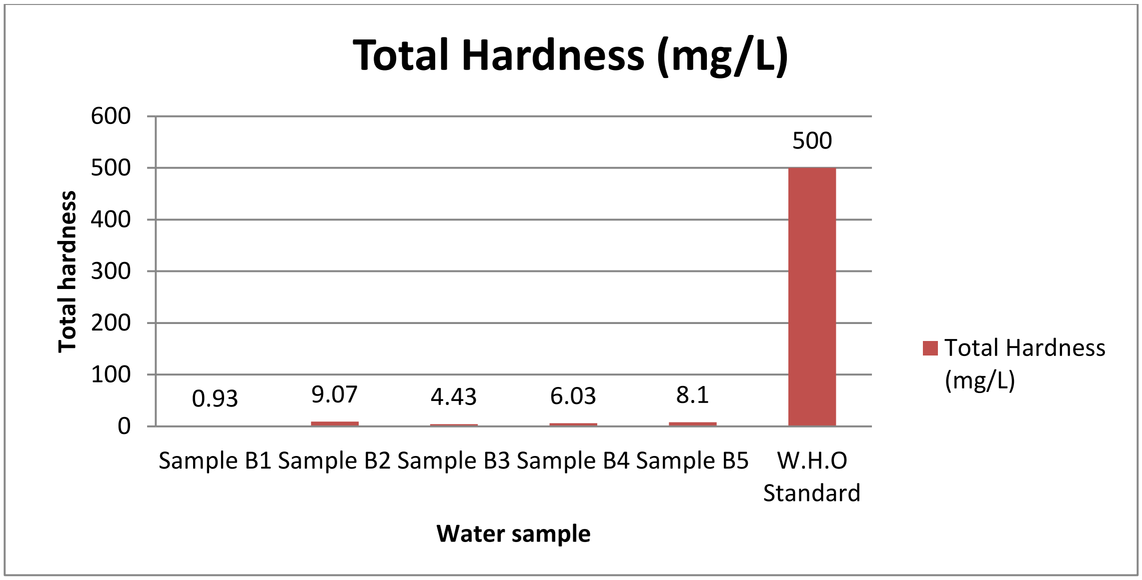

Fig. 5: Total hardness values for the selected borehole water samples and WHO standard.

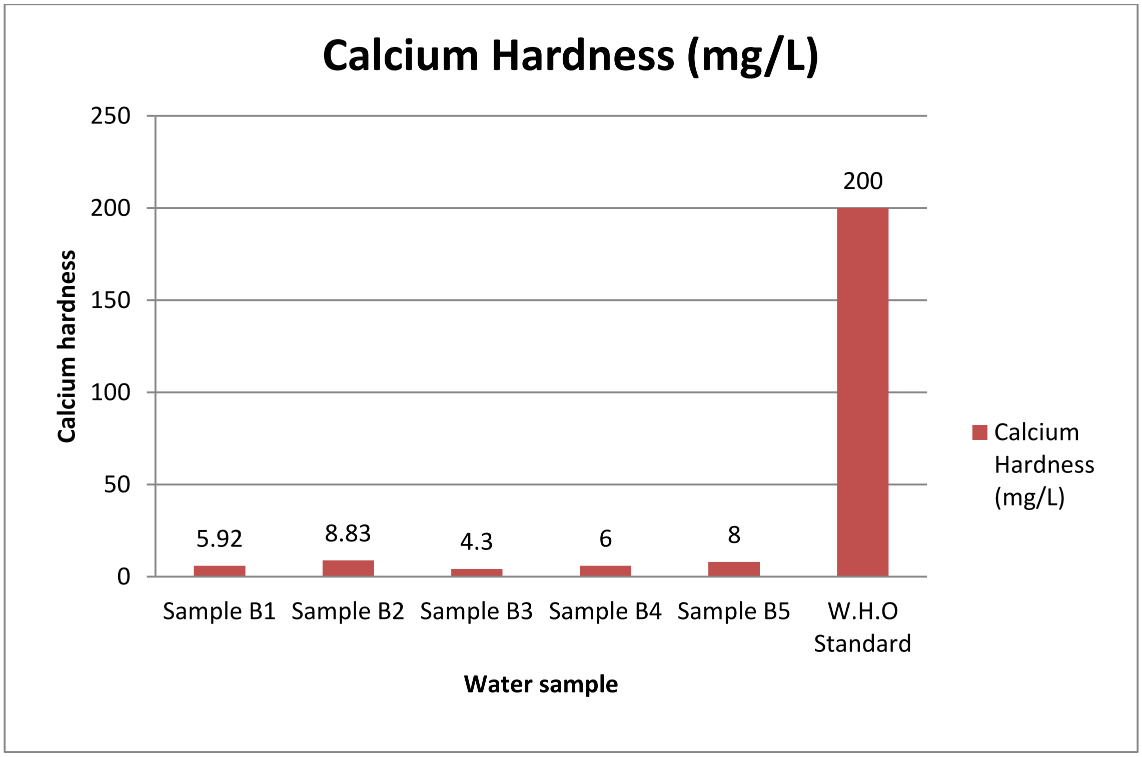

Fig. 6: Calcium hardness values for the selected borehole water samples and WHO standard.

