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Physicochemical and Microbiological Parameters of Waters from the Ogbe Ijoh and Aladja Rivers

Ejomafuwe Erhuen[1] and *Churchill Oriomah[2]
[1](Department of Industrial Safety and Environmental Technology, Petroleum Training Institute, Effurun-Delta State Nigeria)
2(Department of Biology, Nigeria Maritime University Okerenkoko, Warri South-West Delta State Nigeria)
Corresponding Author: Churchill Oriomah Email:oriomahchurchill@gmail.com

Abstract: *Water samples were collected from three different locations each for both the Ogbe Ijoh (OG) and Aladja (AL) Rivers both of Delta State Nigeria and were designated OG1-OG3 and AL1-AL3 respectively. The samples were analysed for some physicochemical and microbiological parameters using standard methods. The results obtained were compared with Standard Organization of Nigeria (SON) and WHO standards for drinking and recreational water. The results showed pH (6.68-6.87 and 6.4-6.6), Temperature range (28 - 28.4°C and 32.7 - 33.1°C), Conductivity (98.4 - 107.8 µS/cm and 283-415 µS/cm), Total Dissolved Solids (260 - 290 mg/L and 201- 297 mg/L), Turbidity (28 - 28.4 NTU and 20.42 - 22.34 NTU), Dissolved Oxygen (4.0 - 5.67 mg/l and 5.8 - 5.9 mg/l), Biological Oxygen Demand (1.77 - 2.08 mg/l and 1.95 - 2.36 mg/l), Chemical Oxygen Demand (3.32 - 5.47 mg/l and 4.88 - 6.0 mg/l), Total Hardness (116.13 - 151 mg/L and 20.32 - 27.41 mg/L), Chlorides (540.3 - 633.7 mg/l and 87.2 - 137.45 mg/l), Total Alkalinity (10.0 – 25.67 mg/l and 16.43 – 26.33 mg/l) for the Ogbe Ijoh (OG) and Aladja Rivers (AL) Rivers respectively. Results of the Atomic Absorption Spectrophotometric (AAS) analysis for some metals showed that the iron concentrations (0.111 – 0.124 mg/l and 0.162- 0.217 mg/l) were less in both the Ogbe Ijoh (OG) and Aladja (AL) Rivers respectively. That of Lead for the Aladja River (0.0073±0.0035 mg/l) was within the SON and WHO limit for drinking and recreational water. However the Lead for the Ogbe Ijoh River (0.036±0.01 mg/l was above the acceptable limit. The analysis of microbiological parameters revealed very high Total Coliform Count for all the water samples, ranging between 27×10^4 cfu/ml - 90×10^4 cfu/ml and 83×10^4 cfu/ml - 91×10^4 cfu/ml for the Ogbe Ijoh and Aladja Rivers respectively, which are higher than the acceptable limits. The presence of high microbial load renders the water unfit for human consumption and recommendation were made to implementing pollution control measures to the rivers and treatments before they are consumed or put to any reasonable domestic applications.*
Key Words: *Aladja River, Ogbe Ijoh River, microbiological analysis, physicochemical analysis*

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I. Introduction

Water is one of the most indispensible and invigorating resources for human life as it constitutes about 60% of the human adult's body. According to Bhati (2010), 70 % of the Earth's surface is covered by water, of which about 97% is salt from the ocean while the remaining less than 3% are contained in soil, rivers, lakes, ground water as well as ice and glaciers. Inspite of the abundance of earth's water, only a small percentage (about 0.3 %), is even usable by humans [1]. The other 99.7 % is in the oceans, soils, icecaps, and floating in the atmosphere. Yet, much of the 0.3 % that is useable is unattainable. Most of the water used by humans comes from ground water and rivers.

The Ogbe Ijoh and Aladja rivers serve as sources of drinking water, fishing and other domestic activities to the community dwellers. However, the rivers are not left out of being polluted as a result of the domestic, industrial and agricultural wastes that are constantly being deposited, which has posed a lot of dangers to public health [2]. Health risks which include respiratory disease, cancer, diarrheal disease, neurological disorder and cardiovascular disease have been associated the consumption and use of polluted water [3].

Since the suitability of water uses is determined by the quality of the water, it is necessary carrying out a periodical water quality assessment as a result of daily human activities around the water basin to achieve pollution control measures that are more environmentally sound, so as to eradicate the potential hazards associated with the use of contaminated water supply. The aim of this study is to do a comprehensive analysis of the Ogbe Ijoh River to determine the extent of pollution in the river.

