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Evaluation of Water Qualities of Ebonyi River for Drinking Purposes in Abakaliki Southeastern Nigeria

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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 and CN managed the literature searches, analyses of the study performed the structural equation modelling and discuss the conclusion. All authors read and approved the final manuscript.

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ABSTRACT

This study evaluated the qualities of Ebonyi River for drinking purposes in Abakaliki southeastern Nigeria. Five replicate water samples were collected from areas of the Ebonyi River dominated by agricultural, domestic, commercial and industrial activities in February 2014. These water samples were used for the determination of conductivity, colour transmittance, dissolved solid, suspended solid, total solid, Ca hardness, Mg hardness, total hardness, zinc and copper concentrations. Temperature measurements were also, recorded in-situ in these areas of different activities. The data collected were analyzed using analysis of variance and standard deviation whereas treatment differences among means were dictated using fisher's least significant difference. Similarly, the data obtained were compared with World Health Organization Standards for drinking water qualities. Apart, from copper which recorded zero concentration in all the areas of different activities studied in Ebonyi River, the results showed a significant ($p<0.05$) difference among the areas of difference activities with respect to all the other parameters studied. The observed total solid, dissolved solid, total hardness, Ca hardness, Mg hardness and zinc concentrations in all the areas of different activities were all within the World Health Organization recommended standards

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for drinking water. Whereas the recorded colour transmittance in all the areas of difference activities; the observed conductivities and temperatures in the areas of commercial and industrial activities and the recorded suspended solid in the area of agricultural activities were higher than recommended standards by World Health Organization. Therefore, Ebonyi River is unfit for drinking and must be treated before using for drinking purposes to ensure healthy living.

Keywords: Different activities; drinking water; Ebonyi river; standard; treatment.

1. INTRODUCTION

Water is vital for the existence of all living organisms, but this valued resource is increasingly being threatened by human activities as human population increases on the earth [1]. The rural communities in developing countries, particularly Nigeria, depend largely on surface water and other water bodies for their water consumption and such rivers constitute health hazard because of anthropogenic activities and indiscriminate disposal of untreated sewage and surface run-off into them [2]. Examples of surface water are streams, ponds, lakes, rivers, seas and oceans.

Regardless of the source, water in its natural environment contains some impurities such as dissolved solids and gases and also hosts a number of pathogenic and non-pathogenic micro-organisms [3,4]. The levels of its physical, chemical and biological impurities define its quality which is evaluated relative to the requirement for its intended use. The quality of water is often affected by natural activities such as rocks, soils and surface through which it flows and anthropogenic activities such as industrial, agricultural and mining activities [5,6]. Several studies revealed that these activities coupled with atmospheric factors affect the suitability of water for any purpose [7-10].

[11] has shown that 2.2 billion people in the developing countries will lack access to safe drinking water whereas 2.7 billion people will lack access to sanitation services in 21st century. The result is a tragic rate of morbidity and mortality in the less developed parts of the world. Water borne diseases, such as cholera and typhoid, cause more than 1.5billion episodes of diarrhea each year, resulting in 4 million deaths annually [12].

Ebonyi River had it source from river Benue and passes through all the three zones in Ebonyi state, bounded by many communities in that state and opens into Cross River that empties its water into the Atlantic Ocean. This river provides domestic and drinking water to more than 50% indigene of Ebonyi state. Apart from provision of water to the people for domestic and drinking uses, it is also a source of fish and other aquatic animal productions, facility for tourism and transportation and source of water for irrigation. At the moment it seems to be fewer published information on the qualities of this river with respect to these uses [13]. Therefore, this work aimed at evaluating the quality of Ebonyi River for drinking purposes.

