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Evaluation of Water Sources in Abakaliki Southeastern Nigeria for Domestic Uses

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Authors' contributions

This work was carried out in collaboration between all authors. Author CN designed the study, wrote the protocol and wrote the first draft of the manuscript. Authors PNN, TSI and AJA managed the literature searches, analyses of the study, performed the spectroscopy analysis. Authors GCO and TSI managed the experimental process. All authors read and approved the final manuscript.

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Short Research Article

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ABSTRACT

This work aimed at evaluation of the qualities of water sources in Abakaliki for domestic uses. The water sources used were rain water, borehole water, Ebonyi River and bottled water. The water samples from these sources were taken to laboratory for analysis of SO_4^{2-}, Cl^-, NO_3^-, Mg^{2+}, Ca^{2+}, pH, Fe, Pb, Cu, Mn, and Zn. The data obtained were analysed using standard deviation and coefficient of variance and compared with World Health Standard. The concentration of SO_4^{2-}, Cl^-, NO_3^-, Fe and Cu observed in all the water sources studied were within acceptable limit for domestic uses of water. The bottled water recorded the acceptable concentrations of Ca^{2+}, Mg^{2+} and Pb whereas the concentrations recorded by other sources were above the World Health Organization Standards. On the other hand borehole water and bottled water recorded the concentration of Mn that is within the recommended standard. Whereas with exception of rain water the pH of all the water sources studied were within the acceptable concentration. Apart from bottled water which recorded the concentrations of all the parameters studied within the recommended ranged, all the

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other sources must be treated to bring them to the acceptable concentrations before usage in order to prevent health hazards associated with the parameters studied.

Keywords: Contaminant; drinking water; health hazard and treatment.

1. INTRODUCTION

Pure water does not exist in nature and mainly all waters contain contaminants [1] and are pre-requisite for human activities and all the creatures living in this world [2,3]. No source of water is entirely free from contaminants. The concentration of these contaminants depends on the location of the water sources, the reaction rate of the water, effect of agricultural such as pesticides residues, extent of discharge of waste from industry into the water body as well as sewage [4].

Water exists as the most common solvent in nature and for this reason; it is referred as the universal solvent. Drinking plenty of water is essential to physical, chemical and emotional well being of the body and it also serve as a transport medium for both plants and animals [5]. Past and present governments of Nigeria and donor agencies have supported water supply programmes in Nigeria. Notwithstanding, all these efforts, access to safe water supply in Nigeria' urbans in which the study area (Abakaliki) is included are not improving [6,7]. These have forced many families in Abakaliki to be using water from unsanitary water sources which make them to prone to pathogenic and disease infection. Generally, public water supply is becoming scarcer in Nigeria towns and where it is operational, it is usually characterized by the twin problems of unreliability and poor quality as a result of some seemingly inherent problems such as lack of electricity to power the water intakes, general mismanagement of public water supply that leads to the inabilities of utilities to recover various operating costs to handle extensive deterioration of water [8]. With an increasing population of Abakaliki the study area, there is also a higher demand for supply of good quality water in which Abakaliki Urban Water Supply and Eziulo Water board being the only good water quality sources cannot provide [9]. That is why many residents of Abakaliki depend on borehole and rain water sources for their water usage. Therefore, the objective of this study is to evaluate the qualities of water sources in Abakaliki for domestic uses.

2. MATERIALS AND METHODS

The experiment was carried out at Abakaliki, Ebonyi State of Nigeri in 2014. Abakaliki (06º 04^{1}N, 06° 65^{1}E) has a mean annual rainfall of 1700 mm distributed between April and November and farming is the major activity in the area. Also, other activities of the area are small scale industries and informal services. The dry season is within January–March while the minimum and maximum temperatures of the area are 27℃ and 31℃, respectively [10]. The relative humidity is 30–45% during dry season and 60 – 65% during raining season. The soil of the area belongs to the order Ultisoil classified as Typic Haplustult [11].

2.1 Site Selection

A reconnaissance survey of the sample sources was carried out and the following sample sources were selected:

i. Raining water from aluminium roof at Kpirikpiri, Abakiliki.
ii. Borehole water from underground water at Kpirikpiri, Abakaliki.
iii. Ebonyi River which is the major river in Ebonyi State.
iv. Ivy bottled water which was bought at Abakaliki meat market.

2.2 Sample Collection

Four replicate water samples were collected from rain water, borehole water, Ebonyi River and bottled water at Abakaliki Urban. The samples were collected within the months of June, 2014 using plastic can with cap and were taken to project development Institute (PRODA) Enugu for analysis and were analysed according to [12].

2.3 Laboratory Analysis

The samples were analyzed in the laboratory for lead, copper, zinc, iron and manganese, using atomic absorption spectrophotometer (AAS) as described by [13]. The pH and Nitrate concentration of the water was determined using the method described by [14,15], respectively while the sulphate content of soil samples was determined using turbidimetric method [16]. The

complexiometric titration method was used for the determination of calcium and magnesium [17].

