Physicochemical Water Analysis of Ikwo-Ihie River in Ivo Local Government Area and Ope-Ekwe River in Izzi Local Government Area in Ebonyi State, Nigeria

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Abstract: Physicochemical water analysis from Ope-ekwe and Ikwo-ihie fresh waters were carried out to determine some physical and chemical parameters such as Temperature (T), Dissolved Solids (DS), pH, Total Solids (TS), Suspended Solids (SS), Dissolved Oxygen (DO), Total Hardness (TH), Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Chloride, Sulphate, Nitrate, Phosphate, Alkalinity, Acidity and Conductivity. The results of the analysis from Ope-ekwe fresh water were compared with that of Ikwo-ihie fresh water. To assess the quality of fresh water from both communities, each parameter was compared with the WHO permissible limits. Alkalinity level in Ope-ekwe (276.50±1.29 mg/l) and BOD level in Ikwo-ihie (30.50±1.00 mg/l) were above W.H.O permissible limit of 200 mg/l and 6 mg/l respectively. Also, the nitrate concentration in Ikwo-ihie (54.01±0.03 mg/l) was high against the W.H.O permissible limit of 45 mg/l. Due to increased human activity and industrialization around these fresh water bodies which is a source of drinking water to the community, the water can be considered unsafe as a result of harmful contaminants. People living close to these fresh water bodies can be considered to be under tremendous threat due to undesired changes in the physical, chemical and biological parameters.

Key words: Physicochemical • Water • Parameters • Nitrate • Alkalinity • BOD

INTRODUCTION

Water is one of the important and abundant compounds of the ecosystem. All living organisms on earth need water for their survival and growth. About 70% of water is made up of the earth. But due to increased human population, industrialization, use of fertilizers in agriculture and man-made activity, it is highly polluted with different harmful contaminants [1]. Therefore, it is necessary the quality of drinking water be checked at regular time interval, because due to the use of contaminated drinking water, human population suffers from varieties of water borne diseases [1]. Thus, the chemistry of water reveals much about the metabolism of the ecosystem [2].

The availability of good quality water has been a high demand among people, which is an indispensable feature for preventing diseases and improving quality of life [1]. Anthropogenic and some natural activities have so far constituted major pollutions in fresh water bodies-both physical and chemical properties of water [3]. Natural water contains different types of impurities which is as a result of both natural and anthropogenic activities, such as weathering of rocks, leaching of soils, controlled and uncontrolled disposal of waste, accidental and processed spillage, mining and smelting of metalliferrous ores, sewage sludge and other anthropogenic events [4]. Also, the increased use of metal-based fertilizer in agricultural revolution of the government could result in continued rise in concentration of metal pollutions in fresh water reservoir due to the water run-off [3]. Excessive amounts of trace elements such as Pb, Cr and Fe, as well as trace elements from industrial processes are of special concern because they produce water or chronic poisoning in aquatic animals [5].

The physicochemical properties of water consist of both physical and chemical components of water. Some physical test should be performed for testing of its physical appearance such as temperature, colour, odour, pH, turbidity, TDS etc., while chemical tests should be performed for its BOD, COD, dissolved oxygen, alkalinity, hardness and other parameters. For obtaining more and more quality and purity in water, it should be tested for its trace elements content and organic residue [1]. Plants can
accumulate trace elements in their tissues in concentrations above the permitted levels which is considered to pose a threat to the life of humans and animals feeding on these crops and may lead to contamination of food chain; as observed that soil and plants contained many toxic metals that received irrigation water mixed with industrial effluent [6]. Also, high levels of pollutants mainly organic matter in river water cause an increase in biological oxygen demand [7], chemical oxygen demand, total dissolved solids, total suspended solids and fecal coli form [1]. They make water unsuitable for drinking, irrigation or any other use [8].

The sites of this analysis are Ope-ekwe and Ikwo-ihie, both in Ebonyi State, Nigeria. Ope-ekwe is located in the eastern part of Izzi LGA while, Ikwo-ihie is located in Ivo LGA in Ebonyi State. Ope-ekwe has a fresh water reserve. Agricultural activities in the water area employ the use of agrochemicals such as herbicides and fertilizers. Also in Ikwo-ihie, the water reserve is located within a bush where people practice open defecating. This is of serious concern since both marine organisms and humans, on consumption of polluted water, are prone to be affected by water borne diseases from the fresh water.

**MATERIALS AND METHODS**

**Sample Collection:** The water samples were collected with sterilized plastic bottles. Each sample was collected at four different points in a depth of about 15cm. The temperature of the samples was taken at the field at the time of sample collection. The samples were labelled accordingly, transported to the Biochemistry department laboratory, Ebonyi State University and stored in the refrigerator at 4°C prior to analysis. The samples were collected between October and November, 2014.

**Water Analysis:** The analysis for different physicochemical properties such as Temperature (T), Dissolved Solids (DS), pH, Total Solids (TS), Suspended Solids (SS), Dissolved Oxygen (DO), Total Hardness (TH), Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Chloride, Sulphate, Nitrate, Phosphate, Alkalinity, Acidity and Conductivity were carried out using standard procedures.

