International Journal of Academic Information Systems Research (IJAISR)
ISSN: 2643-9026
Vol. 4, Issue 5, May – 2020, Pages: 59-65

Physicochemical and Microbiological Characteristics of Boreholes Water from University of Ibadan, Ibadan, Oyo State

[1]Abideen Adeyinka Adekanmi, [2]Muminat Yemisi Adekanmi, [3]Oyekanmi Hidayat Adeola, [4]Muraina Taoreed Adekunle, [5]Opeyemi Shafiu Adekanmi, [6]Sherifdeen Adeniyi Adekanmi

[1]Raw Materials Research and Development Council (RMRDC), Abuja, Nigeria
[2]Department of Architecture, Obafemi Awolowo University, Ile Ife, Osun State, Nigeria
[3]Department of Physiology, University of Lagos, Akoka, Lagos State, Nigeria
[4]Department of Science Laboratory Technology, Federal Polytechnic Ede, Osun State, Nigeria
[5]Centremog Nigeria Limited, Lagos, Nigeria
[6]Lautech Teaching Hospital, Osogbo, Osun State
Email: 1yinklab1234@gmail.com, [2]muminatyemis@gmail.com, 3oyekanmihidayat@gmail.com, 4adekunleade@gmail.com, 5adekanmiopeyemi@gmail.com, [6]adekaniyi01@yahoo.com

***Abstract**: Unavailability of good quality drinking water is wide spread and this has serious health implications. In developing nations of the world, 80% of all diseases and over 30% of deaths are related to drinking water. According to Federal Ministry of Health statistics, only about 30% of Nigerians have access to portable water while the United Nations estimated that about 1.2 billion people all over the world lack access to portable water. The current study is on determination of physicochemical and microbiological characteristics of selected boreholes from University of Ibadan, Ibadan, Oyo State. Water samples were collected from five Boreholes from University of Ibadan, Fish farm, Ibadan, Oyo state. Temperature and pH were determined in-situ while the other parameters were determined out-situ. All properties (physicochemical and microbiological) were examined according to standard methods. The result of physicochemical parameters for the boreholes (Key: T= Tafawa Balewa Hall, D= Department of Microbiology, N= Nnamdi Azikwe Hall, S= Sultan Bello Hall and A= Abdulsalam Abuakar postgraduate Hall) water samples are as follows: Temperature (Ambient), pH (6.5, 6.6, 7.1, 6.8 and 7.0), Total Dissolved Solids (150, 250, 180, 200 and 100 mg/L), Turbidity (1, 3,2,4 and 3 NTU), Conductivity (105, 135, 222, 330 and 133µS/cm), Chloride (0.7, 2, 0.5, 3 and 2 mg/L), Fluoride (0, 0, 0, 0 and 0 mg/L), Iron (0.01, 0.02, 0, 0.01 and 0.04 mg/L), Nitrate (0, 0, 0, 0 and 0 mg/L), Nitrite (0, 0, 0, 0 and 0 mg/L), Magnesium (0.04, 0.008, 0.01, 0.07 and 0.03 mg/L), Calcium (1.85, 2.30, 2.00, 3.56 and 1.22 mg/L) Total Hardness (33, 44, 48, 35, AND 52 mg/L), Total Alkalinity (45, 38, 50, 68 and 54 mg/L), Potassium (0, 0, 0, 0 and 0 mg/L) and Sodium (38, 22, 28, 30 and 34 mg/L). Microbiological analysis recorded 77, 50, 65, 73 and 69 cfu/ml for total plate count while 0 cfu/ml was obtained for Coliform, E coli, Fungi and Salmonella shigella counts. Physicochemical and microbiological properties of boreholes examined conform satisfactorily to WHO stipulated standards for drinking water. Therefore, water from the boreholes is clean and fits for human consumption.*

Keywords: Boreholes, Physicochemical, Microbiological, Nigerian Industrial Standards and Water quality

1. INTRODUCTION

On a global scale, groundwater represents the world's largest and most important source of fresh potable water [1]. Groundwater provides potable water to an estimated 1.5 billion people worldwide daily [2] and has proved to be the most reliable resource for meeting rural water demand in the sub-Saharan Africa Due to inability of governments to meet the ever-increasing water demand, most people in rural areas resort to groundwater sources such as boreholes as an alternative water resource. Thus, humans can abstract groundwater through a borehole, which is drilled into the aquifer for industrial, agricultural and domestic use. However, groundwater resources are commonly vulnerable to pollution, which may degrade their quality.