2. MATERIALS AND METHODS

2.1 Study Area

The study was carried out at Ebonyi River in Abakaliki Ebonyi State southeastern Nigeria. Ebonyi River is one of the major sources of water for different uses for Ebonyi people. Abakaliki lies at latitude 6º15'N and longitude 8º5'E in the derived savannah of southeastern Nigeria. The two distinct seasons within the zone are rainy season which lasts from April to October and dry season which lasts from November to March. The minimum and maximum temperatures of the area are 27ºC and 31ºC, respectively [14]. The relative humidity of the area is between 60 to 80 percent. The area has an annual rainfall range of 1500–2000mm and the soil of the area belongs to the order ultisol classified as typic Haplustult [15].

2.2 Selection of Experimental Site

The areas dominated by the agricultural activities; dominated by domestic activities; dominated by commercial activities and dominated by industrial activities were selected from Ebonyi River after the reconnaissance survey of the river.

2.3 Water Sampling and Preparation

Five replicate water samples were samples from each site and prepared according to [16]. Temperature measurements were taken in-situ using a mercury-in-glass thermometer by dipping

the thermometer into the river and the reading was taken after the temperature was stabilized.

2.4 Laboratory Analysis

The colour of the water samples was determined in terms of percentage transmittance of light. The instrument used was photo electronic colorimeter, model AE-IIM". The instrument was initially calibrated using distilled water and transmittance of each sample was read and digitally recorded in percentage (%) while conductivity of each water sample was determined using SANXIN SX723 conductivity meter. The probe of the conductivity meter was dipped into each sample in a beaker and allowed to stabilize and the result digitally read and recorded in μs/cm. Total solids, total dissolved solids and total suspended solids were determined using the methods described by [17].Total hardness, Calcium hardness and Magnesium hardness were determined using the methods described by [18] while copper and zinc were determined in the water samples using Atomic Absorption Spectrophotometer [19].

2.5 Data Analysis

The data collected were analyzed using analysis of variance and standard deviation whereas treatment differences among means were dictated using fisher's least significant difference [20]. Similarly, the data obtained were compared with World Health Organization (WHO) Standards for drinking water qualities [16].

3. RESULTS AND DISCUSSION

Conductivities, Temperatures and Colours of different Areas of Activities in Ebonyi River are as presented in Table 1. There was a significant ($p<0.05$) difference among the areas of difference activities with respect to the water qualities studied. The order of increase in conductivity is area of commercial activities > area of industrial activities > area of agricultural activities > area of Domestic activities. Area dominated by agricultural activities recorded the lowest temperature of 28.67ºC. This observed temperature in the area of agricultural activities was lower than the temperatures of areas dominated by domestic, commercial and industrial activities by 3, 10 and 7%, respectively. The conductivities and temperatures recorded in the areas dominated by commercial and industrial activities were higher than recommended standard by [16] for drinking water. Therefore, water conductivities and temperatures in these areas must be lowered before using them for drinking purposes. The lowest and highest colour transmittance of 5.67 and 116% were recorded in areas dominated by agricultural and industrial activities whereas colour transmittance values for areas dominated by domestic and industrial activities were 99 and 115%, respectively. With respect to colour, all the areas of activities studied recorded higher transmittance than the recommended standard (0.00%) by [16].

There is a significant ($p<0.05$) difference in the observed values of dissolved solid, suspended solid and total solid in all the different areas of different activities studied as indicated in Table 2. The order of increase in dissolved solid is area of agricultural activities > area of domestic activities > area of commercial activities > area of industrial activities. The lowest value of suspended solid of 5.33 mgl^{-1} was recorded at the area of commercial activities. This recorded suspended solid in the area of commercial activities was lower than the suspended solid in the area of agricultural activities, domestic activities and industrial activities by 3559, 144 and 482%, respectively. Therefore, the area of agricultural activities recorded 195 mgl^{-1} of suspended solid as against 50 mgl^{-1} recommended by [21]. The order of increase in total solid is area of agricultural activities > area of industrial activities > area of domestic activities > area of commercial activities.