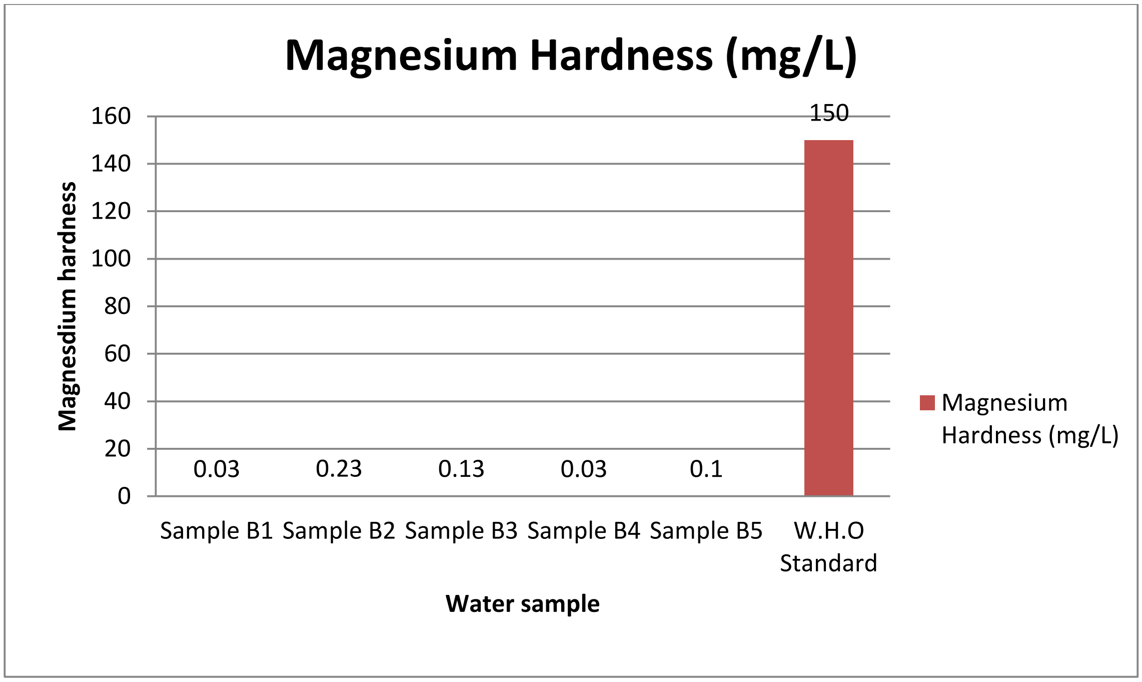

Fig. 7: Magnesium hardness values for the selected borehole water samples and WHO standard.