Generally, groundwater quality varies from place to place, sometimes depending on seasonal changes [3], the types of soils, rocks and surfaces through which it moves [4]. Naturally occurring contaminants are present in the rocks and sediments. As groundwater flows through the sediments, metals such as iron and manganese are dissolved and may later be found in high concentrations in the water [5]. In addition, human activities can alter the natural composition of ground-water through the disposal or dissemination of chemicals and microbial matter on the land surface and into soils, or through injection of wastes directly into groundwater. Industrial discharges [6], urban activities, agriculture [5], groundwater plumage and disposal of waste [7] can affect groundwater quality. Pesticides and fertilizers applied to lawns and crops can accumulate and migrate to the water tables thus affecting both the physical, chemical and microbial quality of water.

In rural Africa, where the most common type of sanitation is the pit latrines, this poses a great risk on the microbial quality of groundwater. For instance, a septic tank can introduce bacteria to water and pesticides and fertilizers that seep into farmed soils can eventually end up in the water drawn from a borehole. Poor sanitary completion of boreholes may lead to contamination of groundwater. Proximity of some boreholes to solid waste dumpsites and animal droppings being littered around them [7] could also contaminate the quality of groundwater. Therefore, groundwater quality monitoring and testing is of paramount importance both in the developed and developing world [8]. The key to sustainable water resources is to ensure that the quality of water resources are suitable for their intended uses, while at the same time allowing them to be used and developed to a certain extent.

Studies on groundwater pollution have been carried out in different parts of Nigeria [9]. Consistent in their findings is that groundwater is polluted from physical processes and anthropogenic activities. In Nigeria and other developing countries, these hazardous materials are disposed off with municipal solid waste into open dumps and surface water bodies, often used for domestic purposes [10]. When disposed through these routes, toxic substances can leach and eventually contaminate surface and groundwater [11]. In Nigeria, open dumping of municipal solid wastes, is mainly the existing method of waste disposal used even in capital cities except perhaps among few and affluent institutions [12]. Water contamination by Leachate can transmit bacteria and disease, typhoid fever is a common problem for the people of developing nations, many of them cannot afford to dig wells deep enough to reach fresh aquifers [10]. The water quality of borehole is generally neglected based on the general belief that it is pure through the natural purification process. There is inadequate information or knowledge of the quantity, quality and pattern of distribution of Nigeria's water resources.

The quality of the water can be evaluated using the WHO, FEPA, SON and other regulatory agencies guidelines. A guideline value represents the concentration of a constituent that does not result in any significant risk to the health of the consumer over a life time of consumption [13]. Physicochemical and microbiological examination study of water is unavoidably important. It is against this backdrop we are carrying out this study, to determine whether these parameters meet the (WHO) World Health Organization standard for drinkable water, as well as to ascertain the possible causes of any contaminations in order to make appropriate recommendations. The present study is to examine physicochemical and microbiological characteristics of selected boreholes water within University of Ibadan, Oyo State, Nigeria. The results of the study serve as baseline data for water quality study in University of Ibadan, Oyo state in the future.

2. Materials and Methods

2.1 Sample size and Sample Collection

Five samples of ground water (borehole) were collected from University of Ibadan, Oyo state. These areas where the samples were taken includes Tafawa balewa Hall, Department of Microiology, Nnamdi Azikwe Hall, Sultan bello Hall and Abdulsalam Abuakar postgraduate Hall. All samples were collected in sterile glass bottles (1 Litre), stored and transported in a cool box at a very low temperature into laboratory and Physico-chemical analyses were conducted immediately.

