Australian Journal of Basic and Applied Sciences, 5(9): 418-425, 2011
ISSN 1991-8178

Physicochemical Analysis of Well-water Samples from Villages in Bwari Area Council-abuja, Nigeria

Yisa, J., Jimoh, T. and Okolo, M.

Department of Chemistry, Federal University of Technology, Minna, Niger State, Nigeria

Abstract: This study involved the determination of the trace metals and some physiochemical properties in well-water samples taken within selected villages in Bwari Area Council, Abuja, where well water samples are not treated before consumed. The purpose was to ascertain the quality of water from these sources. The collected water samples were subsequently analyzed for the following parameters: Na, K, Ca, Zn, Cl, Mg, and SO_4^{2-}, using APHA standard methods of analysis. The data showed the range in variation of the investigated parameters in samples as follows: pH 6.2-6.7, electrical conductivity, 90-570µs/cm, total alkalinity 48-66 mg/L, total hardness 40-60 mg/L , Na 26-542 mg/L,K 56-218 mg/L, Ca 0.44-2 mg/L, Cl^- 29.82-45.44mg/L, SO_4^{2-} 7.7-14.7 mg/L, and Mg 1.01-3.64 mg/L. The concentrations of most of the investigated parameters in the well water samples from these villages were within the permissible limits of the World Health Organization drinking water quality guidelines except sodium and potassium. The linear correlation test conducted indicated that Electrical conductivity, chloride, pH and total alkalinity were slightly correlated.

Key words: Physicochemical characteristic, Water Quality assessment, Bwari

INTRODUCTION

Good drinking water quality is essential for the well being of all people and this has been observed as the most important material required to sustain life (Akoto and Adiyiah, 2007). It is a key determinant of sustainable development that should be carefully managed to make for suitable and sustainable human health (Ogunnowo, 2004). Because of these essential role played by water in supporting human life, it also has a great potential for transmitting diseases and illnesses if contaminated (Ramakrishnaiah *et al*., 2009). Today, major health problems are connected with poor water quality, as it is estimated that over 6 million children die annually as a result of water borne disease (TWAS, 2002). Population growth, coupled with other factors such as urbanization, agricultural activities, industrial and commercial processes etc., has resulted in the accumulation of wastes and pollutants which end up in water bodies, thereby polluting them (Okeke and Igboanua, 2003). The groundwater sources are degraded gradually, therefore pure, safe, healthy and odorless drinking water is a matter of deep concern (Sharma *et al*., 2005). In many countries around the world, including Nigeria, there seems to be inadequate and improper planning which have led to indiscriminate actions including the dumping of waste into rivers, streams, road sides, which through seepage can get into wells. Indiscriminate dumping of waste can be serious in cities lacking efficient waste disposal system or treatment plants, and this we found in Bwari area Council, Abuja.

However, the uncontrolled industrial resolution in Nigeria also created a lot of water pollution problems through discharge of potentially toxic substances and other harmful material into water. It is important to know that high concentrations of these toxic materials are known to be harmful to human health even if no sources of anthropogenic contamination exist. The deleterious and detrimental effects of chemical contaminants (including heavy metals), to the existence of man leading to deteriorating health and sometimes death cannot be overemphasized (Duru *et al.*, 2008).

Further more, the effects water pollution has on man are elaborate and need to be noted. Research conducted in the United Kingdom shows that most polluted well waters are very harmful for drinking/domestic purpose (Devi *et al*., 2003). The study of environmentally polluted water in particular, has been of considerable importance not only to Analytical Chemist, but also to Engineers, Hydrologists and pathologists. Since most of these contaminants pose great threat to man's life due to lack of proper water quality monitoring and

Corresponding Author: Yisa, J., Department of Chemistry, Federal University of Technology, Minna, Niger State, Nigeria
E-mail: teejayola01@yahoo.com, jimohishola8@gmail.com

evaluation. Analysis of natural water for physical and chemical properties are therefore becomes important for public health studies (Kot *et al.,* 2000; Soylak *et al*., 2002a). Portable water supply is the responsibility of government, unfortunately this is not always met most especially in developing countries like Nigeria which in most cases, have been characterized by low productivity, inefficient service delivery compounded by limited technology, insufficient technical inputs and poor maintenance culture (Amoo and Amuho, 2005).