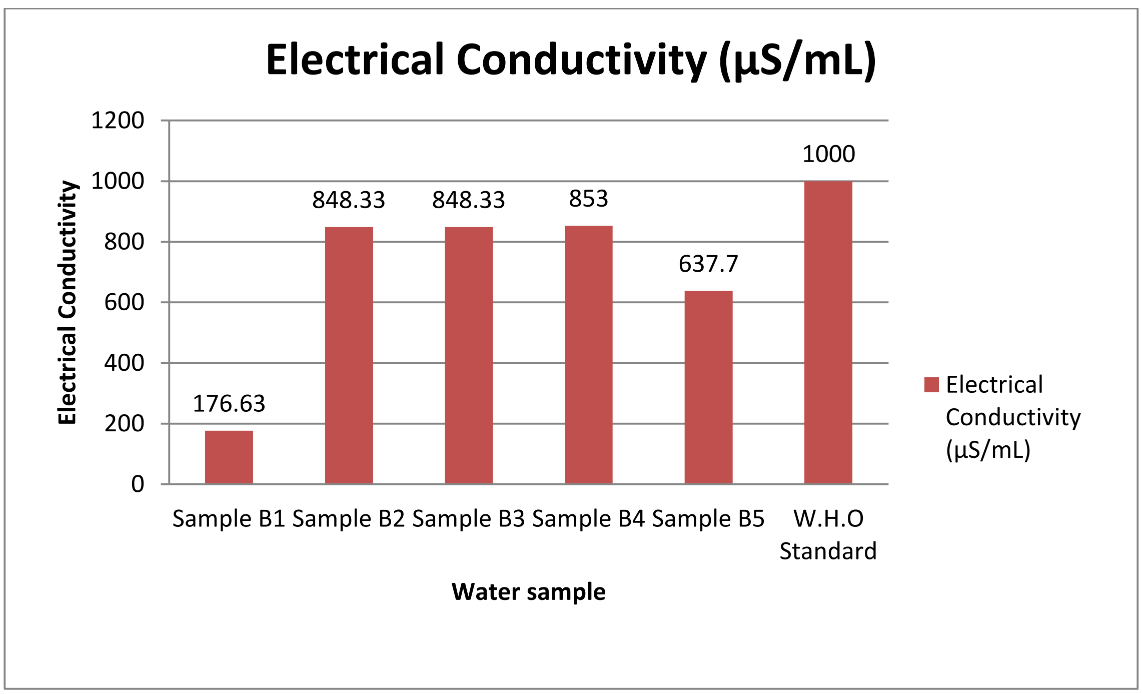

Fig. 8: Electrical conductivity values for the selected borehole water samples and WHO standard.

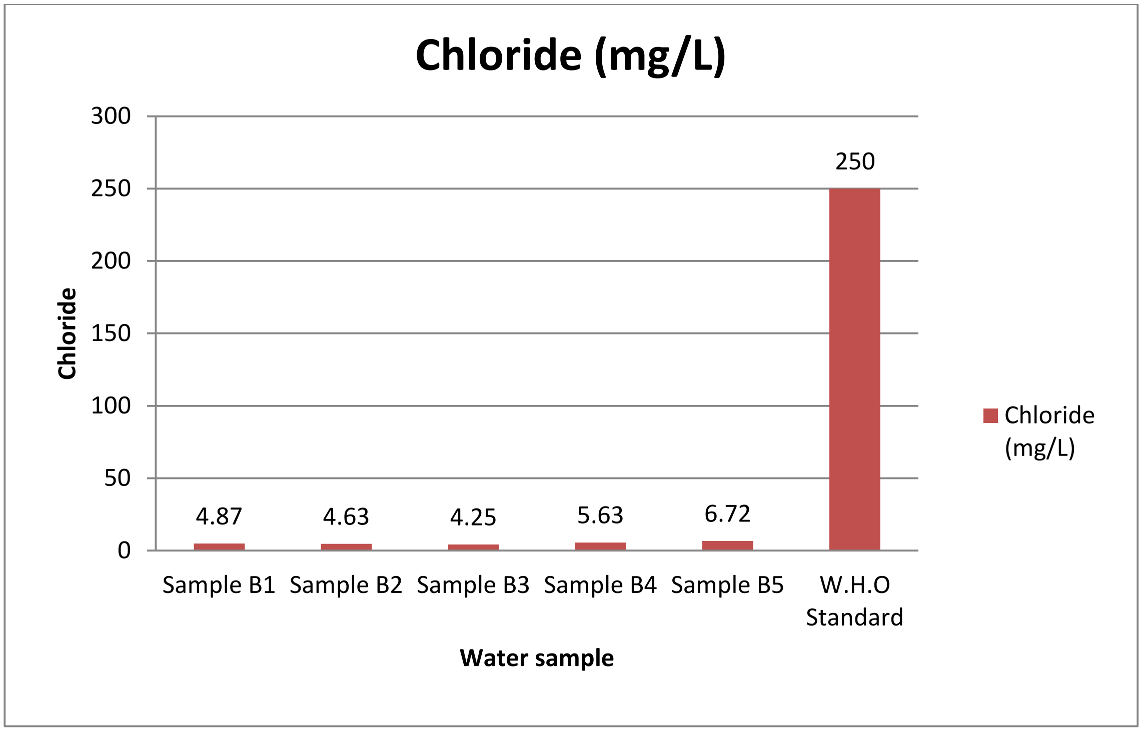

Fig. 9: Chloride values for the selected borehole water samples and WHO standard.