2.2 Physical analysis

2.2.1 Test for color

The color of the samples was determined using color test kit (Lovibon comparator, 2000 visual). One tube of the Lovibond comparator matched tube was filled with the water sample to be examined and the other tube was filled with distilled water used as standard control. Both tubes were placed in the comparator, adjusted by rotating the disc until the nearest color match was observed and recorded as Hazen unit [14].

2.2.2 Test for odour

A 20 mL volume of each water sample was poured into a clean beaker. The beaker was then shaken vigorously to check for any frothing and allowed to settle. The beaker was then observed underbright light for presence of any particulate matter and then brought close to the nose to test for any odour present [15].

2.2.3 Test for taste

Small volumes of each sample was tasted with the tongue and then immediately rinsed with taste free distilled water after each sample, the result recorded accordingly.

2.3 Chemical analysis

2.3.1 Determination of Temperature

The temperature of all water samples was determined using a simple mercury-in-glass thermometer calibrated in degrees centigrade as described by Edema *et al*. [16] and Dinrifo *et al* . [14].

2.3.2 Determination of pH

The pH of the water samples was determined using a pH meter (Toledo, MP220). Each water sample was measured into 100 cm^3 beaker and the pH determined by inserting the pH meter probe after standardization into the beaker and taking the reading. Standardization of the meter was ensured after each reading [17].

2.3.3 Determination of Total Dissolved Solids

Total dissolved solids (TDS) for each water sample was determined mathematically as a product of conductivity multiplied by a constant value, 0.6 [18].

TDS = conductivity×0.6

2.3.4 Determination of Turbidity

Turbidity of all water samples was determined using turbidometer (HANA instrument H193703) expressed in whole number as Nephelometric turbidity unit (NTU) as described by other workers [14].

2.3.5 Determination of Conductivity

Conductivity of all samples was determined using a digital conductivity meter model 4520 JENWAY, serial No.01263. The meter was switched on and allowed to warm up for about 15 minutes. It was then standardized with 0.01M KCl solution where a conductivity value of 1413 microsiemen per centimeter was obtained; the electrode was thoroughly rinsed with distilled water and then introduced directly into the samples. The value for each sample was taken [19].

2.3.6 Determination of Chloride (CL)

To fifty ml of the sample five drops of a Phenolphthalein indicator solution was added and neutralized with 0.1 N sulphuric acid to the colorless side of Phenolphthalein. One ml of potassium chromate indicator solution was added before titration with standard silver nitrate solution to the pinkish-yellow end point. A reagent blank titration was carried out in parallel to the sample titration. Chloride concentration was calculated as follows [20]:

Chloride, mg/l = {(A – B) (N) (35.45)/V} × 100

Where,

A= Silver nitrate solution, in ml for sample titration;

B=Silver nitrate solution, used for blank titration (in ml);

N= Normality of the silver nitrate solution; and

V= Sample volume in (ml).

2.3.7 Test for fluoride

Ten (10) millilitres of each water samples was introduced into dry square sample cell and 2cm^3 of SPADNS reagent was added and swirl to mix. After a minute reaction time the absorbance of the samples was read from the spectrophotometer [17].

2.3.8 Determination of Iron (FE)

A cuvette was filled with each water sample plus 0.25% Ortho-Phenanthroline solution (1:10 dilution), and optical density was taken at 510 nm wavelength using Wagtech photometer. From a standard curve, the concentration of Iron in the sample was determined.

2.3.9 Nitrate and Nitrite

This was done using a potable UV-visible spectrophotometer (HACH D 89). Two cuvettes were filled with 10 cm^3 of the water sample and the content of nitraver 5 nitrate reagent powder pillow was added in one cell, stoppered and shaken vigorously for 1 minute, after which it was allowed to stand for five minutes. An amber color developed if nitrate was present and for nitrite, nitraver 3 reagent powder was added and allowed to stand for 5 minutes, pink colour development is an indication of positive nitrite. Absorbance expressed in mg/l was then measured [17].