According to literature review, there has been no published report concerning the well water quality assessment of most villages in Bwari area council of Abuja, one of the satellite towns within the Federal Capital Territory. As a result of this, rapid increase in population without a corresponding expansion of social amenities, such as portable pipe borne water supply lead to persistent scarcity of clean and safe drinking water (Soylak *et al*., 2002b). This has made inhabitants of Bwari Area Council and environs to resort to well-water as alternative sources of drinking water. The need to assess the state and quality of this water source becomes imperative in view of the health implications. Therefore, the present study was undertaken to determine some physico-chemical parameters so as to ascertain the quality of well- water considered for human consumption and determine its suitability so as to avoid endangering the populace.

MATERIALS AND METHODS

Sampling and Samples Preservation:

The well water samples were collected from ten different villages namely (Ushafa, Dutse Alhaji, Dutse makaranta, Mpape, Kubwa I, Kubwa II, Bwari, Galadima, Byazhin and Jogo).The samples were stored in clean polyethylene bottles previously washed with concentrated HNO_3 and later rinsed with samples water. Samples for elemental analysis such as trace metals was acidified with 2M HNO_3 of high purity. This was to ensure stability of the samples, maintain the oxidation state of the elements and prevent metals from adhering to the walls of the containers.

Laboratory Analysis:

Method described by American Public Health Association, (1998) was adopted in the analysis. pH and electrical conductivity were determined with a Consort digital pH meter and Consort digital conductometer respectively. Both were determined at the point of collection of the samples. Total alkalinity (TA) was determined by acid-base titration, Total Hardness (TH) was by EDTA titration, Chloride content was done using Mohr’s method. Trace metals such as sodium ions and potassium ions were determined with Flame photometer (Gallenkamp flame analyser, UK) while calcium ions and magnesium were by EDTA titration. Sample blanks were run for all the analyses.

Statistical Analysis:

The statistical analysis was done for correlation using SPSS 12:0. A linear correlation test was performed to investigate correlations between physico-chemical parameters as shown in Table 3. The whole data were subjected to statistical analysis and correlation matrices were produced to examine the interrelationships between the investigated parameters. Correlations between physic-chemical parameters in water samples have been widely studied by a number of authors (Akoto and Adiyiah, 2007; Ramakrishnaiah *et al*., 2009).

Results:

Table 1: Summary of the Physicochemical Properties of Well-water samples from villages in Bwari Area Council, Abuja

Parameter	Min	Max.	Mean	Std.Deviation
pH	6.2	6.7	6.5	0.1
Electrical conductivity (µmhos/cm)	90	570	305	16.7
Total alkalinity	48	66	55	8.1
Total hardness	40	60	51	7.1
Sodium	226	542	387	95.0
Potassium	56	218	98	48
Calcium	0.44	2.00	1.2	0.54
Chloride	29.82	45.44	38.06	5.63
Sulphate	7.7	14.7	11.2	3.0
Magnesium	1.01	3.64	1.93	0.65

All units are in mg/L except pH and electrical conductivity

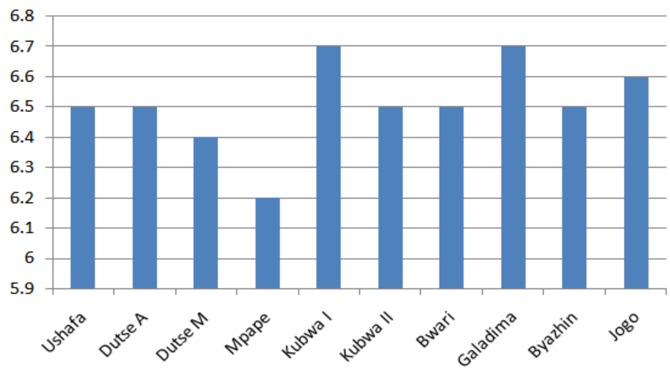

Fig. 1: Variation in Mean Water pH of villages in Bwari Area Council, Abuja.

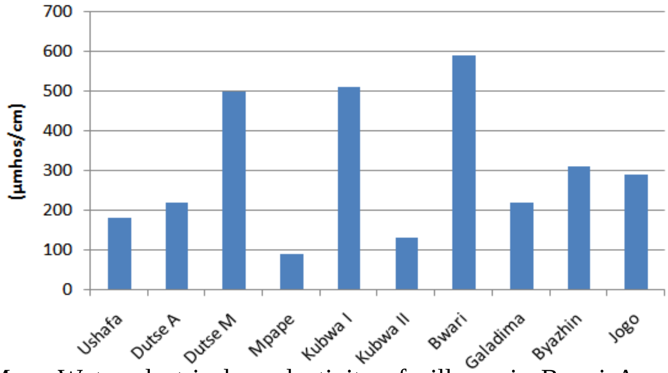

Fig. 2: Variation in Mean Water electrical conductivity of villages in Bwari Area Council, Abuja.