DISCUSSION

The temperature values for the five borehole water samples were found to range between 30°C and 32°C as depicted in table 2 above, these kinds of temperature values were reported by Amoo et al., (2018) and Mohammad *et al.*, (2015). The pH values of the sampled water tested were found to be in the range of 6.93 - 6.98 with the sample 1 having the highest value and samples 3, 4 and 5 having the least value, these values are indicating slightly alkaline (near neural) medium, however, all the values are within the W.H.O standard of 6.5 – 8.5 which means the acid level of all the borehole water samples are safe for human consumption. These pH values are in agreement with the studies of Bello and Bichi (2013) and Amoo et al., (2018) where pH values of 6 – 9 and 6.53 – 7.8 respectively were reported. The turbidity values of all the samples tested are found to range between 0.07 and 0.6NTU with the sample 2 having the lowest and sample 1 being the highest, all the samples fall within the W.H.O standard of 5NTU, this result is in accord with the study by Amoo et al., (2018).

The TOTAL Dissolved Solid (TDS) is an important parameter that indicates the mineralized character of the water. High TDS increases the biological and chemical oxygen demand, which deplete the dissolve oxygen level in the aquatic system. TDS in drinking-water originate from sewage, natural sources, industrial wastewater and urban runoff. Figure 3 shows the results of TDS of the boreholes water analyzed and their comparison with the WHO standard, the results reveal values ranging from 140 to 145mg/L which are all within the standard value of 500mg/L set by the WHO. Similar results were obtained by Tukura et al., (2013) and Ukpong and Okon (2013). The results of the analysis for alkalinity of the boreholes water as shown in figure 4 are 19.67, 11.8, 30.67, 14.97 and 24.97 (mg/L) respectively. All the results obtained are within the WHO acceptable limit for potable water which is 120mg/L. Tukura et al., (2013) reported alkalinity values ranging from 3 – 36mg/L for various boreholes water in Nasarawa State. The total hardness for the boreholes water is presented in figure 5; the values are 0.93, 9.07, 4.43, 6.03 and 8.1 (mg/L) respectively for the selected boreholes. All the values are within the permissible limit of WHO which is 500mg/L, borehole sample 1 has the least hardness while borehole sample 2 got the highest value.

Calcium hardness and Magnesium hardness for the selected borehole water samples were all found to range within the allowable limit set by WHO which are 200mg/L and 150mg/L respectively. Figures 6 and 7 present the respective values of calcium and magnesium hardness. Electrical Conductivity (EC) is a parameter that indicates water quality and soil salinity, therefore, the relatively high values observed in some water samples indicates high salinity; hence the waters might not be very suitable for domestic and agricultural use (Bernard and Ayeni 2012). The EC values obtained in this study as depicted in figure 8 are: 176.63, 848.33, 848.33, 853 and 637.67 (µS/mL), all the borehole samples with the exception of sample 1 are of high salinity which signifies high conductivity. All the borehole samples are within the allowable limits of 1000.0 µS/mL set by WHO. Amoo et al., (2013) obtained EC values ranging from 422 to 690µS/mL for 6 different boreholes analyzed in Jigawa State. The results of the chloride analysis on the selected borehole water samples is provided in figure 9 above, the values ranges between 4.25 and 6.72mg/L and all the values are below the maximum acceptable level established by WHO which is 250mg/L. Garba et al., (2018) found chloride values of 2.1, 2.3, 3.2 and 4.1mg/L for four different boreholes water studied in Jigawa State.

Heavy metal analysis

Results for the heavy metals analysis is presented in table 3 below.

Table 3: Heavy metals analysis results for the selected boreholes

Heavy Metal	Sample B1	Sample B2	Sample B3	Sample B4	Sample B5	W.H.O Standard
Lead (mg/L)	0.252	0.447	0.344	0.447	0.239	0.01
Zinc (mg/L)	0.05	0.09	0.11	0.02	0.01	5
Cupper (mg/L)	0	0	0	0	0	0.05
Iron (mg/L)	0.003	0.0009	0.0	0.0015	0.004	0.02
Cadmium (mg/L)	0.024	0.053	0.158	0.065	0.032	0.005

Heavy metals are important parameters to be checked in analyzing drinking water. Their presence in higher concentration than the set standard by drinking water regulatory organizations poses serious health complications to both human and other living organism. Therefore, the analysis of heavy metals in drinking water is very essential in order to verify the fitness of water for drinking purposes (Tahir et al., 2019). Figures 10 to 14 give the comparison of heavy metals analysis results for the five selected borehole water samples and the standard values set by WHO.

