ASSESSMENT OF PHYSICOCHEMICAL QUALITY OF GROUND AND SURFACE WATER IN OBI LOCAL GOVERNMENT AREA, NASARAWA STATE, NIGERIA

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Abstract: The physicochemical quality of water samples from ground and surface water in Obi Local Government Area was studied. Temperature, pH, electrical conductivity, total dissolved solids, turbidity, suspended solids, total hardness, total solids; sulphate and chloride ions were determined using methods prescribed by APHA. The elements determined were sodium by flame photometer and calcium, magnesium, zinc, copper, lead, chromium and arsenic by atomic absorption spectrophotometer. It was found that the pH values ranged from 6.00 – 6.30 and were not within the limit of 6.50 – 9.50 prescribed by WHO. Copper and turbidity in some of the samples exceeded the WHO maximum permissible limits. However; other parameters were within the WHO limits. Therefore, all the sources assessed are acceptable as potable water to the areas. However, there is the need for constant routine analysis to ensure safety and non contamination of water before exposure for public use in the area of study.

Keywords: Physicochemical parameters, borehole, open well, stream, water

Introduction

Water is extremely essential for the survival of all living organisms and its quality is of utmost importance to humans in every aspect of life (Jabbar *et al.*, 2012). Water is a very significant determinant of sustainable development that should be carefully and properly managed to make for suitable and sustainable human health (Ogunawo, 2004).

However, potable water needed for human consumption does not always occur in nature, due to the presence of dissolved or suspended impurities in most natural water bodies (Goldface, 1999). Also, most water bodies, both underground and surface are normally contaminated by the activities of humans. Surface water bodies could have its quality or status changed by the run-off from agricultural farmlands into it as this could have some metals as well as residual organic and inorganic matters from applied fertilizers and other agrochemicals whereas that of underground water contamination is basically due to leaching from polluted environment.

Potable water is an essential factor that makes for or mar good health and socio-economic development of man (Bouwer, 2012); however, this is lacking in many societies. This is due to the fact the provision of potable water in almost every part of Nigeria is the sole responsibility of the Government. Hence, this provision where available would only be at the local government headquarters with the supply being epileptic. As a result of this, residents in different communities resort to any available water source for their daily water need without attention being given to possible associated contamination of sources.

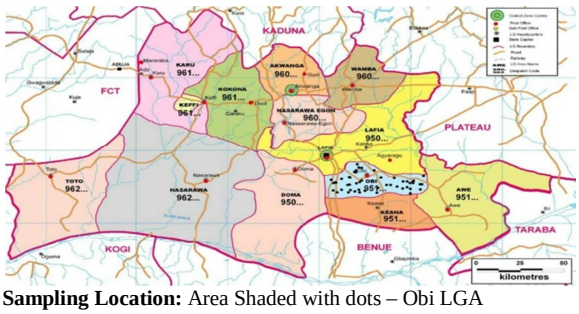
In view of the importance of water to life generally, its contamination at every level is perceived as an issue of serious environmental concern and threat to life. The basic purposes for which water is domestically required include drinking, bathing, cooking and general sanitation such as laundry, flushing of closets and other household chores (Aremu *et al.*, 2008). Water is also required industrially for almost all production processes, cleaning and in some cases for cooling, etc. and for whichever usage, if contaminated it affects the industrial set up and so there is always the need for potable or clean water. The determination of metal content in water is of great importance because despite the fact that some trace elements are essential to man, at elevated levels, essential and non essential elements can cause morphological abnormalities, reduced growth, increased mortality and mutagenic effects (Asaolu, 2002; Adeyeye and Abulude, 2004).

This study was aimed at providing information on the level of pollution of domestic water sources (mainly borehole, open well and streams) in Obi Local Government Area, Nasarawa State, Nigeria. This was done by comparing the results obtained on the quality status with standards set by WHO. This was however, required to evaluate and ascertain the quality of water consumed by residents of the communities in this area and also look at associated dangers if any.

Materials and Methods

Study area

Obi LGA is in Nasarawa State, north central geo-political zone, Nigeria. It is located on longitude 8° 30′ to 9° 00′ E and latitude 8° 00′ to 8° 30′ N (Fig. 1). It is generally very warm and humid with dry season spanning from October to March and the rainy season from April to September. Residents in communities in this area live on ground water and surface water (streams) as sources of potable water supply, while the residents in the administrative headquarters of local government area live on individual and government owned boreholes and deep hand dug wells as potable water supply sources. The communities used for this study are Agwantashi, Obi, Odobu and Tudun Adabu.