2.3.10 Determination of Magnesium (MG)

Ten ml of the sample was measured, a pinch of hydroxylamine hydrochloride was added and 5ml of mono-ethanol buffer or (buffer 10) was added, then two drops of Eriochrome black T indicator was added. This was titrated with 0.01 EDTA. The color changes from purple to blue black.

2.3.11 Determination of Calcium (CA)

Ten ml of water sample was measured into a beaker; a pinch of potassium cyanide was added together with a pinch of hydroxylamine hydrochloride. Five ml of eight molar potassium hydroxides was added then a pinch of indicator (Putton and readers reagent) was added and titrated with 0.01M EDTA using a burette. Color changes from brown to green.

2.3.12 Test for Total Hardness

Total hardness of each water sample was determined using a potable UV-visible spectrophotometer (HACH D 89) in which 10 cm^3 of each water sample was pipetted into a sample cell and total hardness reagent H-1K added and allowed to stand for 3 minutes for reaction to take place, after which the total hardness was read [17].

2.3.13 Determination of Total Alkalinity (TA)

Alkalinity determination was done by measuring fifty ml of each sample into a onical flask and two drops of sodium trioxosulphate (ii) added to remove traces of chlorine. Three drops of mrthyl orange indicator was then added and titrated with 0.02N tetraoxosulphate (vi) acid acid in the burette.

Titer value × 20 = Alkalinity (mg/l) [21]

2.3.14 Determination of Potassium (K) and Sodium (NA)

Potassium and Sodium were analyzed with flame atomic absorption spectrophotometer (FAAS) in accordance with APHA 20th edition 31113. Samples were analyzed by direct aspiration in an air/acetylene flame at a specified wavelength for both potassium and sodium [22].

2.4 Determination of Heavy Metals

The following heavy metals; Copper (Cu), Lead (Pb), Arsenic (As), Zinc (Zn) and Cadmium (Mn), were determined for each water sample using Test kits

2.4 Microbiological Analyses

The microbiological quality of the water samples was determined using total viable count and total coliform count as indices. Total viable count was determined by the pour plate method. Ten fold dilution of the water sample was prepared and 0.1 ml of the dilution was poured on nutrient agar plates and incubated at 37^{o}C for 24 h. The plates were examined for growth after incubation and developed colonies counted using a digital colony counter (Gallenkamp, England). Total coliform count was determined on each sample by plating presumptive positive samples on Mac Conkay agar. *E.coli* , *Salmonella shigella* and Fungi counts were determined by plating out on Eosin Methylene blue agar, Mannitol Salt Agar and Potato Dextrose Agar respectively. Incubation was done at 35^{o}C for 48hr.

3. Result and Discussion

3.1 Physical Characteristics of Selected Boreholes water sample

Physical property is one of the determinants of quality of water for human consumption. The physical assessments of water do reflect general acceptability of the water [23]. In this study, physical characteristics such as color, odor and taste were examined in selected water from boreholes within University of Ibadan premises. The result of physical examination of selected boreholes shows that all water samples are clear, colorless and unobjectionable (Table 1).

Table 1: Physical Characteristics of Boreholes Water Sampled At University Of Ibadan, Ibadan Oyo-State

SAMPLE CODE	ODOUR	COLOUR	TASTE
T	Unobjectionable	Clear	Unobjectionable
D	Unobjectionable	Clear	Unobjectionable
N	Unobjectionable	Clear	Unobjectionable
S	Unobjectionable	Clear	Unobjectionable
A	Unobjectionable	Clear	Unobjectionable
STANDARD RANGE	Unobjectionable	Clear	Unobjectionable

Key: T= Tafawa Balewa Hall, D= Department of Microbiology, N= Nnamdi Azikwe Hall, S= Sultan Bello Hall and A= Abdulsalam Abuakar postgraduate Hall.

3.2 Chemical Characteristics of Selected Boreholes water sample

The result recorded for temperature in this study showed that all five boreholes water sample examined are within ambient temperature as stipulated and required by regulatory authority [24]) Table 2.4

The pH obtained in this study ranging from 6.6 to 7.1 (Table 2). This showed that the Boreholes water analyzed in this study are slightly acidic. All the boreholes water examined fit for human drinking because they are within an acceptable pH range for drinking water (6.5-8.5). Therefore, the pH values recorded for different Borehole water samples are in conformity with W.H.O Standard.