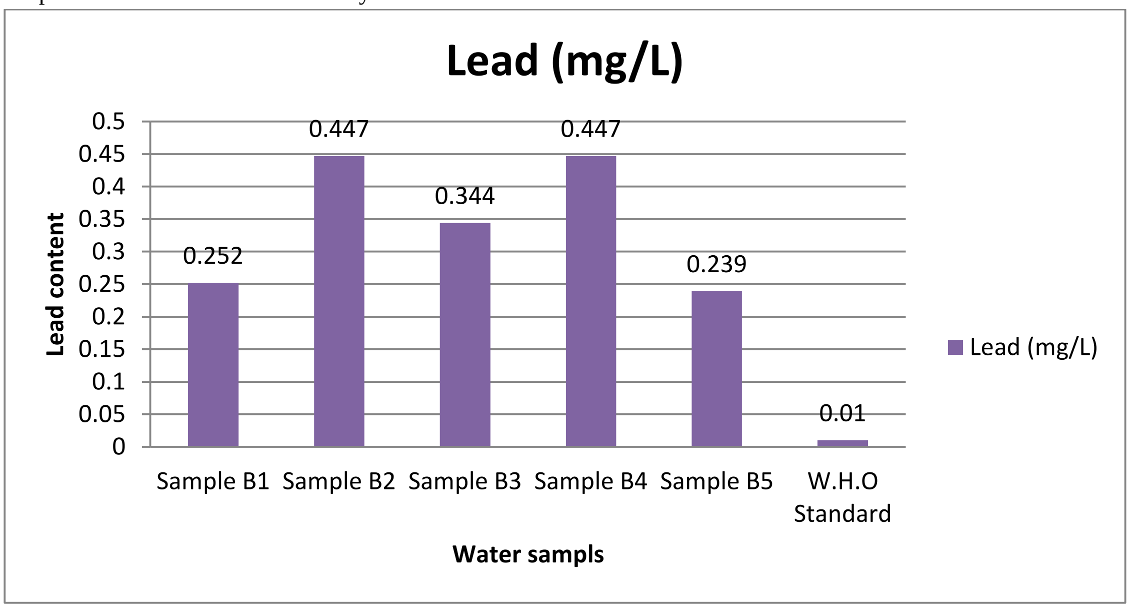

Figure 10: Lead values for the selected borehole water samples and WHO standard.

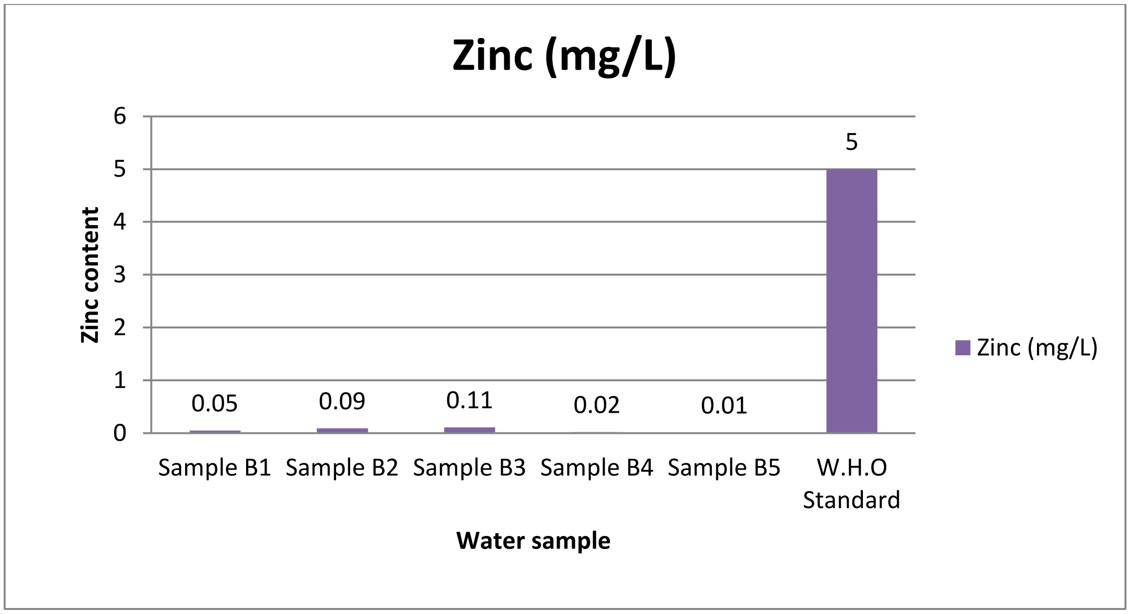

Fig. 11: Zinc values for the selected borehole water samples and WHO standard.