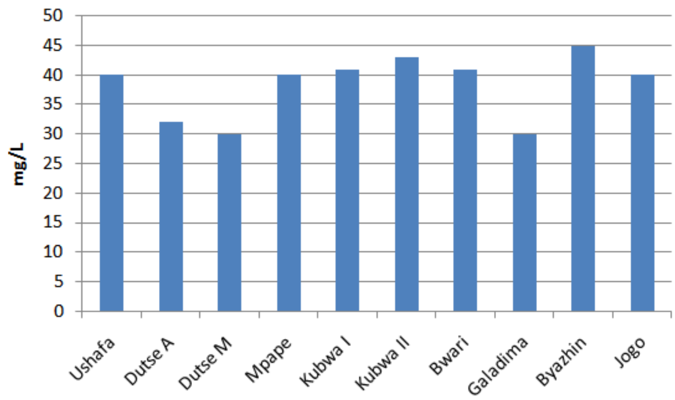

Fig. 3: Variation in Mean Water Chloride of villages in Bwari Area Council, Abuja.

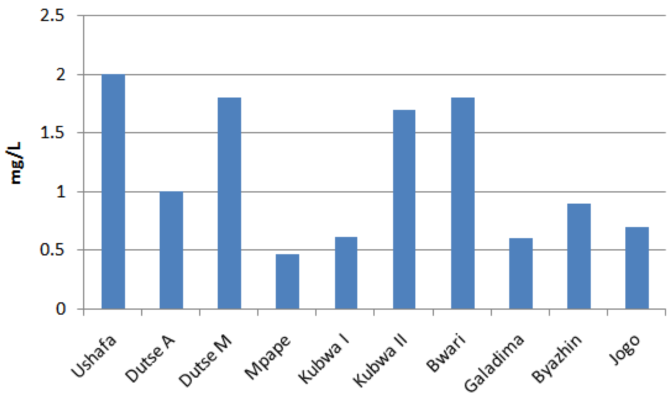

Fig. 4: Variation in Mean Water Calcium of villages in Bwari Area Council, Abuja.

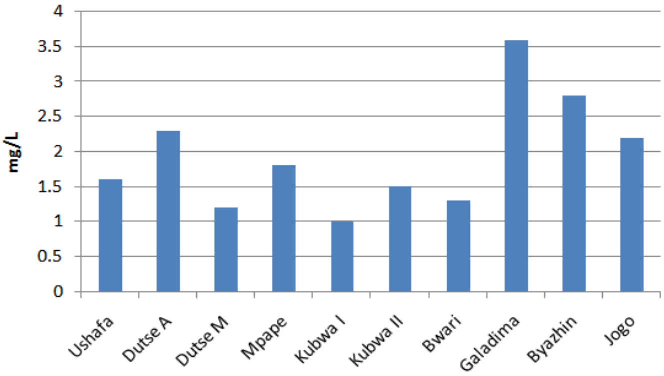

Fig. 5: Variation in Mean Water Magnesium of villages in Bwari Area Council, Abuja.

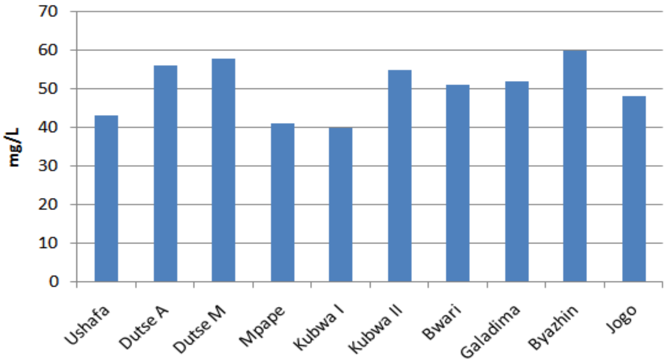

Fig. 6: Variation in Mean Water Total hardness of villages in Bwari Area Council, Abuja.