2.4 Statistical Analysis

The data collected were analyzed using coefficient of variance (CV) and Standard deviation [18] and also, compared with World Health Organization Standards for the individual parameters determined [12].

3. RESULTS AND DISCUSSION

The concentration of SO_4^{2-}, Cl^-, NO_3^-, Mg^{2+}, Ca^{2+} and pH of the water sources studied are shown on Table 1. The order of increase in SO_4^{2-} was borehole water > rain water > Ebonyi river > bottled water. The lowest value of Cl^- was recorded in rain water. This observed value was lower than Cl^- in borehole water, Ebonyi river and bottled water by 40, 220 and 110%, respectively. The lowest and highest NO_3^- value of 0.026mgl^{-1} and 0.04mgl^{-1} was observed in Ebonyi river and borehole water, respectively while rain water and bottled water recorded 0.03 mgl^{-1} and 0.036 mgl-1 of NO_3^-, respectively. The observed SO_4^{2-}, Cl^- and NO_3^- in all the water sources studied were within the acceptable limit. According to [19] and [12] any water with the concentration of SO_4^{2-}, Cl^- and NO_3^- above 500, 250 and 10 is unfit for drinking. The order of increase in Mg^{2+} and Ca^{2+} values were borehole water > Ebonyi river > rain water > bottled water. With exception of bottled water all the other water sources studied recorded Mg^{2+} and Ca^{2+} above World Health Standard for drinking water. The pH of rain water was acidic and was far below the World Health Standard for drinking whereas that of borehole water Ebonyi river and bottled water were within the range recommended by [12].

Table 2 shows the concentration of Fe, Pb, Cu, Mn, and Zn of the water sources studied. The order of increase in Fe was Rain water > borehole water = Ebonyi river > bottle water. This observed Fe concentration is still within the acceptable Fe concentration of drinking water and therefore will not pose any health hazard with respect to this parameter. The lowest Pb concentration of 0.009mgl^{-1} was recorded in bottled water whereas that of other sources ranged between 0.04–0.07 mgl^{-1}. The World Health Organization Standard with respect to Pb for drinking water is 0.01mgl^{-1}. According to [20] the presence of Pb leads to teratogenic effect, cancer, interferes with vitamin D metabolism and is toxic to the central and peripheral nervous system. Therefore, every other sources of drinking water than bottled water must be treated for Pb before using for drinking purposes. No water sources studied recorded Cu. Copper is a micronutrient that plays an important role in human nutrition and when is above standard causes gastrointestinal disorder [9]. With an exception of borehole water and bottled water which recorded 0.19mgl^{-1} and 0.12mgl^{-1} of Mn, respectively, all the other water

Table 1. Concentration of SO_4^{2-}, Cl^-, NO_3^-, Mg^{2+}, Ca^{2+} and pH of the water sources studied

Water Sources	SO_4^{2-}(mgl^{-1})	Cl^- (mgl^{-1})	NO_3^-(mgl^{-1})	Mg^{2+}(mgl^{-1})	Ca^{2+} (mgl^{-1})	pH
Rain Water	35.30±0.56	71.00±0.17	0.030±0.01	58.00±0.18	87.30±0.18	3.08±0.01
Borehole Water	59.40±0.22	99.40±0.10	0.040±0.03	95.00±0.11	131.06±0.15	7.71±0.01
Ebonyi River	50.50±0.61	227.20±0.10	0.026±0.02	72.00±0.10	90.70±0.15	7.95±0.02
Bottled Water	31.70±0.26	149.10±0.16	0.036±0.02	38.50±0.20	33.00±0.16	7.49±0.03
CV (%)	25	50	19	36	47	51
WHO Standard	500	250	10	50	76	6.5–8.5

Table 2. Concentration of Fe, Pb, Cu, Mn and Zn of the water sources studied (mgl^{-1})

Water sources	Fe	Pb	Cu	Mn	Zn
Rain Water	0.024±0.06	0.04±0.01	-	0.46±0.03	32.69±0.07
Borehole Water	0.022±0.05	0.05±0.03	-	0.19±0.04	114.40±0.10
Ebonyi River	0.022±0.04	0.07±0.03	-	0.60±0.05	39.23±0.07
Bottled Water	0.013±0.05	0.009±0.01	-	0.12±0.02	-
CV%	24	35	0	34	73
WHO Standard	3	0.01	2.0	0.20	3.0

sources recorded the concentration of Mn which was above World Health Organization Standard of 0.40mgl^{-1}. Manganese is associated with neurological effect when it is above 0.2mgl^{-1} [20]. With exception of bottled water which recorded zero concentration of Zn all the other water sources recorded Zn concentration that were above the acceptable concentration in drinking water. Although, Zn is not known to cause any health problem in animal or human being [12].

4. COCLUSION

The results showed that all these water sources in Abakaliki are contaminated from one or more of these contaminants studied with an exception of bottled water. The reason while bottled was free of all these contaminants may be attributed from the fact that most of them might have undergone treatment before bottling. Therefore, this work recommended the treatment of water from these sources before usage to prevent health hazard associated from drinking untreated water from these sources.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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