Quality Assessment of some selected Boreholes Water from Federal University Dutse. Jigawa State, Nigeria.

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Abstract

Study of water quality tells about present status of useable water for domestic as well as industrial use. Indiscriminate and wasteful water consumption and improper waste disposal practices have led to deterioration in the water quality. This study was aimed to determine water quality parameters in borehole water Samples from four different boreholes in Federal University Dutse. The water Samples were collected and analysed using different types of analytical techniques. The parameters analysed include; Electrical conductivity, Turbidity, pH, calcium hardness, magnesium hardness, total hardness, Acidity, Chloride, Nitrate, Alkalinity, And some Heavy metals using standard methods of analysis. The data provided by this investigation will be useful in designing water quality management issues. All the water samples analyzed were moderately hard water, thus the waters are suitable for domestic use. Moreover, the results showed that borehole water yield water of very moderate water quality. The results from this study clearly demonstrate that the water quality obtained from boreholes are fit for human consumption but requires more treatments for safe in take.

Keywords: Physicochemical parameters, analytical techniques, Boreholes water.

INTRODUCTION

Water is one of the most important of all natural resources known on earth. It is important to all living organisms, ecological systems, human health, food production and economic development. The safety of drinking water is important for the health. The safety of drinking water is affected by various contaminants which included chemical and microbiological. Such contaminants cause serious health problems. Due to these contaminants quality of drinking water becomes poor. Sometimes such poor quality water causes many diseases in the humans, so that quality of water must be tested for both the chemical as well as for the microbial contaminants. Water is abundant in nature and is an important part of the earthly environment, covering about (75%) of the earth surface. It occurs as surface water in lakes, streams, rivers, ponds, shallow aquifers, oceans, seas, ice caps, glaciers, etc, and as ground water (when it accumulates in the ground) which is obtained as spring water, well water, and borehole water (Chandra *et al*, 2012). Small amount of gases like N_2, O_2 and CO_2 in the atmosphere are contained in all natural water (Borne, 1978). Water is made up of two element, hydrogen and oxygen and is the most popular solvent as it has the ability to dilute many chemicals. Water also has tremendous heat absorbency and plays an important role in the physiology of both flora and fauna (plant and animals) and also in their metabolic processes (Golterman, 1978). Water takes part in many reactions including those with complex organic compound like amino acids. It is vital in industrial and manufacturing activities and various agricultural aspects, especially irrigation. Water is essential natural resources as it is impossible for life to exist without water and most manufacturing industries cannot function in its absence. Historically, (Okonkwo *et al.*, 2009) water scarcity has led to severe conflict, migration and change in agricultural patterns. Water, after air, is the most essential commodity to the survival of life. Human life depends to a large extent on water. It is used for an array of activities; chief among these being for drinking, food preparation, as well as for sanitation purposes.

Water is a fundamental resource, integral to all environmental and social processes. Access to adequate safe drinking water is of prime importance to many governmental and international organizations. It is the core component of primary health care and a basic component of human development as well as a precondition for man's success to deal with hunger, poverty and death (SOPAC/WHO, 2005). There is a growing concern everywhere that in the coming century, cities will suffer imbalances in quality water supply, consumption, and population. Many regions of the world are already limited by the amount and quality of available water

The rapidity with which cities are growing is frightening in the sense that human population with its associated sanitation problems will grow faster than increases in the amount of accessible quality water (Jackson *et al*, 2001). The growing demands for adequate quality water resources create an urgent need to link research with improved water management, better monitoring, assessment, and forecasting of water resources and sanitation issues with much emphasis on the roles of stakeholders (Yamaguchi & Wesselink, 2000). It must however be emphasized that adequate water quality needs seem to have improved greatly in some regions and countries especially in the developed world but for poor nations this is still a major issue (Stockholm International Water Institute, SIWI, 2001). As observed by WHO-UNICEF (2004), while in 2002, countries like Japan, Australia, Austria, Switzerland and