II. Material and Methods

2.1 Study Area

Ogbe Ijoh is a place situated in Warri south west of Delta state Nigeria. Its geographical coordinates are 5^0 28' 0" N and 5^0 44' 0" E. It is has a river called the Ogbe Ijoh River. Aladja is a coastal town and one of the largest and highly populated indigenous towns in delta state Nigeria with coordinates 5^0 20' 0" N and 6^0 11' 0". They are neighboring communities of 35.3km apart. The Ogbe Ijoh river here is coded as (OG) while the Aladja river is coded as (AL).

2.2 Sampling

The water samples were, in each case, collected at three different points of the two rivers; two each, from the sides and middle of the running water at distances of 500 meters intervals. Samples collected from the Ogbe Ijoh river were labeled OG1 to OG3 while those collect from the Aladja River were labeled AL1 to AL3 in that order Water samples for microbiological analysis were leached in 10ml universal containers while 1.75ml plastic containers were used for water collected for chemical analysis. Samples which could not be analysed immediately were stored at 4^0C to avoid destabilisation. The holding period for all samples which could not be analysed immediately never exceeded 7days.

Figure 1: Map of study areas

2.3 Analysis of Physicochemical Parameters

The physicochemical analysis carried out on the water samples included the pH, temperature, Conductivity, Total Dissolved Solids (TDS), Chlorides, Total Hardness, Turbidity, Chlorides, Nitrate, Sulphate, Phosphate, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) which were determined by standard methods [4]. The pH, temperature and Dissolved Oxygen (DO) were determined and recorded immediately at the site. The determination of metal concentration for Lead (Pb) and Iron (Fe) were subsequently conducted using an Atomic Absorption Spectrophotometer (AAS) as earlier described in APHA (1998) and Aremu et al [4,5].

2.4 Microbiological Analysis

The samples were analysed for the detection and enumeration of total coliforms using conventional membrane filtration method (MF) according to APHA 1998. (1ml test sample, 99ml sterile phosphate buffered dilution water) and processed according to APHA 1998 [4]. The sterile cellulose nitrate membrane filter (Whatman 47mm diameter, 0.45µm pore size) was placed over a sterilized porous plate receptacle using sterile forceps, then sterilized funnel unit was placed over receptacle and locked. The samples were filtered through the membrane filter. After filtration the funnel was removed and the membrane filter was immediately placed on m-Endo Agar with a rolling motion to avoid entrapment of air, Petri dish was inverted and incubated for 22 to 24h at 35±0.5°C. Then the colonies were counted.

III. Results and Discussion

The results of the physicochemical and microbiology analysis of the water samples analysed from the Ogbe Ijoh and Aladja Rivers are presented in Tables 1 and 2.

3.1 pH

The pH range obtained was between 6.68-6.87 and 6.4-6.69 for the two Rivers, with a mean ± standard deviation of 6.79±0.1 and 6.54±0.115 respectively which is slightly acidic. These values falls within desirable pH limit for drinking water which ranges from 6.5 – 8.5 [6, 7]. When the pH becomes extreme, it increases the solubility of elements and compounds, making toxic chemicals more mobile, which increase the risk of absorption by aquatic lifes [8]. Also, pH values greater than 11 can cause skin and eye irritations, as well as pH below 4. Irreversible damage to skin and organ linings can be caused by a pH value below 2.5 [7]. Factors such as such as photosynthesis, respiration, temperature exposure to air, disposal of industrial wastes, acid mine drainage, geology and mineral content of a catchment area, agricultural runoff, carbon dioxide concentration in the atmosphere, and accumulation and decomposition of organic detritus in the water producing weak carbonic acids can impact the pH of an aquatic environment[9].

3.2 Temprature

The temperature range of the two rivers was between 28 – 28.4°C and 32.7 – 33.1°C, with a mean ± standard deviation of 28.17±0.21°C and 32.9 ± 0.2°C for the Ogbe Ijoh and Aladja Rivers respectively. The mean value of temperature from the ogbe ijoh river is within the World Health Organization (WHO) standard and national guidelines and standard for water quality (20^oC – 30^oC) in Nigeria for aquatic, industrial and agricultural uses while that of the aladja river was higher than the standard. Reuben et al. [10] reported the temperature range of 24.48±0.354 and 25.56±0.497 for the north and south location of the Rivers in Keffi, Central Nigeria respectively the slightly higher temperature obtained from the Aladja River may be an indicator that the water may be polluted due to different activities being carried on it. It may also be as a result of land and sea breeze which makes the water cold during the day and warm at night [11, 12].