Sampling Location: Area Shaded with dots – Obi LGA
Fig 1: Map of Nasarawa State Showing Sampling Location, Obi Local Government Area

Sampling

Borehole water samples were collected from Kaura street of Agwantashi town and Agada street of Obi town, while well water samples were collected from Oleye street of Agnwan tashi town, Oriso street of Obi town, Agwan-Alago of Odobu and Agwan-Ali of Tudun – Adabu. These areas were specifically chosen for the study because a greater percentage of the population of people from these various communities depends on these water bodies for their daily potable water supply need.

Sample collection, treatment and preservation

Water samples were collected twice every day at interval of two weeks and the day and time varied in order to account for the cyclic intermittent variations that may occur at the collection source. Borehole water samples were collected directly from the taps; well water samples were collected using a fetcher and stream water samples collected directly from the stream using a cup. The samples were all collected in clean 1.5 L white polyethylene stopper containers which had been soaked overnight in dilute HNO_3 solution, 0.1M before washing finally with soap solution and firstly rinsed with distilled water and filled with distilled water to the sampling points. The containers were emptied at the sampling points and rinsed severally with the samples to be collected and eventually, the collection of samples and the containers covered (air tight) immediately. Preservations of the samples were carried out as prescribed by APHA (2002). The samples were then placed in a plastic container with ice and transported and stored thereafter at 4^oC in the refrigerator, Haier Thermocool, T 300, to slow down bacteria and chemical reaction rates, prior to analysis (Akpoveta, 2011).

Physicochemical analysis

The temperature of water sample was taken at the site of collection using the mercury bulb thermometer calibrated in degree Celsius, pH was measured at the site of sample collection using pH meter JENWAY–53800, turbidity by Hanna instrument (LP 2000 Turbidity) and the electrical conductivity measured using conductivity meter model NAPTOP PB5 (London, UK). Other parameters determined in the preserved water samples were: Total dissolved solids by gravimetric method, total hardness, calcium hardness, chloride ion all by titrimetric method and sulphate ion by spectrophotometric method (APHA, 2002). All the chemicals used for this research were of analytical grade obtained from BDH (British Drug House, London).

Metal Analysis

Digestion of samples

250 cm^3 of water sample was collected into an evaporating dish and 5 cm^3 of concentrated HNO_3 was added. The sample was digested for about 60 min using digestion block in a fume cupboard until the solution reduces to 25 cm^3 with a characteristic colour, indicating complete digestion. The digest was allowed to cool and transferred to a 50 cm^3 acid washed volumetric flask and brought to the 50 cm^3 mark with deionized water (Atolaye *et al*., 2006). Sodium in water sample was determined using flame photometer (Corning, model 405, Gallenkamp, London, UK) using NaCl to prepare the standard as described by Aremu *et al*. (2010) and Ca, Mg, Zn, Cu, Pb, Cr and As were determined using atomic absorption spectrophotometer AAS (VGB 210 System).

Statistical analysis

The data generated were treated statistically by evaluating the grand mean, standard deviation and coefficient of variation. All determinations were done in triplicates.

Results and Discussion

Table 1 shows the sampling locations and the source of samples in Obi Local Government Area. Table 2 shows the results of physicochemical parameters of water samples from Obi Local Government Area. The results indicates that temperature values ranged between 25.60 – 29.00ºC which were within the WHO (2006) recommended values of between 5 – 55 ºC. This is an important biologically significant factor, which plays an important role in metabolic activities of organism. Electrical conductivity which is an indication of the level of dissolved ions, for all the water samples ranged from 119.00 – 146.00 µS/cm which were all generally far below its tolerable limit of 1000 µS/cm recommended by SON (2007). The pH of water is likely to be corrosive and this may cause the leaching of household common metal, clay pot and water containers. These values are not within the same range with values obtained from various works reported by Aremu *et al.* (2010) and Murhekar (2011).