Sweden had achieved hundred percent, others, such as countries in sub Saharan Africa are far below 50%. For instance, Guinea 6%, Liberia 7%, Niger 4%, Togo 15%, and Ghana 46%.The problems also prevent millions of people from leading healthy lives, and undermine developmental efforts by burdening the society with substantial socio-economic costs for treatment of water-borne diseases. This problem is of great significance in cities in developing countries, where polluted water, water shortages, and unsanitary living conditions prevail. WHO/UNICEF (2004) says although access to water has improved greatly, access to safe water is still a major issue. The source quoted that about some 1.1 billion people rely on unsafe drinking water sources in developing countries and the lowest drinking water coverage rates are in sub Saharan Africa (58%) with a corresponding low sanitation coverage rates (36%) which leads to many deaths especially among children through diarrhoea among other water-related diseases. Sources of water available to mankind are: atmospheric water (precipitate), surface water (including rivers, streams, ponds, etc), and ground water. The portability of water from any of these sources is determined by the water quality (Miller, 1997). With 97% of all freshwater found on the earth being stored underground, accessing ground water in the quest for potable water is a laudable venture. Groundwater is accessed by way of sinking wells and boreholes to reach the water table (Overseas Development Institute, 2009). Potable water is defined as water that is free from pathogens, low in compounds that are acutely toxic or that have grave long-term effects on human health. Potable water should be free from compounds that can cause change in the 'normal' colour, taste (e.g. high salinity) and odour. Shallow wells are normally located in valleys where the groundwater.

MATERIALS AND METHOD

MATERIALS:

Digital pH Meter (Systronics), Digital Conductivity Meter, Conical flask, pipette, calorimeter, and photometre was used during this research.

REAGENTS: Buffer Solution, Eriochrome black ,EDTA. Phenolpthalein indicator,Na_2CO_3,0.1M NaOH Meroxide, methyl orange, 0.1M HCL,K_2CrO_4,Silver nitrate, Sample cell, Sulfaver 4, Zinc tablet, Hexavalent chromium powder pillow, curver1Cupper Reagent Powder Pillow, Nitraver5 and Nitrate reagent powder pillow

3.2 METHOD

The major water quality parameters considered for the examination in this study are pH, colour, taste, turbidity, total hardness, and alkalinity. The Water Samples were collected from four different places at Federal University Dutse. The Water samples were immediately brought to Laboratory for the estimation of various Physico-chemical Parameters like taste, colour and turbidity using Turbidity metre. Electrical conductivities were measured by using digital conductivity meter. While other Parameters Such as Nitrate, Magnesium, heavy metals (zinc, copper, chromium), Hardness, free CO_2, Calcium and Chloride, were estimated in the Laboratory by using Standard laboratory methods. Present Study involves the Analysis of Water Quality in Terms of Physico-chemical methods. (Trivedy and Goyal, 1986 APHA 1985).\

Determination of pH and Conductivity

Non-conservable parameters such as temperature, pH and electrical conductivity were determined at the time of sampling in the field. The pH of the sample was measured with a pH meter that had been calibrated with buffer solutions and conductivity was measured with a conductivity meter calibrated with potassium chloride solution.

Determination of Heavy Metals

Heavy metals (Cr, Cu, Zn, Pb, and Cd) were determined by digesting a known volume of effluent sample with analytical grade HNO_3. The digested effluent was filtered into 20ml standard flask made up to the mark with distilled de-ionised water, and stored in a refrigerated nitric acid pre-washed polyethylene bottle prior to chemical analysis. The effluent extracts were analysed for metals with HACH Spectrophotometer. Each sample was analysed in triplicate and average of the results taken. General laboratory quality assurance measures were always observed to prevent sample contamination and instrumental errors. The water used throughout the experiment was doubly distilled in an all glass distiller before it was de-ionised. Wavelength setting of spectrophotometers used was done daily by standard instrumental procedure and other equipment used was always calibrated against reference standards.

Determination of Chromium

Total chromium was determined by alkaline hypobromite oxidation method (APHA, 1985). Sample cell container (25ml) was filled with the sample the prepared sample. The content of one Chromium 1 Reagent Powder Pillow was added to the sample, stoppered and swirled to mix. The sample was placed into boiling water bath and allowed to stand for five minutes and then cooled to 25^{O}C with running tap water. The content of one Chromium 2 Reagent Powder Pillow was added to the sample, and swirled to mix. The contents of one Acid Reagent Powder Pillow were added to the sample, and swirled to mix. The contents of one Chroma ver 3 Reagent Powder Pillow were added to the sample, and swirled to mix. The sample was allowed to stand for five minutes for a purple colour to develop. A second sample cell was filled with the sample only and served as blank. The concentration of chromium in the prepared sample was then measured in mg/l at a wavelength of 100nm.