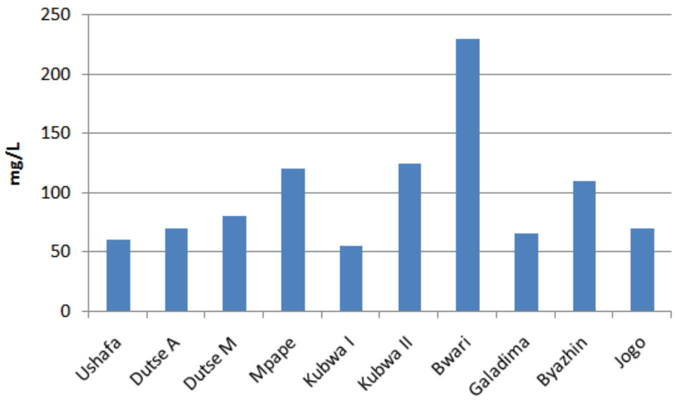

Fig. 7: Variation in Mean Water Potassium of villages in Bwari Area Council, Abuja.

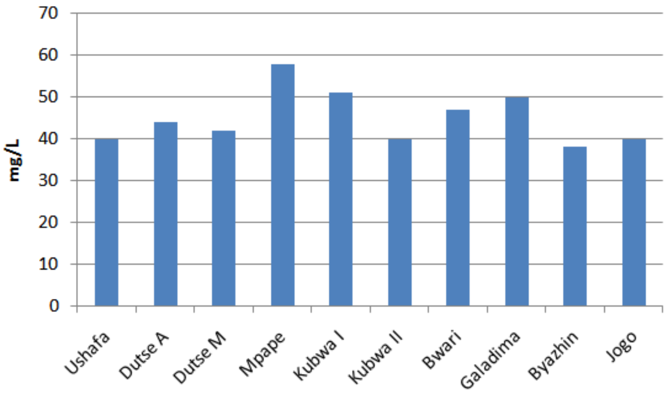

Fig. 8: Variation in Mean Water Total alkalinity of villages in Bwari Area Council, Abuja.

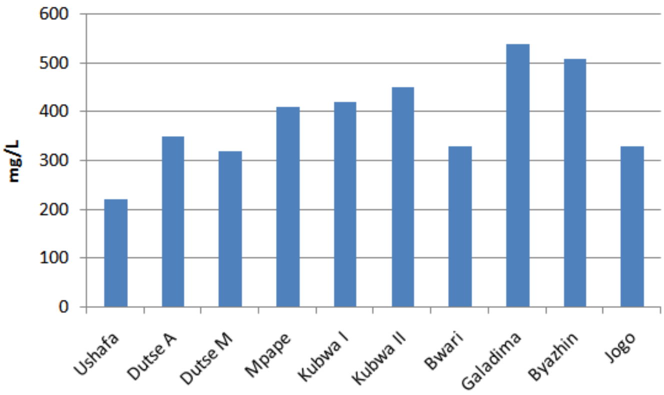

Fig. 9: Variation in Mean Water Sodium of villages in Bwari Area Council, Abuja.

Discussion:

In chemistry, pH is a measure of the acidity or basicity of a solution. It is related with the molar concentration of the dissolved hydroxonium ions (H_30^+): a low pH (pH<7) indicates a high concentration of hydroxonium ions, while a high pH (pH>7) indicates a low concentration. This is a very important parameter in water quality assessment as it influences many biological and chemical processes within a water body (Chapman, 1997). The results of the well-water samples studied revealed that the pH ranged from 6.2 to 6.7 as indicated in Figure 1. Average pH values of 6.51±0.12 for all the samples studied within Bwari area council slightly lower than mean pH value of 6.1 reported by Idzi *et al.*, (2009) but higher than mean pH value of 6.60 reported by Egereonu and Emeziem (2006) in their studies on groundwater in Nassarawa and River State of Nigeria respectively. Minimum pH value of (6.2±0.11) was observed for Mpape village, while maximum pH value of (6.7±0.14) was recorded for Kubwa phase one and Galadima area. The acidity of most of these wells can be attributed to the fact that portions of the casing above the water level are covered with condensate, saturated with air. Since air contains carbon dioxide, the carbondioxide reacts with water to form carbonic acid which is a weak acid. The summary of the pH value is shown in the Figure 1 above.