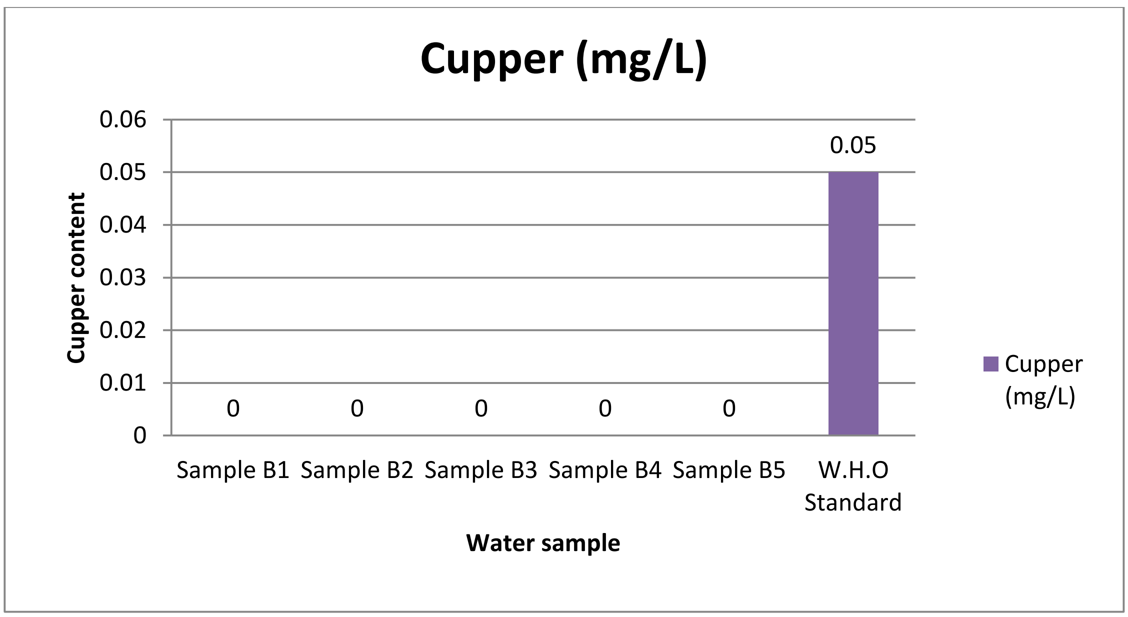

Fig. 12: Cupper values for the selected borehole water samples and WHO standard.

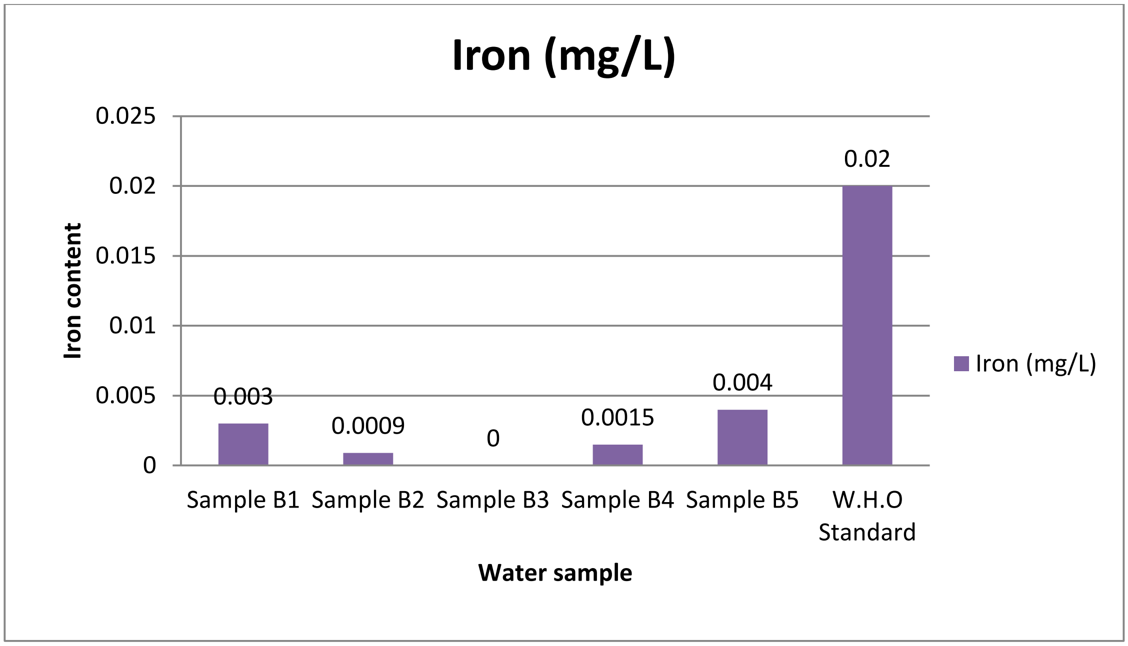

Fig. 13: Iron values for the selected borehole water samples and WHO standard.