Determination of Copper.

Copper was determined by a Bicinchoninate method (USEPA, 1996). A sample cell was filled with 10ml of sample. The content of one cuver 1 Copper Reagent Powder Pillow was added to the sample (the prepared sample). The sample was allowed to stand for two minutes for a purple colour to develop. A second sample cell was filled with the sample (the blank). The concentration of copper in the prepared sample was measured in mg/l at wavelength of 135nm.

Determination of Zinc

Zinc was determined by Zincon method (APHA, 1985; USEPA, 1996). A 25ml graduated mixing cylinder was filled with 20ml of the sample. The contents of one Zinco ver 5 Reagent powder Pillow were added to the sample, stoppered and inverted several times to dissolve the powder. The solution (10ml) was measured into sample cell (the blank). Cyclohexanone (0.5ml) was added to the remaining in the mixing cylinder, then stoppered and shaken vigorously for 30 seconds (the prepared sample). The sample was allowed to stand for 3 minutes for red-orange, brown or blue colour to develop. The concentration of Zinc in the prepared sample was measured in mg/l at wavelength of 780nm.

Determination of Calcium and Magnesium

Calcium and magnesium were determined by Calmagite colorimetric method (APHA, 1985). The sample (100ml) was poured into 100ml graduated cylinder. Calcium and Magnesium indicator was added into the sample, stoppered and inverted several times to mix. Alkali solution (1ml) for calcium and magnesium test was added into the sample, stoppered and inverted several times to mix. The solution (25ml) was poured into each of the three sample cells. EDTA (1M) was added to one cell (the blank) and swirled to mix. EGTA solution was added to another cell (the prepared) and swirled to mix. The concentrations of calcium and magnesium were measured at wavelength of 220nm and 225nm respectively.

Result and Discussions

The results of the Borehole water physicochemical analysis were compared with the World Health Organization (WHO, 2006) standards.

Overall descriptive analysis of the results is shown in the Table 1 below:

Table 1 Results of Chemical Analysis of Borehole water sample

S/N	Parameters	WHO Limit	Male Hostel	Female Hostel	Senate Building	Faculty of Science
1	Total Hardness (mg/L)	150	82.3	104.7	59.8	89.78
2	Chloride (mg/L)	200	44	20	18	16
3	Free CO_2 (mg/L)		20	46	30	42
4	Calcium (mg/L)	100	41.5	21.63	34.25	36.05
5	Alkalinity (mg/L)	150	83.3	75	48.3	66.6
6	Acidity (mg/L)	150	20	20	22	28
7	Magnesium (mg/L)	150	35	64	23	44
8	Nitrate (mg/L)	10	0.56	0.50	0.33	0.37
9	Sulfate (mg/L)	100	15	5	6	3

10	pH	6.5-8.5	7.0	7.2	6.6	6.6
11	Copper (mg/L)	1	0.17	0.02	0.02	0.18
12	Chromium (mg/L)	0.05	0.03	0.04	0.07	0.02
13	Zinc (mg/L)	3	0.21	0.00	0.00	0.00

TABLE 2 Results of physicochemical analysis of Borehole water samples

S/N	Parameters	WHO Limit	Male Hostel	Female Hostel	Senate Building	Faculty of Science
1	Turbidity (NTU)	5	0	1	4	3
2	Conductivity(μs/cm)	1000	5867	504	644	759
3	Taste	-	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable
4	Colour(Hazen)	6	5	5	5	10

4.2 Discussions

The result of the pH obtained ranged between 6.6 to7.2, the values fall within the standard range provided by WHO. In the case of turbidity, the values ranged between 0 to 4 NTU, which are below the limit 5 NTU.. Also, the value obtained from determinations of chromium falls within standard limit but that of zinc was below .The conductivity values in this study area of all four boreholes ranged between 504 us/cm to 759 us/cm falls within the standard limit prescribed by WHO.