**Determination of Physicochemical Properties:** The physical and chemical properties analysed were: Temperature using thermometer, pH- measured using standard pH meter. Total Dissolved Solids (TDS), Total Solids (TS), Suspended Solids (SS) and Total Hardness (TH) were analysed by standard methods. Biochemical Oxygen Demand (BOD) and Dissolved Oxygen (DO) were analysed using standard dissolved oxygen meter, Electric Conductivity using conductivity meter, Chloride content by argentometric method, Total Hardness (TH) by EDTA titrimetric method, Alkalinity and Chemical Oxygen Demand (COD) by open reflux method. Turbidity was determined using electronic turbidity meter, Sulphate by nephelometric method, while Nitrate and Phosphate was measured using UV visible spectrophotometer.

**RESULTS AND DISCUSSIONS**

The results of the physicochemical analysis in Ope-ekwe and Ikwo-ihie rivers are shown in Table 1.

**Colour and Odour:** The water samples have acceptable colour and smell.

**Temperature (°C):** The temperature of the water samples is of serious concern since both marine organisms and humans, on consumption of polluted water, are prone to be affected by water borne diseases from the fresh water.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>MEAN±S.D Ope-ekwe</th>
<th>MEAN±S.D Ikwo-ihie</th>
<th>WHO LIMIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour</td>
<td>Colourless</td>
<td>Colourless</td>
<td>-</td>
</tr>
<tr>
<td>Odour</td>
<td>Acceptable</td>
<td>Acceptable</td>
<td>-</td>
</tr>
<tr>
<td>TS (mg/l)</td>
<td>341.75±1.71</td>
<td>217.50±8.66</td>
<td>-</td>
</tr>
<tr>
<td>TDS (mg/l)</td>
<td>317.25±2.22</td>
<td>353.25±9.07</td>
<td>500 mg/l [1]</td>
</tr>
<tr>
<td>SS (mg/l)</td>
<td>17.75±1.71</td>
<td>2.36±0.10</td>
<td>-</td>
</tr>
<tr>
<td>Alkalinity (mg/l)</td>
<td>276.50±1.29</td>
<td>22.50±2.89</td>
<td>200 mg/l [2]</td>
</tr>
<tr>
<td>Acidity</td>
<td>14.50±2.65</td>
<td>4.30±0.25</td>
<td>-</td>
</tr>
<tr>
<td>Chloride (mg/l)</td>
<td>10.62±0.02</td>
<td>14.35±0.44</td>
<td>250 mg/l [2]</td>
</tr>
<tr>
<td>Sulphate (mg/l)</td>
<td>70.14±0.02</td>
<td>84.15±2.94</td>
<td>250 mg/l [2]</td>
</tr>
<tr>
<td>TH (mg/l)</td>
<td>6.27±0.03</td>
<td>3.63±0.41</td>
<td>-</td>
</tr>
<tr>
<td>COD (mg/l)</td>
<td>0.03±0.02</td>
<td>4.80±0.00</td>
<td>-</td>
</tr>
<tr>
<td>DO (mg/l)</td>
<td>12.51±0.02</td>
<td>12.77±0.16</td>
<td>-</td>
</tr>
<tr>
<td>BOD (mg/l)</td>
<td>0.03±0.02</td>
<td>30.50±1.00</td>
<td>60 mg/l [2]</td>
</tr>
<tr>
<td>Nitrate (mg/l)</td>
<td>27.00±2.16</td>
<td>54.01±0.03</td>
<td>45 mg/l [2]</td>
</tr>
<tr>
<td>Phosphate (mg/l)</td>
<td>4.61±0.03</td>
<td>3.81±0.13</td>
<td>-</td>
</tr>
<tr>
<td>pH</td>
<td>7.22±0.02</td>
<td>6.39±0.50</td>
<td>-</td>
</tr>
<tr>
<td>Conductivity (mg/l)</td>
<td>510.32±0.03</td>
<td>166.72±0.48</td>
<td>-</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>25.73±0.02</td>
<td>25.46±1.27</td>
<td>-</td>
</tr>
</tbody>
</table>

The results are mean ± standard deviation of water samples [9], [10].
Dissolved Solids (DS): The values obtained from the two fresh water bodies, 317.25 mg/l (Ope-ekwe) and 353.25 mg/l (Ikwo-ihie) are within WHO [9] standard. High Dissolved Solid in water may be due to water pollution when waste from industrial sites is discharged into the water bodies. The quantity of dissolved solids can cause undesirable taste, gastro-intestinal irritation and corrosion when used [1].

pH: $P^\text{H}$ is an important parameter in water body since most of the aquatic organisms are adapted to an average $P^\text{H}$ and do not withstand abrupt changes [11]. The $P^\text{H}$ values are 6.39 (Ikwo-ihie) and 7.22 (Ope-ekwe). The limit of pH value for drinking water by WHO [9] is 6.5-9.5. The $P^\text{H}$ value for Ikwo-ihie is slightly acidic while Ope-ekwe is slightly alkaline.

