

Assessment of Physiochemical Characteristics of Surface Water from Iwofe River, Niger Delta, Nigeria

Owoh-Etete Ukamaka^{1,2}, Ogunbiyi Oluwagbenga J.², Umeasiegbo Chioma U., Michael Nancy E.² and Yurkusi Mairam Medugu²

¹Department of Biology, Faculty of Natural and Applied Sciences, Ignatius Ajuru University of Education, Port Harcourt, Nigeria. ²Biology Unit, Faculty of Science, Air Force Institute of Technology, Air Force Base, Kaduna, Nigeria.

Corresponding author: owohetete@gmail.com

Abstract

This study was conducted to assess the physiochemical parameters of Iwofe River at Obio/Akpor Local Government Area of Rivers State. The study was investigated between the months of February - July 2021. Surface water samples were collected from six sampling stations with their corresponding control stations. Results were analyzed and compared with both the control and standard permissible limits for the various parameters under study for both river water samples respectively. The result of the sampling station and their respective control revealed the following: Temperature (Experimental station: $28.33 \pm 0.76^\circ\text{C}$; Control station: $27.67 \pm 0.81^\circ\text{C}$), pH (Experimental station: 6.86 ± 0.15 ; Control station: 6.61 ± 0.20). Salinity (Experimental station: $1.22 \pm 0.91\text{‰}$; Control station: $1.13 \pm 0.01\text{‰}$). BOD (Experimental station: $1.90 \pm 0.85\text{mg/l}$; Control station: $1.70 \pm 0.31\text{mg/l}$), DO (Experimental station: $4.23 \pm 0.68\text{mg/l}$; Control station: $5.92 \pm 0.90\text{mg/l}$), TDS (Experimental station: $51.74 \pm 8.52\text{mg/l}$; Control station: $50.33 \pm 6.03\text{mg/l}$), EC (Experimental station: $144.87 \pm 12.0\mu\text{S/cm}$; Control station: $108.3 \pm 4.16\mu\text{S/cm}$). The study also indicated that the mean value of the studied parameters of the river were below or within the permissible limit of DPR/FMEnv for Surface Water. This observation perhaps may be an indication that the river is a productive water system.

Keywords: Physiochemical, surface water, river, concentration, permissible.

Introduction

Polluted water may be unfit for human consumption, recreation and domestic purposes (Ekubo and Abowei, 2011). At source, water is pure, notwithstanding its contaminations differs depending on its different usage in different sector of human development. Seasonal change has been used as one of the ways to assess surface water quality (Arafat *et al.*, 2021). This is usually used as an indicator of pollution from rainfall or other sources since the values of different physicochemical properties varied with seasons (Arafat *et al.*, 2021).

Contaminated Water is one of the major leading cause of death for human across the globe (Moss, 2008). Water pollution affects our ocean, lakes, rivers as well as our drinking water thereby making it one of the major concerns all over the world (Moss, 2008). The assessment of water quality is very crucial, either as a check on its present state or as an instrument for management and policy implementation. In such way, some water pollution

effects may be recognized instantly, whereas others may not show up for months or years (UN-Water, 2018).

Recent report has shown that river water can be polluted by fecal materials and some organic wastes (Onyegeme-Okerenta *et al.*, 2016). Analysis of water quality carried out on Imeh, Edegelem and Chokocho Communities located along Otamiri-oché River in Etche ethnic of Rivers State in both rainy dry rainy seasons revealed that the river is not suitable for use as source of drinking water due to high numbers of coliform bacteria found in the water body (Onyegeme-Okerenta *et al.*, 2016). Assessment of water quality to ascertain its suitability for domestic purposes is very imperative since this water serve as the basis of life of residential people living in these riverine communities (Olubanjo and Adeleke, 2020).

Rivers are being polluted as a result of several factors such as indiscriminate dumping of sewage, agricultural waste, waste from industries and other human activities (Aboyeji, 2013), in and around creeks and this polluted river constitute a major environmental challenge, particularly to people in developing areas of Niger Delta region in Nigeria. Consequently, River Iwofe, Rumuolumini an important fishing site in Rivers State is presently impacted by human activities such as boating activities practice of oil bunkering and discharge of effluent by industries which deteriorates the water quality and alters the natural dynamics of aquatic ecosystem. Hence, it is crucial and imperative to regularly carry out an assessment on our rivers.