The values obtained for chloride ranged from 16mg/L to 44 mg/L. These values obtained are well below the recommended standard value of 200 mg/L by WHO; they are also within the range of values reported by Obi and Okocha (2007). Nitrate values in the samples ranged from 0.33 to 0.56 mg/ L. The values are below the WHO recommended limit of 10.0 mg/ L. Methemoglobinemia is a disease caused by nitrate, which is converted to nitrite in the intestines (Adeyomo et al.,2002). The safe nitrate limit for domestic water is set at 45mg/l (WHO 1998). Nitrate cannot be removed from water by boiling but must be treated by distillation (Maureen et al., 2012). Ca^{2+} and Mg^{2+} values obtained for the water samples ranged from 21.63 to 41.5 mg/L. They fell far below WHO standard. Ca and Mg are among the general elements essential for human health and metabolism and should be available in normal drinking water (Kolo, 2009). However, if one or more of these elements occur in the water above certain limits, the water may become objectional to consumers and even become hazardous to health.

The alkalinity values of all four samples ranged between 83.3mg/ L to 43.3mg/ L, falls within the standard range provided by WHO. The result of the acidity obtained , ranged between 28 mg / L to 20 mg / L correspond to that of (Onwughara et al., 2013).

However, the values of sulphate and copper indicated the good quality of Water while the colourless property of water indicated the absence of transition metals, the Odourless nature is due to absence decayed plants/animals and tasteless due to the absence of Salts of group i and ii. The World Health Organization (WHO) International Standard for Drinking Water (1984) classified water with a total hardness of $CaCO_3$ less than 50 mg /L as soft water, 50 to 150 mg /L as moderate hard water and water hardness above 150 mg /L as hard $CaCO_3$. Based on this classifications, all the water samples analyzed are moderately hard water, thus the waters are suitable for domestic use in terms of hardness. This is because moderately hard water is preferred to soft water for drinking purposes as hard water is associated with low death rate from heart diseases (Onwugwara et al., 2013). The hardness value of 81 indicated that the borehole water of F.U.D is safe for human's consumption and other laundry activities (can form lather easily with soap due to low/absent of $MgCaCO_3$).

Conclusion

The result obtained during study was compared with WHO standards. Borehole water is safe enough to be consumed by humans or used with low risk of immediate or long term harm. After physicochemical analysis we found that the sample of borehole water and is free from pollution & ecologically balanced. The hardness value of 81 indicated that the borehole water of F.U.D is safe for human's consumption and other laundry activities (can form lather easily with soap due to low/absent of $MgCaCO_3$). All the water samples analysed were moderately hard water, thus the waters are suitable for domestic use.

Moreover, the results showed that borehole water yield water of very moderate water quality. The results from this study clearly demonstrate that the water quality obtained from boreholes are fit for human consumption but requires more treatments for safe in take.

5.2 Recommendations

Borehole water contamination often correlates with areas of poor hygienic standards and sanitation. Minimizing faecal pollution of wells within communities must be an integrated approach. Developing sound water resource management programmes will be crucial to poverty reduction, economic growth, food security and maintenance of natural systems. The following recommendations are made:

I. More surveys of water quality analysis should be carried out in the university.

II. A fitting water purification method for purifying water from borehole needs to be developed for the area of study as soon as possible.

III. Household treatment such as boiling should be encouraged before water from these wells is used for drinking purposes.

IV. The F.U.D staffs managements should organise awareness to students for proper water in -take and hygiene.

REFERENCE

Ademorati, C. M. A. (1996).Environmental chemistry and toxicology, foludex press Ltd Ibadan, Nigeria p. 218.

Adeyemo, O., Ayodeji, I., and Aiki-Raji, C.,(2002). The Water Quality and Sanitary Conditions in aMajor Abbatoir (Bodija) in Ibadan, Nigeria.*Africa Journal of Biomedical Research*. IbadanBiomedical Communications Group, (1-2), 51-55.

APHA-AWWA-WPCF (1985). Standard methods for the examination of water and waste water. APHA-AWWA-WPCF. Washington DC.

Borne, R. A. (1978); the Chemistry of our Environment , J Wiley & Sons, Inc., NY . 2nd Ed. Pp. 187-189.

Chandra, S; Singh, A.; Tomar, P. K. Assessment of water quality values in Porur Lake Chennai, Hussain Sagar Hyderabad and Vihar Lake Mumbai, India. *Chem. Sci. Trans.* 2012, *1*: 508-515.