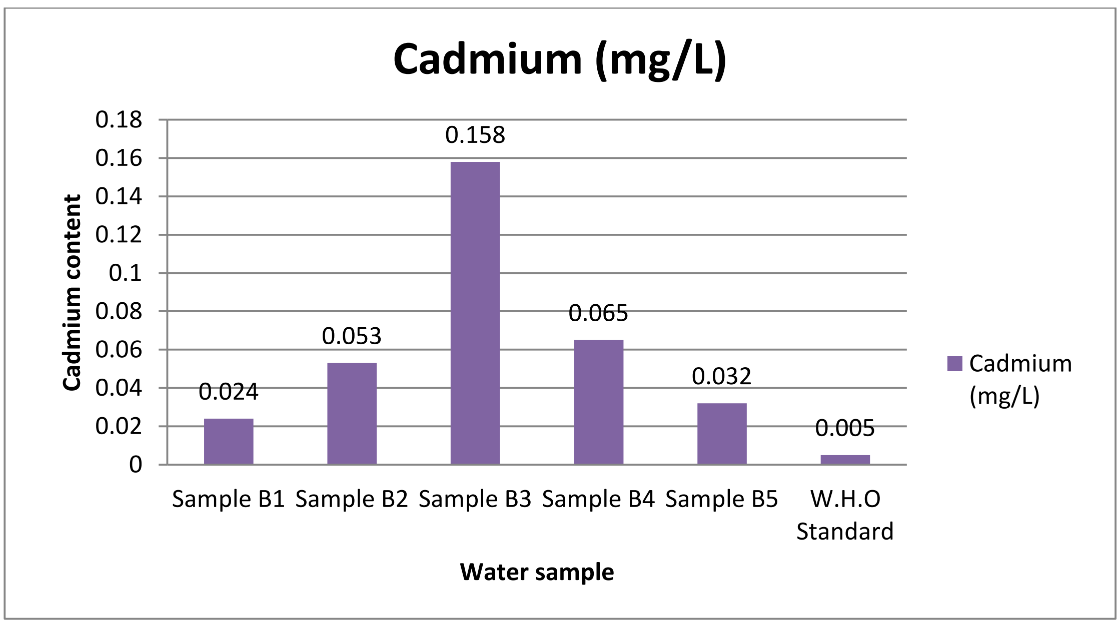

Fig. 14: Cadmium values for the selected borehole water samples and WHO standard.

The results for heavy metals reveal that zinc, copper and iron concentrations present in all the selected boreholes are within the accepted limits of WHO, while lead and cadmium concentrations in all the boreholes are out of the WHO permissible limits. The lead and cadmium concentrations in all the boreholes are alarming as they are relatively above the standard values, and this signifies the need for treating the boreholes to lower the concentrations of these elements in order to prevent potential danger to people drinking from the boreholes especially young children whom lead concentration affected most. The results also show absence of cupper in all the boreholes analyzed, this result is in accord with the study of Garba et al., (2018) where the absence of copper was reported in four different boreholes water analyzed in Jigawa State. The values obtained for lead, zinc and iron in this study are in concurrence with the values found by Tahir et al., (2019) for some ten different boreholes and wells water analyzed.

CONCLUSION

This study investigated the quality of some selected boreholes water in Dutse Metropolis and has disclosed that; the less industrial activities which can lead to the disposal of pollutants contaminants and the natural filtration process of the soil are responsible for good quality underground water in Dutse town. On comparing results of the analysis for pH, turbidity, alkalinity, TDS, total hardness, calcium hardness, magnesium hardness, conductivity, chloride and heavy metals with the WHO standards for drinking water, all the above mentioned parameters are found to be below the maximum permissible limits. This suggested that the water is of good quality for human consumption and other domestic and agricultural uses. The results obtained for Lead (Pb) and Cadmium (Cd) heavy metals concentration are above the limit set by WHO while the results obtained for Zinc, Copper and Iron are within the standard limit set by WHO. A good treatment is required in order to reduce the concentration of Lead and Cadmium in the boreholes for the water to be good and safe for human and other organism consumption.

REFERENCES

Akpoborie, T., Egbo, S. H. O., Ebenuwa C. C and Emeshili E. M (2008). Comparative study of the Satchet Water in Asaba Metropolis, South-South, Nigeria. Book of proceeding of international conference of the chemical Society of Nigeria held in Effurun, Delta State.