Table 1: Sampling Location in and around Obi Local Government Area of Nasarawa State, Nigeria

Sample Locations	Source	Sample Number
Agwantashi	Borehohe	AG-B
Agwantashi	Open well	AG-O
Agwantashi	Stream	AG-S
Obi	Borehohe	OB-B
Obi	Open well	OB-O
Obi	Stream	OB-S
Odobu	Open well	OD-O
Odobu	Stream	OD-S
Tudun Adabu	Open well	TA-O
Tudun Adabu	Stream	TA-S

The range for this work is (6.00 – 6.30) compared to 6.50 – 9.50 prescribed by WHO, 2006. TDS values ranged from (30.40 – 41.80 mg/L), water containing more than 500 mg/L of TDS is not considered desirable for drinking water supplies as recommended by WHO (2006); hence the water from the various sources is good for domestic and industrial uses. Suspended solids values ranged from 1. 00 – 25.00 mg/L and turbidity values ranged from 4.00 – 28.00 mg/L and the values exceeded WHO limits, this is due to colloidal and extremely fine dispersions. The value of total hardness ranged from 60.00 – 120.00 $CaCO_3$ mg/L for samples from Agwantashi borehole, stream in Obi, open well in Obi, stream in Odobu and open well in Tudun Adabu which were found to be within the WHO (2006) limits, while open well and stream in Agwantashi, borehole in Obi, open well in odobu and stream in Tudun Adabu had values that fall below WHO limits. TS values range was (32.60 – 56.00 mg/L) and fall below 500 mg/L WHO limits. The ranges for sulphate (24.00 – 48.00 mg/L) and that of chloride (82.80 – 104.80 mg/L) were far below WHO (2006) limits. The highest variability was found in suspended solids (50.00%) while the least was pH (1.80%).

Table 2: Physicochemical parameter values in water samples from Obi Local Government Area of Nasarawa State, Nigeria

Parameters	AG-B	AG-O	AG-S	OB-B	OB-O	OB-S	OD-O	OD-S	TA-O	TA-S	Mean	S.D	CV%
Temp℃	26.5	27.00	25.60	29.00	27.00	26.00	29.00	27.00	28.00	27.00	27.21	1.14	4.19
Conductivity (µS/cm)	121.00	134.00	145.00	119.00	131.00	144.00	133.00	146.00	130.00	144.00	134.70	9.88	7.33
pH	6.00	6.00	6.10	6.20	6.00	6.30	6.20	6.20	6.20	6.20	6.12	0.11	1.80
TDS (mg/L)	36.80	32.00	30.60	30.40	35.00	34.00	30.40	41.80	30.80	31.00	33.30	3.74	11.23
SS (mg/L)	ND	1.00	2.00	8.00	6.00	11.00	8.00	4.00	8.00	25.00	7.30	6.74	92.33
Turbidity (NTU)	ND	6.00	13.00	12.00	13.00	28.40	12.00	9.00	4.00	14.00	11.14	6.64	59.61
TH ($CaCO_3$mg/L)	100.00	80.00	60.00	60.00	100.00	120.00	60.00	120.00	100.00	60.00	86.00	69.63	80.97
TS (mg/L)	36.80	33.00	32.60	38.40	41.00	35.20	38.40	45.80	38.80	56.00	39.60	5.34	13.48
Sulphate (mg/L)	32.00	28.00	24.00	30.00	36.00	45.00	30.00	48.00	28.00	30.00	33.50	7.65	22.84
Chloride (mg/L)	104.00	122.00	82.00	99.20	104.00	98.60	99.20	112.00	88.60	99.20	94.52	14.29	15.12

ND=Not Detectable, NA=Not Available, TDS=Total Dissolved Solid, SS=Suspended Solids, TH=Total Hardness, TS= Total Solids

Table 3: Mean metal concentration (mg/L) in water samples from Obi Local Government Area of Nasarawa State, Nigeria

Metal	AG-B	AG-O	AG-S	OB-B	OB-O	OB-S	OD-O	OD-S	TA-O	TA-S	Mean	S.D	CV%
Ca	80.20	60.10	40.12	40.17	80.23	80.11	40.00	60.00	60.00	40.00	58.09	17.56	30.23
Mg	20.15	20.13	20.45	20.35	20.22	40.56	20.00	60.00	40.00	20.00	28.19	13.96	49.52
Na	6.40	8.20	12.80	14.60	10.40	8.33	8.33	6.80	2.80	14.60	9.33	3.66	39.23
Zn	1.42	1.22	1.14	1.68	1.28	1.41	1.14	1.26	1.80	1.20	1.36	0.32	23.53
Cu	1.99	1.77	2.23	0.56	2.35	2.15	2.15	0.59	1.78	2.31	1.79	0.67	37.40
Pb	ND	0.01	ND	0.01	ND	ND	ND	0.01	0.01	ND	NA	NA	NA
Cr	ND	0.02	0.01	0.05	0.01	ND	ND	0.03	0.02	0.01	0.02	0.01	50.00
As	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	NA