The values obtained for Total dissolved solids (TDS) in this work varied between 100 to 250 mg/L (Table 2). The reported values are within the range (0-500 mg/L) of acceptable limit as stipulated by NIS (977:2017) and WHO.

The result of turbidity in this study ranged from 1 to 4 mg/L (Table 2). The recorded values for all water samples from five different boreholes are within the required standard (5 NTU) by NIS (977:2017)

Conductivity in all the Borehole water samples analyzed are below the maximum limits of 1000µs/cm stipulated by NIS (977:2017) standard as it ranges from 105 µs/cm to 330 µs/cm (Table 2). Conductivity values in all Boreholes water analyzed are within the acceptable limit of less than 1000µs/cm and conform to the W.H.O standards for drinking water.

Chloride values in borehole water examined in this study ranged from 0.5 to 3 mg/L (Table 2). The result recorded for all boreholes sample conform satisfactorily to the required regulatory standard (100 mg/L) by NIS (977:2017) and W.H.O specification of 250mg/l for drinking water.

Fluoride content reported for all boreholes analyzed in this work is zero (Table 2). The values observed met 100 mg/L stipulated standard by NIS (977:2017) and WHO for Fluoride specification.

The iron concentration in boreholes tested ranging between 0 and 0.04 mg/L (Table 2). All the samples examined fall within the range (0.3 mg/L) stipulated by NIS (977:2017) and W.H.O specification for drinking water.

Nitrate and Nitrite contents of the water samples from all boreholes examined are zero (Table 2). The values recorded conform to NIS (977:2017) and W.H.O standard (10 and 0.1 mg/L for nitrate and nitrite respectively) and are portable for drinking.

Magnesium content of all the samples of the boreholes water in this study ranges between 0.01 and 0.08 mg/L (Table 2). The obtained results for all samples are within 2 mg/L stipulated standard by NIS (977: 2017) and W.H.O standard for drinking water.

Calcium content in borehole water samples in this study is between 1.85 to 3.56 mg/L (Table 2). All examined samples are in conformity with the required standard of 75 mg/L by NIS (977: 2017) and WHO requirement for drinking water. This shows that the whole samples tested are soft, hence little or no probability of causing hardness. They will produce ladder easily with soap.

The values observed for Total Hardness in this work varies between 33 to 52 mg/L (Table 2). The reported values for borehole water examined are in conformity with NIS (977:2017) standard (100 mg/L) and WHO requirement for drinking water.

Total Alkalinity values observed in this study is between 38 and 68 mg/L (Table 2). All values obtained for the boreholes are within the stipulated standard by NIS (977:2017) and WHO requirements.

The potassium content obtained in this study for all borehole water tested is zero (Table 2). The values recorded are within WHO acceptable standard required for drinking water.

All borehole water analyzed in the present work had sodium with range of 22 and 38 mg/L (Table 2). The observed values are satisfactory with 100 mg/L stipulated by NIS (977:2017) and WHO for drinking water.

Table 2: Chemical Analysis of Boreholes Water Sampled at University Of Ibadan, Ibadan Oyo State

Sample Code		T	D	N	S	A
Parameters	NIS (977:2017)					
Temperature (^{o}C)	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient
pH	6.5-8.5	6.5	6.6	7.1	6.8	7.0
Total Dissolve Solids (mg/L)	0-500	150	250	180	200	100
Turbidity (NTU)	0-5	1	3	2	4	3
Conductivity (µs/cm)	0-1000	105	135	222	330	133
Chloride (mg/L)	0-100	0.7	2	0.5	3	2
Fluoride (mg/L)	0-1.0	0	0	0	0	0
Iron (mg/L)	0-0.3	0.01	0.02	0	0.1	0.04
Nitrate (mg/L)	0-10	0	0	0	0	0
Nitrite (mg/L)	0-0.1	0	0	0	0	0
Magnesium (mg/L)	0-2	0.04	0.08	0.01	0.07	0.03
Calcium (mg/L)	0-75	1.85	2.30	2.00	3.56	1.22
Total Hardness (mg/L)	0-100	33	44	48	35	52
Total Alkalinity (mg/L)	0-200	45	38	50	68	54
Potassium (mg/L)	0-20	0	0	0	0	0
Sodium (mg/L)	0-100	38	22	28	30	34