Bernard E. and Ayeni N. (2012). Physicochemical analysis of groundwater samples of Bichi local government area of Kano State of Nigeria, *World Environment, 2(6)*, 116 -119.

Berthold, S. (2010). Synthetic Convection Log-Characterization of Vertical Transport Processes in Fluid-Filled Boreholes. *Journalof Applied Geophysics*, 72 (1): 20-27.

American Public Health Association (APHA) (2012). Standard methods for the examination of water and wastewater, 22nd edition edited by E. W. Rice, R. B. Baird, A. D. Eaton and L. S. Clesceri. American Water Works Association (AWWA) and Water Pollution Control Federation (WPCF). Washington, D.C.

Amoo A, O, (2018). Water Quality Assessment of Selected Boreholes in Federal University Dutse Campus North-West, Nigeria. *UMJR*, ISSN: 2616-0668.

Bello, U. F and Bichi, M. H. (2013). Heavy metals pollution in surface water and Groundwater used for irrigation along River Tatsawarki in Kano state, Nigeria. *IOSR Journal of Engineering.* 3(7): 2278-8719.

Egwari L. and Aboaba, O. O. (2002). Bacteriological quality of domestic waters: Revision. *Saude Publica*, 36(4): 513-520.

Garba Y.I., Gano U.T., Yusuuf M.S. and Musa D.M. (2018). Assessment of physicochemical and microbiological quality of borehole water in Dutse metropolitan Jigawa state, Nigeria, *Science World Journal,* 13(3), 1597-6343

Haruna, A. Uzaini, A. and Harrison, G. F. S. (2008). Evaluation of Water Quality of Shallow Tube Wells of Some Fadama Lands in Zaria City, Nigeria. Book of Proceedings of the international conference of the chemical society of Nigeria held in Effurun, Delta State.

Lu, X. X. (2004). Vulnerability of Water Discharge of Large Chinese Rivers to Environmental Changes: An Overview. *Reg Environ Change*, 4:182–191.

Mohammad, S. D., Fikri, N. A., Irda, K., Dwiluci, A., Emma, T. S. and Tantowi, E. P (2015). Ground water Quality Assessments for suitable Drinking and Agricultural Irrigation Using Physicochemical water analysis in the Rancaekek-Jatinangor District, West Java, Indonesia. *Int. Conference on Environmental Sciences and Technology*. Vol. 84: 56-62

Momodu, M.A. and Anyakora, C.A. (2010): Heavy Metal Contamination of Ground Water: The Surulere Case Study. *Research Journal Environmental and Earth Sciences.* 2(1). 39-43.

Okeola, F. O., Kolawole O. D. and Ameen O. M (2010). Comparative Study of Physicchemical Parameters of Water from a River and Its Surrounding Wells for Possible Interactive Effect. *Advances in environmental Biology*, 4(3):336-344.

Okuo, J. M., Okonji, E. J. and Omoyerere, F. R. (2007) Hydro physiochemical Assessment of the Warri Coastal Aquifer, Southern Nigeria. *Journal of Chemical Society,* 32 (1) Pg. 53-64.

Sunnudo-Wilhelmy, S. A. and Gill, G. A. (1999). Impact of the Clean Water Act on the Levels of Toxic Metals in Urban Estuaries: The Hundson River Estuary Revisited. *Environmental Science Technology*, 33: 3471-3481.

Tahir, M.T., Abdulmalik, S. and Suleiman, A.K. (2019). Analysis of Physicochemical Parameters and Heavy Metals in Drinking Water from oreholes and Wells in Dutse District, Jigawa State, Nigeria, *IJSRST*, 6(2), 2395-6011.

Tukura B.W., Ibrahim E.G., Onche E.U. and Ibrahim M.A.G. (2013). Preliminary Assessment of Physicochemical Properties of Borehole Water in the vicinity of Public Health Facility in Nasarawa State, Nigeria, IOSR Journal of Applied Chemistry, 2278-5736, 5(6), 55-63

Ukpong, E. C. Okon, B. B. (2013). Comparative analysis of public and private borehole water supply sources in Uruan LocalGgovernment Area of Akwa Ibom state, *International Journal of Applied Science and Technology, 3(1),* 76-91

World Health Organisation (WHO). (2011). Guidelines for Drinking-Water Quality. Available at https://www.epd.gov.hk/eia/register/report/eiareport/eia_2242014/EIA/app/app02.0 2.pdf. Assessed on December 14, 2018.

WHO/UNICEF (2010) Diarrhea*: Why Children are Still Dying and What can be Done.*