Golterman, H.I. (1978). Methods for Physical and Chemical Analysis of Fresh Waters, Billing and Sons Ltd. U.S.A. 2nd Ed. P.25

Hach, C. (1997). Spectrophotometer Manual, Colorado USA, pp 250.

Hach, C. (1996). Conductivity meter Manual, Colorado USA,pp 12.

Jackson, R.B., Carpenter, S.R., Dahm, C.N., McKnight, D.M., Naiman, R.J., Postel, S.L. & Running, S.W. (2001).Water in a changing world.Issues in Ecology. Ecological Society of America, USA, 9, p. 14.

Kolo, B., Dibal J. M., and Ndakawa, I. I.(2009).Elemental Analysis of Tap and Borehole Waters inMaiduguri, Semi Arid Region, Nigeria.*European Journal of Applied Sciences*, 1(2):26-29.

Maureen, B. N., Anttoniette, N. O., and Afolayan, J. A.,(2012). Physico-chemical and microbiological assessment of borehole water in Okutukutu, Bayelsa State, Nigeria. *Advances in Applied ScienceResearch*, 3 (5):2549-2552

Onwughara, N.I. Ajiwe, V.I.E and Nnbuenyi, H.O.(2013).Physico-chemical Analysis of Drinking Water.International Journal of Pure &Applied Biosci.1(3):34-44. Nations, New York.

Obi,CN.Okacha,C.O.(2007).Microbiology and Physicochemical Analysis of Selected Borehole Waters.Jornal of Engineering And Applied Science.25(7):920-929.

Obuobie, E., & Barry, B. (2010). Groundwater in Sub-Saharan Africa: Implications for food security and livelihood – Ghana Country Status on Groundwater: Final Report.

Okonkwo IO, Ogunjobi AA, Kolawale OO, Babatunde S, Oluwole I, Ogunnusi TA, Adejoyi OD, Fajobi EA (2009). Comparative Studies and Microbial Risk Assessment of a Water Samples Used for Processing Frozen Sea foods in Ijora- Olopa, Lagos State, Nigeria.EJEAFChe. 8(6): 408-415.

OverseasDevelopment Institute (2009). Background Note: What will climate change mean for groundwater supply in Africa? Westminster Bridge Road, London.

SOPAC/WHO (2005). Drinking Water Quality in the Pacific Island Countries: Situation Analysis and Needs Assessment. World Health Organisation, Geneva, Switzerland.

StockholmInternational Water Institute (SIWI) (2001). Water management in developing countries – Policy and priorities for EU development cooperation.Stockholm International Water Institute, Stockholm, Sweden.p.7.

Trivedy, R. K. and Goel P. K. (1986): Chemical and Biological Methods for Water Pollution Studies, Environmental Publication, Karad, Maharashtra Kaushik.

United States Environmental Protection Agency (USEPA) (2000). 2000 National Water Quality Inventory.

United States Environmental Protection Agency (USEPA) (1996). Environmental indicators of Water Quality in the United States. pp 841.

United States Environmental Protection Agency (USEPA) (1995). 1994 National Water Quality Inventory Report, pp 97.

United States Environmental Protection Agency (USEPA) (1989). Is your drinking water safe? pp 89-105.

WHO (2001).Water Quality. Guidelines, Standards and Health: Assessment of risk and risk

WHO (2003). Iron in Drinking Water. Background document for Drinking Water Quality. Geneva,

WHO/UNICEF (2000).Global Water Supply and Sanitation Assessment 2000 Report. United

WHO/UNICEF (2004). Joint Monitoring Programme for Water Supply and Sanitation; Meeting the MDG drinking water and sanitation target: a mid-term assessment of progress. Geneva, Switzerland.

WHO Guidelines for drinking-water quality, vol. 1: Recommendations, 2nd ed. Geneva, Switzerland: World Health Organization, 1993.

Woke GN, Bolaji. B.B. Assessment of Ground Water Quality in Emohua Lga, Rivers State, Nigeria l .J Nat Sci Res.2015:5(24).

World Health Organisation (WHO), Guidelines for Drinking water quality, Recommendations Geneva, Switzerland (1984).

World Health Organisation. (WHO/SDE/WSH/03.04/8)WHO(2004). Guidelines for Drinking-Water Quality, Vol. 1, third ed. World Health Organisation, Geneva, Switzerland.