Electrical conductivity is a numerical expression of the ability of an aqueous solution to conduct electric current. It is a valuable indicator of the amount of material dissolved in water. In the present study as shown in Figure 2, the values of water samples analyzed in Bwari area council ranged from 90 to 570µmhos/cm. The minimum value of (90±0.11 µmhos/cm) was reported for Mpape village while maximum value of (570±0.23 µmhos/cm) was equally observed for Bwari village. By analyzing the results obtained when compared with NIS, 2003 showed that 60% of the villages have lower electrical conductivity value whereas 40% of the villages have higher electrical conductivity above the tolerable limit. There is a general linear relationship between electrical conductivity and total dissolve solids. The greater the electrical conductivity the greater the TDS. These result signifies that the water sample in 40% of the villages contain total dissolve solids. These could cause osmotic effect, specific ion toxicity and soil particle dispersion as such villages with high electrical conductivity depict high corrosion potential. Findings of the present study were in agreement with the results of the survey conducted by (Akoto and Adiyiah, 2007). The graphical representation for electrical conductivity values for all the villages considered is shown in Figure 2.

Chloride is present in nearly all natural waters at varying concentrations depending on the geochemical conditions (Braide *et al.*, 2004). The chloride content of the studied area as indicated in Figure 3 ranges from 29.82 to 45.44 mg/L with minimum value of 29.82 mg/L observed for the samples taken from Dutse Makaranta and Galadima village and the maximum value of 45.44 mg/L was detected for the samples taken from Byazhin village. The value obtained for the chloride content of the well-water samples investigated was still below the tolerable limit of 250 mg/L. This finding is in agreement with Egereonu and Nwachukwu, (2005) who studied the surface and groundwater resources of Efuru River catchment and observed that chloride content of groundwater may be due to the presence of salt water intrusion or contamination by industrial effluent or domestic sewage. The graph of the chloride content distribution in the water sample analyzed within Bwari area council is shown in Figure 3 above.

Calcium content of the samples ranged between 1.01 mg/L to 2.00 mg/L with Minimum value (1.01±0.11 mg/L) being observed for water sample from Kubwa phase one while the maximum calcium content of (2.00± 0.15mg/L) was reported for Ushafa village. The values obtained are within the calcium concentrations in typical natural waters, generally below 15 mg/L. Magnesium arise principally from the weathering of rocks containing ferromagnesium minerals and from some carbonate rocks. The graph showing the calcium content distribution across the villages is shown in Figure 4.

The magnesium content of the water samples investigated ranged from 1.01 to 3.64 mg/L. The minimum value of (1.01±0.11 mg/L) was reported for Kubwa phase one while Galadima districts had the maximum value of (3.64±0.14 mg/L). This value is similar to what was reported by Emoyan, (2006) and also within the natural concentration of magnesium in fresh water. The variation in mean Magnesium of villages in Bwari Area Council, Abuja is shown in Figure 5.

The hardness of natural waters depends mainly on the presence of dissolved calcium and magnesium salts (Ikomi and Emuh, 2000). In groundwater, hardness is mainly due to calcium or magnesium carbonate, bicarbonate, sulphates and chloride. Donald *et al.*, (1995) observed total hardness concentration to be similar to the total alkalinity in most water because calcium and magnesium are commonly bound to the main bicarbonates and carbonate. The total hardness varied from 40 mg/L-60 mg/L, with minimum value of (40±0.26 mg/L) and maximum value of (60±0.50 mg/L) reported for Kubwa I and Byazhin villages respectively .This value is within the recommended safe limit for hardness. According to WHO, (2004) tolerable limit is 100 -500 mg/L. According to Sawyer and McCarty, (1993), Nigeria groundwater can be generally classified into soft water (0- 55ppm), slightly hard water (56-100ppm) and moderately hard (101-200ppm). Based on this classification, the well-water studied was either soft or slightly hard. Very recently, Egereonu and Nwachukwu, (2005)had earlier reported that hardness of water causes chocking, clogging troubles of pipelines, formation of scales in boilers that often resulted to wastage of fuel and hence danger of over heating of boilers. Hence, it is worthy of mentioning that the alkalinity values in the surveyed area considered exceeds hardness values, this implies that, some of the bicarbonates and carbonates are associated with sodium and potassium rather than calcium and magnesium. This is evident in the results obtained for sodium because the well-water samples investigated contained high concentration of sodium ion as shown in Table 1. Most well-water in Ushafa village has the minimum value of (226±0.21mg/L) while Galadima village has the maximum value of (542±0.34 mg/L) respectively. These values are above the 200 mg/L acceptable sodium ion range for drinking purpose recommended by World Health Organisation in 2004. The reason for this high values may arise from sewage and run-off from agricultural land. The explanation is illustrated graphically in Figure 9.