3.3 Conductivity

Measurement of the conductivity helps in the determination of the concentration of dissolved salts in water since the formation of ions in the solution depends on the dissociation of inorganic compounds. The value obtained from the analysis of the Ogbe ijoh and Aladja Rivers ranges from 283-415 µS/cm and 98.4-107.8µS/cm with a mean ± standard deviation of 366.33±72.51 µS/cm and 107.17±8.47 µS/cm respectively, which is within the permissible limit [6, 7]. Although these values fell within the acceptable limits, they were nevertheless far less than the values obtained by by Olorode [13] (303µs/cm to 8972µs/cm). The variation in conductivity averages depends on the presence of the ions and their total conductivity, mobility, relative concentration and the temperature of measurement [14].

3.4 Total Dissolved Solid

The value of the total dissolve solid for the Ogbe ijoh and Aladja Rivers ranges from 260 – 290 mg/L and 201- 297 mg/L with mean ± standard deviation of 279.33 ± 18.55622 mg/L and 261 ± 52.31 mg/L respectively, which is within the permissible limit [6, 7]. The total dissolve solid (TDS) is a measure of the amount of dissolved material in water. It includes solutes such as chlorides, magnesium, bicarbonate, calcium, sodium and other solid residue that is remaining after evaporation of water from the sample. A higher concentration of TDS usually serves as no health threat to humans until the values exceed 10,000 mg/L [14].

Table 1: Physicochemical properties of water samples from different sites of Ogbe Ijoh River.

S/N	PARAMETER	OG1	OG2	OG 3	AVERAGE AND STANDARD DEVIATION	SON STANDARD
1	pH	6.87	6.83	6.68	6.79±0.1	6.5-8.5
2	Temperature (°C)	28.1	28	28.4	28.17±0.21	20-30
3	Conductivity (µS/cm)	401	283	415	366.33±72.51	1000
4	TDS (mg/L)	281	260	297	279.33±18.56	500
5	Turbidity (NTU)	26.8	37.5	20.5	28.27 ± 8.59	5
6	DO (mg/L)	5.13	5.67	4	4.93 ± 0.85	7.5
7	BOD (mg/L)	1.77	2.08	1.3	1.72 ± 0.79	6
8	COD (mg/L)	4.38	5.17	3.32	4.29±0.93	200
9	Total Hardness (mg/L)	116.13	151	134	133.71 ± 17.43	500
10	Chloride (mg/L)	540.3	633.7	621.6	598.53 ± 50.79	250
11	Iron (mg/L)	0.111	0.113	0.124	0.116±0.007	0.30
12	Lead (mg/L)	0.035	0.047	0.027	0.036±0.01	0.01
13	Total Alkalinity (mg/L)	16.76	25.67	10	17.48 ± 7.86	200
14	Total Coliform ($\times 10^4$cfu/ml)	27	43	90	53.3±32.74	0

Table 2: Physicochemical properties of water samples from different sites of Aladja River

S/N	PARAMETER	AL1	AL2	AL3	AVERAGE AND STANDARD DEVIATION	SON STANDARD
1	pH	6.4	6.52	6.69	6.54 ± 0.115	6.5-8.5
2	Temperature (°C)	32.9	32.7	33.1	32.9 ± 0.2	20-30
3	Conductivity (μS/cm)	98.4	115.3	107.8	107.17±8.47	1000
4	TDS (mg/L)	285	201	297	261 ± 52.31	500
5	Turbidity (NTU)	20.42	22.34	20.98	21.25±0.99	5
6	DO (mg/L)	5.8	5.8	5.9	5.83±0.058	7.5
7	BOD (mg/L)	1.95	2.1	2.36	2.14 ± 0.21	6
8	COD (mg/L)	4.88	5.25	6	5.38±0.57	200
9	Total Hardness (mg/L)	24.1	20.32	27.41	23.94 ± 3.55	500
10	Chloride (mg/L)	122.17	87.2	137.45	155.61±25.76	250
11	Iron (mg/L)	0.195	0.162	0.217	0.191±0.028	0.30
12	Lead (mg/L)	0.007	0.004	0.011	0.0073±0.0035	0.01
13	Total Alkalinity	16.43	18.62	26.33	20.46 ± 5.2	200
14	Total Coliform ($\times 10^4$cfu/ml)	85	83	91	86.33±4.16	0

3.5 Turbidity

The turbidity values that were recorded for the Ogbe ijoh and Aladja rivers ranges from 28 – 28.4 NTU and 20.42 – 22.34 NTU with mean ± standard deviation of 28.27 ± 8.59 NTU and 21.25±0.99 NTU respectively which is far above the acceptable limit (5 NTU) for drinking water [6, 7].