However, the aim of this research is to carry out an assessment of physiochemical properties of surface water along Iwofe River in order to ascertain its quality and current status.

Statement of Research Problem

Iwofe River is impacted by human activities and industrial discharge of effluents.

Materials and Methods

The study area was from two locations: Iwofe and Rumueme in Obio/Akpor Local Government Area of Rivers State is located between latitude 4.8°N and longitude 6.9°E. They are the tributary of the upper Bonny Estuary in the Niger Delta (Fig. 1). The Vegetation is dominated by Red Mangroves (*Avecennia nitida*). Human activities practiced within and around the river include boating, illegal oil bunker, transportation, excreta disposal, dredging, bathing and swimming.

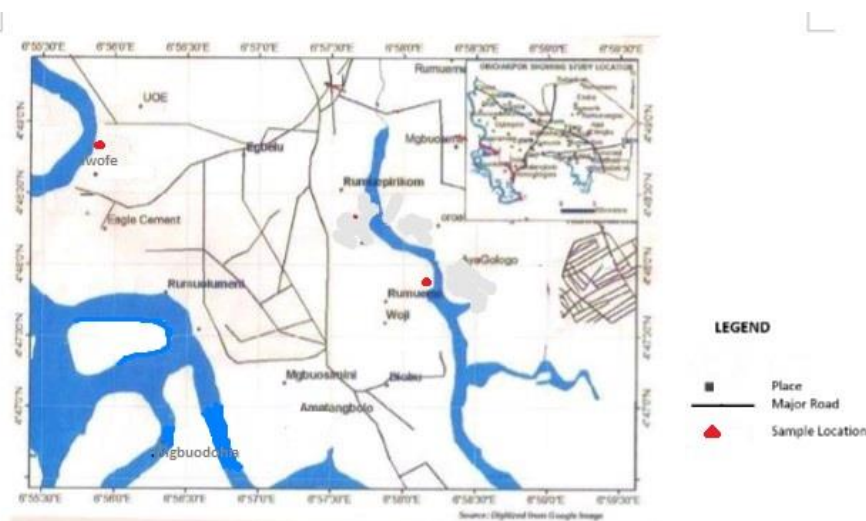


Fig. 1 Map of the study area showing the sampling stations

Source: Google map

Water Sample Collection and Analysis

Sampling was done at lowest ebb tide on a monthly basis for six months, samples were collected in clean plastic bottles of 2litre capacity preserved in ice packs and taking to the laboratory for analysis. Prior to their use, the bottles were thoroughly washed and rinsed with deionized water. Some parameters such as temperature, pH, electrical conductivity, total dissolved solids (TDS), dissolved oxygen (DO) and salinity were measured on site using Horriba water checker (U-10model) but that of biochemical oxygen demand (BOD) was carried out by measuring the amount of DO present in the sample before and after 5 days of incubation in the dark at 20°C.

Statistical Analysis

Data obtained from this study was statistically analyzed using SPSS (version 19.1). One Way Analysis of Variance (ANOVA) was used to determine significant variations between stations and season. Significant difference was set at $p < 0.05$.

Results and Discussion

A summary of some physicochemical parameters of surface water from Iwofe sampling stations and Rumueme the control stations in Rivers State recorded between the months of February to July 2021 was presented in Table 1. The parameters investigated includes: temperature, pH, salinity, Biochemical Oxygen Demand, Dissolved Oxygen, Total Dissolved Solids and Electrical Conductivity.

Table 1: Experimental Stations

Parameters	Study stations			
	I ₁	I ₂	I ₃	Mean±SD
Temperature (°C)	27.8	28.0	29.2	28.33±0.76
pH (units)	6.84	7.02	6.72	6.86±0.21
Salinity (‰)	1.18	1.15	1.32	1.22±0.091
BOD (mg/l)	1.48	1.33	2.86	1.90±0.85
DO (mg/l)	3.70	4.00	5.00	4.23±0.68
TDS (mg/l)	58.67	54.33	42.33	51.74±8.52
EC (µS/cm)	144.6	157	133.0	144.87±12.0