ND = Not Detectable, NA = Not Available

Mean metal concentrations in water samples (Table 3) shows the range of values of (40.00 – 80.23 mg/L), (20.00 – 60.00 mg/L), (2.80 – 14.60 mg/L), (1.20 – 1.80 mg/L), (0.56 – 2.35 mg/L), (0.00 – 0.01 mg/L) and (0.01 – 0.05 mg/L) obtained for Ca, Mg, Na, Zn, Cu, Pb and Cr respectively but for As, it was not detected in any of the samples. Calcium is directly related to hardness; the concentrations fall within the permissible limit recommended by WHO (Table 4) from sampling points, Agwantashi borehole, stream in Obi and open well in Obi but its concentrations at other sampling locations were below the WHO (2006) permissible limits. The values fall below that of similar work on comparing with the physicochemical status of ground and surface water in Akot city, India as reported by Murheker (2011). Magnesium is also related to hardness and the concentration falls within the WHO (2006) limits except for samples from sampling points, stream in Obi, stream in Odobu and stream in Tudun Adabu in which it exceeded the WHO (2006) tolerable limits but still within the permissible limits. The values are above that of similar research work reported by Aremu *et al.* (2008).

Table 4: World Health Organisation (WHO) tolerable value limits for potable water

Parameters	Highest Desirable	Maximum Permissible
Temperature (℃)	5 – 55	5 – 55
pH	7.00 – 8.90	6.50 – 9.50
Conductivity (µS/cm)	1000	1000
TDS (mg/L)	500	1500
Turbidity	5.00	5.00
TH ($CaCO_3$ mg/L)	100	500
Sulphate (mg/L)	250	500
Chloride (mg/L)	200	250
Calcium (mg/L)	75	200
Zinc (mg/L)	0.01	3.00
Copper (mg/L)	0.50	2.00
Lead (mg/L)	0.01	0.01
Magnesium (mg/L)	30	250
Chromium (mg/L)	0.05	0.05
Sodium (mg/L)	200	200
Arsenic (mg/L)	0.001	0.001

Source: WHO (2006)

Sodium concentrations in all the samples fall below WHO limit of 200.00 mg/L. When compared with the work reported by Aremu *et al.* (2008) the concentrations of sodium are within the same range. Zinc, lead and chromium concentrations fall within the WHO (2006) recommended limits. But compared to the work reported by Aremu *et al.* (2008) the concentrations of zinc are not in the same range while lead and chromium levels were within the same range. Copper concentrations exceeded the WHO limit for water samples from stream in Agwantashi, stream in Obi, open well in Obi, open well in Odobu, and stream in Tudun Adabu but within WHO (2006) acceptable limits for samples from borehole and open well in Agwantashi, borehole in Obi, stream in Odobu and stream in Tudun Adabu. Copper even though very useful to the body system of humans, when there is accumulation of this essential element beyond the tolerable limit prescribed by regulatory bodies it constitutes health risks. The most highly varied element was chromium (CV, 50.00%) while the least was zinc (CV, 23.53%) as shown by the calculated percentage coefficient of variation (Table 2).

Conclusions

In the light of the parameters determined, it can be concluded that users of ground and surface water in and around Obi Local Government Area are not likely to have any adverse effect as far as some parameters like temperature, suspended solids, total hardness, total solids, sulphate, chloride, calcium, sodium, zinc, lead, chromium and arsenic are concerned. This is because these parameters recorded values that were within WHO (2006) limits for drinking water. On the other hand adverse effects due to high values of pH, turbidity, magnesium and copper are likely to be encountered because almost all the samples recorded values that exceeded WHO limits for drinking water. Thus the sources are acceptable water supply to the areas. There is the need for constant routine analysis of the water bodies in this area to ensure safety and non contamination of water before exposure for public use.

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Conflict of Interest
There is no conflict of interest with respect to the research work.

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