Turbidity is the measure of the degree of suspended particles in the water which makes it loses its transparency. The high turbidity values recorded in the two rivers may have been caused by phytoplankton, sediments from erosion, resuspension of sediments from the botton by benthic organisms, algae growth and urban runoff. High turbidity levels can reduce the amount of light reaching lower depths, which can inhibit growth of submerged aquatic plants and as a result affect organisms which are dependent on them [15, 16].

3.6 Dissolved Oxygen

The DO value that was recorded for the ogbe ijoh and aladja rivers ranges from 4.0 – 5.67 mg/l and 5.8 – 5.9 mg/l with mean ± standard deviation of 4.93 ± 0.85 mg/l and 5.83±0.058 mg/l respectively which is a little below the acceptable limit [6,7]. DO can be used to determine the extent to which a water body is being polluted. The higher the pollution rate, the lower the DO and vice versa [17]. Adequate dissolved oxygen is necessary for good water quality. Oxygen is a necessary element to all forms of life. Natural stream purification processes require adequate oxygen levels in order to provide for aerobic life forms. As dissolved oxygen levels in water drop below 5.0 mg/l, aquatic life is put under stress. The lower the concentration, the greater the stress. Oxygen levels that remain below 1.0-2.0 mg/l for a few hours can result in death of large number of fishes [18].

3.7 Biochemical Oxygen Demand

The BOD value that was recorded for the Ogbe ijoh and Aladja rivers ranges from 1.77 – 2.08 mg/l and 1.95 – 2.36 mg/l with mean ± standard deviation of 1.72 ± 0.79 mg/l and 2.14 ± 0.21 mg/l respectively. BOD value of 6.0 mg/l is considered as the acceptable limit while water with BOD value less than 4 mg/l are considered clean [19]. BOD is the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic materials present in a given water sample at certain temperature over a specific time period. It can be affected by variables such as temperature, pH, the presence of certain kinds of microorganisms, and the type of organic and inorganic material in the water.

3.8 Chemical Oxygen Demand

The BOD value that was recorded for the Ogbe ijoh and Aladja rivers ranges from 3.32 – 5.47 mg/l and 4.88 – 6.0 mg/l with mean ± standard deviation of 4.29±0.93 mg/l and 5.38±0.57 mg/l respectively. They were observed to be within the SON and WHO acceptable limits [6, 7]. COD is the amount of oxygen required for the decomposition of organic matter and the oxidation of inorganic chemicals like ammonia and nitrite. Increasing of COD value may be due to concentrations of pollutants and organic matter. The COD value of a water sample is always higher than the BOD value of the same sample.

3.9 Total Hardness

The value of the total hardness obtained from the water samples of the Ogbe ijoh and Aladja rivers ranges from 116.13 – 151 mg/L and 20.32 - 27.41 mg/L with mean ± standard deviation of 133.71 ± 17.43 mg/L and 23.94 ± 3.55 mg/L respectively. These values were within the stipulated SON and WHO acceptable limits (500 mg/L) [6, 7]. Water hardness is usually caused by carbonate and bicarbonate of calcium and magnesium.

Their relative low concentrations as recorded were indications of low contents of carbonates and bicarbonates which are the major causes of hardness of water.

3.10 Chloride

The value of the chloride obtained from the water samples of the ogbe ijoh and aladja rivers ranges from 540.3 – 633.7 mg/l and 87.2- 137.45 mg/l with mean ± standard deviation of 598.53 ± 50.79 and 155.61±25.76 mg/l respectively. Chlorides are salts resulting from the combination of the gas chlorine with a metal. Some common chlorides include sodium chloride (NaCl) and magnesium chloride ($MgCl_2$). The value obtain for the Ogbe Ijoh river is far beyond the WHO standard for portable water (250 mg/l) while that of the Aladja river was within the permissible limit [6,7]. High chloride content may harm metallic pipes, inhibit the growth of plants, slow reproduction and reduce the diversity of aquatic life. It may also result in salty taste of the water [7].