Key: T= Tafawa Balewa Hall, D= Department of Microbiology, N= Nnamdi Azikwe Hall, S= Sultan Bello Hall and A= Abdulsalam Abuakar postgraduate Hall.

3.3 Level of Heavy Metal in Selected Boreholes water sample

Copper content in borehole water samples examined ranged between 0.1 to 0.6 mg/L (Table 3). The obtained results are within the stipulated standard by NIS (977:2017) and WHO for drinking water. Lead content of the borehole water samples in this study is zero (Table 3). The results are satisfactorily with 0.01 mg/L stipulated by NIS (977: 2017) and WHO for drinking water. The values reported for arsenic in this study is zero for all boreholes examined. The recorded zero value is within the WHO standard stipulated for drinking water. Zinc concentration of borehole water in this study varies between 1 to 3 mg/L (Table 3). All the samples are within the range of W.H.O specification for drinking water. The result reported for Cadmium ranged between 0 and 0.02 mg/L and fall within 0.03 standards required for drinking water.

3.4 Microbiological analysis of Selected Boreholes water sample

The findings from this study showed that the following results were recorded for microbial Total plate count of the water samples from borehole; Tafawa Balewa Hall (77 cfu/ml), Department of Microbiology (50 cfu/ml), Nnamdi Azikwe Hall (65 cfu/ml), Sultan Bello Hall (73 cfu/ml) and Abdulsalam Abuakar postgraduate Hall (69 cfu/ml). All the values observed for the respective borehole are in conformity with maximum 100 cfu/ml stipulated for drinking water (Table 4). The values for Coliform count, E coli count, Fungi count and Salmonella shigella counts are within the regulatory standards for drinking water as they all recorded zero which is permissible level.

Table 3: Level of Heavy Metal in Water Sampled from Boreholes at University Of Ibadan, Ibadan Oyo State

Sample Code Parameters	NIS (977:2017)	T	D	N	S	A
Copper (mg/L)	1	0.4	0.1	0.6	0.3	0.4
Lead (mg/L)	0.01	0	0	0	0	0
Arsenic (mg/L)	0.01	0	0	0	0	0
Zinc (mg/L)	5	2	1	1	3	2
Cadmium (mg/L)	0.03	0.01	0.01	0	0.02	0.02

Key: T= Tafawa Balewa Hall, D= Department of Microbiology, N= Nnamdi Azikwe Hall, S= Sultan Bello Hall and A= Abdulsalam Abuakar postgraduate Hall.

Table 4: Microbiological Properties of Water Sampled from Boreholes at University Of Ibadan, Ibadan Oyo State

Sample Code	Total Plate Count (cfu/ml)	Coliform count (cfu/ml)	*E.coli* (cfu/ml)	Fungi (cfu/ml)	Salmonella shigella (cfu/ml)
T	77	Nil	Nil	Nil	Nil
D	50	Nil	Nil	Nil	Nil
N	65	Nil	Nil	Nil	Nil
S	73	Nil	Nil	Nil	Nil
A	69	Nil	Nil	Nil	Nil
NIS (977:2017) LIMIT	100	Nil	Nil	Nil	Nil

Key: T= Tafawa Balewa Hall, D= Department of Microbiology, N= Nnamdi Azikwe Hall, S= Sultan Bello Hall and A= Abdulsalam Abuakar postgraduate Hall.