Potassium is usually found in the ionic form and the salts are highly soluble. Potassium content of the well-water samples varied from 56 mg/L to 218 mg/L .Kubwa phase one was observed to have a minimum potassium content value of (56±0.25 mg/L) while Bwari village was discovered to have the maximum potassium content value of (218±0.17 mg/L).Potassium is usually found in low concentration in natural water since rocks which contain potassium are relatively resistant to weathering, however, contrary to the expectation, the potassium content value is above the tolerable limit of 10 mg/L. This could be due to industrial discharges and run-off from diffuse non-point urban and rural wastes including waste dumpsites and agricultural lands. The variation in mean water potassium of villages in Bwari Area Council, Abuja is represented in Figure 7.

The main ions which are responsible to alkalinity are carbonates, CO32- and bicarbonates, HCO32-. The total alkalinity of these villages lie between 40 mg/L - 60.5 mg/L, Byazhin village and its environs had the minimum alkalinity value of (38±0.36 mg/L) while Mpape village had the maximum value of (56±0.24 mg/L).The values obtained are within the WHO, (2004) permissible level for alkalinity. The variation in mean total alkalinity of villages in Bwari Area Council, Abuja is graphically represented in the Figure 8.

Table 3: Correlation Coefficient Matrix of Water Quality Parameter of Villages in Bwari Area Council, Abuja

	pH	Tem	Ec	Cl	TH	TA	Mg	K	Ca	Na
pH	1	-0.62	0.32	-0.07	-0.02	-0.14	0.25	-0.32	-0.04	0.27
Tem		1	-0.64	0.43	0.06	-0.39	-0.12	-0.11	0.17	-0.02
Ec			1	-0.04	0.09	0.02	-0.16	0.34	0.14	-0.42
Cl				1	-0.23	-0.18	0.05	0.33	0.13	-0.24
TH					1	-0.58	0.31	0.25	0.06	-0.57
TA						1	0.25	0.06	-0.57	-0.05
Na							1	-0.02	-0.52	0.6
K								1	0.37	-0.23
Ca									1	-0.39
Mg										1

The correlations between Electrical conductivity and chloride, pH and Total alkalinity were found as 0.34, 0.33, 0.25, and 0.25 respectively. The interrelationship between electrical conductivity and chloride could be attributed to sewage effluents, agricultural and road run-off while the linear relation between pH and total alkalinity might be associated with atmospheric deposition of acid-forming substances. The result of the analysis indicates that there is correlation between some of the parameters determined although the correlations were not that significant.

Conclusion:

It could be concluded that most of the well water studied are fit for domestic and drinking purpose owing to the fact that the concentrations of the vital parameters investigated were within the tolerable limit of Nigeria Industrial Standard and World Health Organization. The sodium and potassium concentration were above the recommended safe limit hence the well-water require little chemical purification or treatment. Further research on other communities in this area council for drinking water analyses is required

REFERENCES

Akoto, O. and J. Adiyiah, 2007. Chemical analysis of drinking water from some communities in the Brong Ahafo region. Int. J. Environ. Sci. Tech., 4(2): 211-214.

Amoo, I.A. and U.E. Amuho, 2005. Comparison of water quality in concrete ringed water wells and unringed wells, M.Sc Thesis, Chemistry Department, Federal University of Technology, Akure, Ondo State, Nigeria, pp: 13.

Anawara, H.M., J. Akaib, K.M.G. Mostofac, S. Safiullahd, S.M. Tareqd, 2002. Arsenic poisoning in groundwaterhealth risk and geochemical sources in Bangladesh. Environ. Int., 27: 597-604.

APHA., 1998. Standard methods for the examination of water and wastewater. 18th Edition.American Public health Association, Washington, DC, pp: 45-60.

Braide, S.A., W.A.L. Izonfuo, P.U. Adiukwu, A.C. Chindah and C.C. Obunwo, 2004. Water Quality of Miniweja Stream,A Swamp Forest Stream Receiving Non-point Source Waste Discharges in Eastern Niger Delta,Nigeria. Journal of Scientia Africana, 3(1): 1-8.