3.11 Iron

The value of the Iron obtained from the water samples of the ogbe ijoh and aladja rivers ranges from 0.111 – 0.124 mg/l and 0.162- 0.217 mg/l with mean ± standard deviation of 0.116±0.007 mg/l and 0.191±0.028 mg/l respectively, which falls within the SON and WHO acceptable limits (0.30 mg/L) [6, 7], when iron is present in high detectable amounts, it can affect the flavor of tea coffee and alcoholic beverages. It can also promote the growth of iron bacteria in water and also cause the water distasteful [20] (Yagoub and Ahmed 2009). Also, the consumption of water containing Fe above the acceptable limit will certainly have negative health implications as iron overload is associated with polycythemia [21].

3.12 Lead

The value of the Lead obtained from the water samples of the Ogbe ijoh and Aladja rivers ranges from 0.27-0.47 mg/l and 0.004-0.11 mg/l with mean ± standard deviation of 0.036±0.01 mg/l and 0.0073±0.0035 mg/l respectively, the mean value obtained for the Ogbe Ijoh river is higher than the limit of SON and WHO (0.01mg/l) while that of the Aladja river falls within the limit [6, 7]. The high concentrations of Pb recorded in this study with regard to the Ogbe Ijoh river may be as a result of the direct disposal of domestic wastes containing Pb from human activities at the riverbank and also gasoline containing Pb used in the fueling of speed boats engine that spilled. Cardiovascular effect, increased blood pressure, decreased kidney function, reproductive problems (in both men and women) have being linked to Lead exposure in adults. Exposure to Lead can cause damage to the central and peripheral nervous system, learning disabilities, shorter stature, impaired hearing, and impaired formation and function of blood cells in children. Lead can also cross the placental barrier exposing the fetus to Lead, which can result in growth impediment of the fetus and also premature birth [18].

3.13 Total Alkalinity

The value of the alkalinity obtained from the water samples of the Ogbe Ijoh and Aladja rivers ranges from 10.0 – 25.67 mg/l and 16.43 – 26.33 mg/l with mean ± standard deviation of 17.48 ± 7.86 mg/l and 20.46 ± 5.2 mg/l respectively, mean value obtained for the Ogbe Ijoh river is less than the SON and WHO acceptable limit (20-200 mg/l) for drinking water except for OG 2 (25.67 mg/l) [6, 7]. The mean value obtained for the Aladja River falls within the SON and WHO acceptable limit. However, a lesser value 16.43 and18.62 mg/l were recorded for AL1 and AL2 respectively. **Alkalinity** is a measure of a river's "buffering capacity," or its ability to neutralize acids. Alkaline compounds in the water such as bicarbonates, carbonates, and hydroxides remove H+ ions and lower the acidity of the water (which means increased pH). It is also important as an indicator of water body's ability to resist pH change with the addition of acid through acid rain and from an accidental spill or acid preparation [22]. Alkalinity helps to protect the pH of water bodies, therefore, pH of water bodies with lower alkalinity easily drops below 7 when contaminated with acidic solutions which may hinder the reproductive capacity of aquatic life and even cause death.

3.14 Total Coliform Count

The range of Total Coliform Count (TCC) obtained were between 27×10^4 cfu/ml - 90×10^4 cfu/ml and 83×10^4 cfu/ml - 91×10^4 cfu/ml for the Ogbe Ijoh and Aladja Rivers respectively. The values exceeded the SON and WHO of 0.00cfu/ml and 100cfu/ml respectively [6, 7]. The presence of such high concentration of coliforms which is an indication of the potential presence of entero-pathogens in water environments shows that the water had been influenced by human and animal wastes. Disease causing microbes (pathogens) in these wastes may pose a lot of risks to public health when the water is consumed without proper treatments. Diseases such as diarrhea, dysentery, cholera, typhoid fever had been linked with the consumption of contaminated water [23].

IV. Conclusion

We investigated the physicochemical and microbiological parameters of the Ogbe Ijoh and Aladja rivers. Although some of the physicochemical parameters fall within the acceptable limits by SON and WHO, few were however observed to be above the requirements. The presence of high microbial load renders the water unfit for human consumption, although they can be used for other purposes. The use of poor quality water for both drinking and domestic purpose could lead to serious health challenges to the populace as most of them greatly depend on the rivers as sources of water supply. It is therefore recommended that severe efforts in limiting the numbers of microorganisms released into the rivers in the study areas be implemented. Individuals residing along the riverine areas as well as those outside should be educated that nature always gives back what they give to it. Hence proper disposal of refuse, treatment of sewage and other pollution control majors should be encouraged. Also, they should be educated on the need to purity water from these rivers before consumption. Open defecation, especially around the rivers, which is a very common trend in the study areas should be discouraged.

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