Conclusion

Prompt monitoring and regular assessment of quality of water is essential key to ensure conformity to Nigerian Industrial Standard and World Health Organization Standard. This will also serve as signal and assurance to general public on necessity for quality, portable and hygienic water. All the physicochemical, heavy metals and microbiological parameters examined for all five boreholes within University of Ibadan premises conform satisfactorily with required stipulations for drinking water. Hence, the water from boreholes is quite clean, and safe for human consumption.

5. ACKNOWLEDGMENT

Special appreciation goes to Almighty for the success of this research. We are also grateful to the members of our family for understanding, supports, prayer during the course of this work.

6. REFERENCES

[1] Howard, K.W.F. Impacts of urban development on groundwater. In *Environmental Geology of Urban Areas*; Geotext 1997; Eyles, E., Ed.; Special Publication of the Geological Association of Canada: St. John's, Nfld, Canada, 1997; Volume 3, pp. 93–104

[2]Department of International Development: London, UK, 2001. MacDonald, A.M.; Davies, J. *A Brief Review of Groundwater for Rural Water Supply in Sub-Saharan Africa*; British Geological Society: Nottingham, UK, 2002.

[3]Trivede, P.; Bajpai, A.; Thareja, S. Comparative study of seasonal variations in physico-chemical characteristics in drinking water quality of Kanpur, India with reference to 200 MLD filteration plant and groundwater. *Nat. Sci.* **2010**, *8*, 11–17.

[4] Seth, O.N.; Tagbor, T.A.; Bernard, O. Assessment of chemical quality of groundwater over some rock types in Ashanti region, Ghana. *Am. J. Sci. Ind. Res.* **2014**, *5*, 1–6.

[5] Moyo, N.A.G. An analysis of the chemical and microbiological quality of ground water from boreholes and shallow wells in Zimbabwe. *Phys. Chem. Earth*. **2013**, *66*, 27–32.

[6] Govindarajan, M.; Senthilnathan, T. Groundwater quality and its health impact analysis in an industrial area. *Int. J. Curr. Microbiol. App. Sci.* **2014**, *3*, 1028–1034.

[7] Bello, O.O.; Osho, A.; Bankole, S.A.; Bello, T.K. Bacteriological and physicochemical analyses of borehole and well water sources in Ijebu-Ode, Southwestern Nigeria. *Int. J. Pharm. Biol. Sci.* **2013**, *8*, 18–25.

[8] Nash, H.; McCall, G.J. *Groundwater Quality*; Chapman & Hall: London, UK, 1994.

[9] Adekunle, I. M. M., Adetunji, M. T., Gbadebo, A. M., and Banjoko, O. B., Assessment of groundwater quality in a typical rural settlement in south west Nigeria. *Int. J. Res. Pub. Health,* **4:**307-315 (2007).

[10] Onwughara, I. N., Nnorom, I. C., and Kanno, O. C., Issues of roadside disposal habit of municipal solid waste, environmental impacts and implementation of sound management practices in developing country: Nigeria. *International Journal of Environmental Science and Development*, **1(5):** 409-417 (2010).

[11] Onwughara, I. N., Umeobika, U. C., Obianuko, P. N., and Iloamake, I. M., Emphasis on effects of storm runoff in mobilizing the Heavy metals from leachate on Waste Deposit to contaminate Nigerian Waters: Improved Water Quality Standards. *International Journal of Environmental Science and Development*, **2(1):** 55-63 (2011).

[12] Okoye, C. O., and Okoye, A. C., Urban Domestic Solid Waste Management. Nimo: Rex Charles and Patrick Limited Awka, pp.5-7 (2008).

[13]WHO 1999.. *Guidelines for Drinking Water Quality*. Vol. 1 Geneva. Addendum to the 3rd Vol. 1 Recommendations. World Health Organization. pp. 23-48.

[14] Dinrifo, R. R.; Babalunde, S. O.; Bankole, Y. O. and Demu, Q. A., (2010): Physicochemical properties of rain water collected from some industrial areas of Lagos State, Nigeria. European Journal of Scientific Research 41(3): 383 – 390.

[15] Yakassai, I.A., (2009) Analysis and production of packaged water, Pressma printing and publications, Nigeria, 30-41.