Devi, S., S.B. Barbuddhe, D. Hazel and C. Dolly, 2003. Physico-chemical characteristics of drinking water at Velsao, Goa. J. Ecot. Env. Monit., 13(3): 203-209.

Duru, E.D., V.O. Njoku and C. Obi, 2008. Heavy metals concentration in Urban wells:A case study of Owerri municipal.Journal of Chemical Society of Nigeria, 33(2): 89-93.

Egereonu, U.U. and U.L. Nwachukwu, 2005. Evaluation of the Surface and Groundwater Resources of Efuru River Catchment, Mbano, South Eastern, Nigeria. J. Asso. Adv. Modelling and Stimulation Techniques in Enterprises, 66(2): 53-71.

Egereonu, U.U., 2004b.Groundwater investigation in the Niger-Delta area and parts of the eastern states in Nigeria.Journal Association.Adv.of Modelling and simulation Techniques in Enterprises, 65(6): 71-88.

Egereonu, U.U. and D. Emeziem, 2006. Physicochemical Analysis of Selected Groundwater in River State, Nigeria to Ascertain Pollution Level, Encrustation and Corrosion Potentials. Journal of chemical Society of Nigeria, 31(1and2): 141-146.

Emoyan, O.O., E.F. Akporhonor, I.A. Akpoborie and E.O. Adaikpoh, 2006. Water Quality Assessment of River Ijana, Ekpan, Warri, Delta State, Nigeria. Journal of chemical Society of Nigeria, 31(1and2): 154-160.

Idzi, A.A., L. Lajide and M.O. Aremu, 2009. Physico-Chemical Analysis of Water Sources in Awe Town, Nassarawa State, Nigeria. International Journal of Chemical Sciences, 2(2): 190-196.

Ikomi, R.B. and C.T. Emuh, 2000. The Status of the physicochemical Hydrology of Upper Warri River Nigeria.Journal of Science and Environment, 2: 75-86.

Kot, B., R. Baranowski, A. Rybak, 2000. Analysis of mine waters using X-ray fluorescence spectrometry.Polish J. Environ. Stud., 9: 429.

Nigerian Industrial Standards (NIS 306:2003)-Standard Organization of Nigeria.

Ogunowo, C.O., 2004. Coping with Domestic water supply problems in Nigeria urban centres. The Ijebu-Ode City experience. International Journal of Environmental issues, 7(1 and 2): 21-25.

Okeke, O.C. and A.H. Igboanua, 2003. Characteristics and quality assessment of surface water and groundwater resourses of Akwa Town,Southeast, Nigeria, Journal of Nigerian Association of Hydro Geologists, 10(1): 71-72.

Ramakrishnaiah, C.R., C. Sadashivalah and G. Ranganna, 2009. Assessment of Water Quality Index for the Groundwater in Tumkur Taluk,Karnataka State, Indian Journal of Chemistry, 6(2): 523-530.

Sawyer, C.N. and P.I. McCarty, 1993. Chemistry for sanitary Engineers,McGraw-Hill, NY, pp: 68-91.

Sharma, J.D., P. Jain, D. Sohu and P. Sharma, 2005.Chemical analysis of drinking water of villages of Sanganer Tehsil, Jaipur District.. Int. J. Environ. Sci. Tech., 2(4): 373-379.

Singh1, S. and L.M. Mosley, 2003. Trace metal levels in drinking water on Viti Levu, Fiji Islands. S. Pac. J. Nat. Sci., 21: 3134.

Soylak, M., U. Divrikli, S. Saracoglu and L. Elci, 2002b. Monitoring trace metal levels in Yozgat-Turkey: Copper, iron, nickel, cobalt, lead, cadmium, manganese and chromium levels in stream sediments. Polish J. Environ. Stud., 11: 47.

Soylak, M., F. Armagan Aydin, S. Saracoglu, L. Elci, M. Dogan, 2002a. Chemical analysis of drinking water samples from Yozgat, Turkey. Polish J. Environ. Stud., 11(2): 151-156.

Third World Academic of Science, TWAS., 2002. Safe drinking water: The needs , the problems, solutions and action plan, Italy, pp: 8-12.

WHO, 2004. Guidelines for drinking water quality, 2nd Ed., 1(1): 188.