Table 3 shows the total hardness, magnesium (Mg) hardness, calcium (Ca) hardness, zinc and copper Concentrations of different Areas of Activities in Ebonyi River. There is also a significant ($p<0.05$) difference with respect to these parameters in all the areas of difference activities studied. The order of increase in total hardness is area of area of industrial activities > area of commercial activities > area of agricultural activities > domestic activities. The lowest and highest Mg hardness value of 104.60 and 110.33 mgl^{-1} were recorded in the areas of domestic and industrial activities, respectively whereas observed Mg hardness at areas of agricultural and commercial activities were 104.73 and 106.40 mgl^{-1}, respectively. The highest Ca hardness concentration of 5.79 mgl^{-1} observed in area of agricultural activities was higher than Ca hardness concentration observed in areas of domestic, commercial and industrial activities by 5, 23 and 35%, respectively. According to [21], the recorded total hardness,

Table 1. Conductivities, temperatures and colors of different areas of activities in Ebonyi river

Location	Conductivity (µs/cm)	Temperature (℃)	Colour (%transmittance)
Area of Agricultural Activities	79.62±0.92	28.67±0.15	5.67±1.20
Area of Domestic Activities	52.33±0.20	29.67± 0.20	99±0.90
Area of Commercial Activities	123.84±0.15	31.77±019	115.00± 0.20
Area of Industrial Activities	114.30±0.21	30.68±0.19	116.00±1.00
F – LSD	3.34	1.67	9.49
WHO drinking water standard	100	20–30	0.00

Table 2. Dissolved Solid, suspended solid and total solid concentrations of different areas of activities in Ebonyi river (Mgl^{-1})

Location	Dissolved Solid	Suspended Solid	Total Solid
Area of Agricultural Activities	28.00± 1.30	195 ± 0.80	223±0.52
Area of Domestic Activities	18.33 ± 1.20	13.00 ± 0.90	31.33±1.20
Area of Commercial Activities	13.30±1.10	5.33± 0.90	33.33±1.10
Area of Industrial Activities	13.10±1.10	25.67±1.00	35.67±0.60
F – LSD	10.19	8.14	7.73
WHO drinking water standard	250	50	500

Table 3. Total hardness, magnesium (mg) hardness, calcium (ca) hardness, zinc and copper concentrations of different areas of activities in Ebonyi river (Mgl^{-1})

Location	Total Hardness	Mg Hardness	Ca Hardness	Zinc	Copper
Area of agricultural activities	110.53± 1.13	104.73±1.30	5.79±0.60	0.14±0.20	0.00
Area of domestic activities	110.13±1.50	104.60±1.40	5.53±0.71	0.33±0.30	0.00
Area of commercial activities	110.88±1.30	106.40±1.20	4.45±1.10	0.31±0.30	0.00
Area of Industrial Activities	114.10±1.40	110.33±1.10	3.77±1.00	0.17±0.40	0.00
F – LSD	12.05	11.30	7.71	2.71	0.00
WHO drinking water standard	500	150	200	5.00	1.00

Mg hardness and Ca hardness in these various activities in Ebonyi River are below the standard and do not make the water unfit for drinking or domestic uses. The order of increase in zinc concentration is area of domestic activities > area of commercial activities > area of industrial activities > area of agricultural activities. The observed zinc concentration in all the areas of different activities was below 5.00 mgl^{-1} which is the recommended highest acceptable concentration of zinc in drinking water [16]. Zero copper concentration was observed in all the areas of different activities. The absence of copper in water does not constitute any health hazard in drinking water nor make water unfit for drinking [19].

4. CONCLUSION

The results have shown that colour transmittance in all the areas of difference activities; the observed conductivities and temperatures in the areas of commercial and industrial activities and the recorded suspended solid in the area of agricultural activities were higher than recommended standards by [16]. Thus, it imperative that water from Ebonyi River must be treated before using it for drinking purposes to avoid health hazards associated with drinking Ebonyi River.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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