Total Solids (TS): Total solids comprise both suspended solids (SS) and total dissolved solids (TDS). The values for total solids are 341.75 mg/l (Ope-ekwe) and 217.50 mg/l (Ikwo-ihie). The high values of total solids in the samples can be drawn from human activities in the area such as farming and erosion.

Suspended Solids (SS): Suspended solids observed in Ope-ekwe water sample showed a higher value up to 17.75 mg/l, while Ikwo-ihie has a lesser value of 2.36 mg/l.

Dissolved Oxygen (DO): DO is one of the most important parameter. Its correlation with water body gives direct and indirect information e.g. bacterial activity, photosynthesis, availability of nutrients, stratification etc. [12]. The DO values are 12.51 mg/l and 12.77 mg/l for Ope-ekwe and Ikwo-ihie respectively.

Total Hardness (TH): Hardness of water is caused by Mg$^{2+}$ and Ca$^{2+}$ [1]. The values for total hardness in fresh water samples are 6.27 mg/l (Ope-ekwe) and 3.63 mg/l (Ikwo-ihie). The levels of hardness in the water samples are within WHO (2008) permissible limit of 20 mg/l.

Chemical Oxygen Demand (COD): COD is the amount of dissolved oxygen required to cause chemical oxidation of the organic material in water [1]. COD values for the fresh water samples ranged from 0.03 mg/l (Ope-ekwe) to 4.80 mg/l (Ikwo-ihie). The COD levels for the fresh water samples are within the WHO [10] permissible limit for drinking water.

Biological Oxygen Demand (BOD): BOD is the amount of dissolved oxygen required for the biochemical decomposition of organic compounds and the oxidation of certain inorganic materials (e.g., iron, sulphites) [1]. The observed BOD values in both fresh waters are 0.03 mg/l (Ope-ekwe) and 30.50 mg/l (Ikwo-ihie). The WHO [10] limit for BOD is 6. With Ikwo-ihie having 30.50 mg/l BOD value which is above WHO permissible limit, it can be traced to high human activities; especially open defecating around the area. Its high level decreases the amount of dissolved oxygen in water [1].

Chloride: Chlorides are important in detecting the contamination of fresh water bodies by industrial and anthropogenic activities [11]. Chlorides are water additives used to control microbes [1]. The levels of Chloride in the water samples are 10.62 mg/l (Ope-ekwe) and 14.35 mg/l Ikwo-ihie and are within the WHO [10] permissible limit of 250 mg/l.

Sulphate: Sulphate occurs due to dissolved Ca/Mg/Fe sulphate [1]. The sulphate values for Ope-ekwe and Ikwo-ihie are 70.14 mg/l and 84.15 mg/l respectively. The values are within WHO [10] 250 mg/l permissible limit.

Nitrate: Run-off from fertilizers and erosion of natural deposits are factors that increase nitrate concentration [1]. The values of nitrate from the fresh water bodies are 54.01 mg/l and 27.00 mg/l for Ope-ekwe and Ikwo-ihie respectively. The high value of nitrate recorded in Ikwo-ihie fresh water can be attributed to faecal deposits around the fresh water body and is against WHO [10] 45 mg/l permissible limit.

Phosphate: Their presence in water is due to detergents, fertilizers and biological processes. Phosphates are essential for growth of organisms and at low concentration inorganic phosphates play a vital role in aquatic ecosystem. The phosphate values obtained from the fresh water bodies are 4.61 mg/l (Ope-ekwe) and 3.81 mg/l (Ikwo-ihie).

Alkalinity: This describes the presence of dissolved carbonates ($CO_3^{2-}$) and bicarbonates ($HCO_3^{-}$) in fresh water bodies [1]. The values obtained from the fresh water bodies are 276.50 mg/l (Ope-ekwe) and 22.50 mg/l (Ikwo-ihie). The W.H.O. [10], permissible limit for alkalinity is 200 mg/l. The highest value was obtained from Ope-ekwe fresh water, which is above WHO
permissible limit. This could be as a result of mineral deposits in water from soil and other industrial waste discharge into the fresh water bodies [11].

**Acidity:** Acidity is an important parameter in determining water stability. The acidic values from the water bodies are 14.50 mg/l (Ope-ekwe) and 4.30 mg/l (Ikwo-ihie). The 14.50 mg/l value of Ope-ekwe can be drawn from the activity of carbonate compounds such as limestone found in the fresh water body which can neutralize acidity in the fresh water body [13]. The acidity of the surrounding environment can also affect the pH of water. This is most obvious near mining areas, but the effect can also occur naturally. Acid runoff depletes the water’s alkalinity and lowers pH below optimum levels [14].

**Electrical Conductivity (EC):** Dissolved solids present in water increases conductivity and high conductivity increases corrosive nature of water [1]. The electric conductivity value for Ope-ekwe is 510.32 mg/l while Ikwo-ihie is 166.72 mg/l. The high EC in Ope-ekwe fresh water body suggest the high corrosive nature of the water body attributable to the high use of agrochemicals such as fertilizers in the water body area.

REFERENCES