Source: Author's result

Table 2: Control Stations

Parameters	Study stations			
	I ₁	I ₂	I ₃	Mean±SD
Temperature (°C)	27.8	28.4	26.8	27.67±0.81
pH (units)	6.47	6.84	6.53	6.61±0.21
Salinity (‰)	1.12	1.14	1.13	1.13±0.01
BOD (mg/l)	1.37	1.77	1.97	1.70±0.31
DO (mg/l)	4.90	6.60	6.27	5.92±0.90
TDS (mg/l)	56.67	49.67	44.67	50.33±6.03
EC (µS/cm)	112.6	104.3	108.0	108.3±4.16

Source: Author's result

Table 3: Environmental Standards for Surface Water Quality

Parameters	Surface Water Stds. (drinking water)	Limit for discharge into surface water	WHO	DPR/FMEnv
Temperature (°C)	-	<40	35.0	35
Salinity (‰)	100-300/350	-	-	-
pH (units)	5-9	6-9	6.5-8.5	7.0-8.5
BOD (mg/l)	1.5	50	-	10
DO (mg/l)	6	-	7.5-10	10
TDS (mg/l)	250-500	-	100	500
EC (µS/cm)	-	-	-	10,000

Source: Author's result

Temperature: Temperature of the water samples recorded a mean of 28.33°C while the control stations recorded a mean of 27.67°C. The highest temperature of 29.2°C (I_2) was recorded from Iwofe sampling station whereas the lowest temperature of 27.8°C (R_3) were from Rumueme control station. Mean water temperature in all stations under study fell within the temperature of 20-35°C which is most suitable for plant growth but above 30°C may lead to regression (Kara *et al.*, 2004). The mean also compares favourably with 27.6°C reported by (Gideon *et al.*, 2013; Ige *et al.*, 2008) and 29.5°C to 32.67°C recorded by Oboh and Agbala (2017) while a slightly lower mean temperature of 18.44°C was reported by Rauf *et al.* (2015) in River Kabul Pakistan.

pH: The mean pH values ranges from 6.72 - 7.02 at Iwofe station, 6.47 - 6.84 at Rumueme station. The observed values from the study locations show that the water is slightly acidic which could be attributed to so many factors, including domestic activities and acid rain. Although pH value did not exceed 7.0 - 8.5 and 6.5 - 8.5 set by Department of Petroleum Resources and Federal Ministry of Environment (DPR/FMEnv). This is an indication that the various anthropogenic inputs did not alter the ambient pH of both waters (Davies and Abowei, 2019).

Salinity: Is a measure of the salt content of a water body. A mean salinity of 1.18‰, 1.15‰, and 1.32‰ respectively were observed from the sampled stations. The observed mean showed there was significant variation ($p < 0.05$) of salinity level in the water sample from the various locations, although the variation showed at the sampling location indicates that the ongoing anthropogenic activities in the River study station did not alter the salinity level of the water. Contrary the control stations recorded salinity value of 1.12‰, 1.14‰, and 1.13‰ respectively showing there was no significant ($p > 0.05$) variation between the stations. The observed mean of (1.22‰) and (1.13‰) obtained from the sampled and control stations respectively from this study was higher than 0.04‰ and 0.016‰ that was recorded from sampled and control station in Sagbama Creeks, Bayelsa State by Iyama *et al.* (2019).

Biochemical Oxygen Demand (BOD): The concentrations of biochemical oxygen demand under investigation were shown in Table 1&2. The sampled stations are I_1 (1.48mg/l), I_2 (1.33mg/l), and I_3 (2.86mg/l) whereas, the corresponding control stations R_1 (1.37mg/l), R_2 (1.77mg/l), R_3 (1.97mg/l). The mean concentration for the sampled and control station were 1.90 ± 0.85 mg/l and 1.70 ± 0.31 mg/l respectively. These mean values were higher than the permissible limit for surface water (1.5) limit for discharge into surface water (50 mg/l) and DPR/FMEnv of 10mg/l. The mean BOD values recorded in this present study was lower than 405.57mg/l reported by Andem *et al.* (2012) in Ona River but higher than those recorded of Iyama *et al.* (2019) in Sagbama Creek.

Dissolved Oxygen (DO): Dissolved Oxygen recorded spatial variations in the study stations as I_1 (3.70mg/l), I_2 (4.0mg/l), I_3 (5.0mg/l) while the control stations recorded R_1 (4.9mg/l), R_2 (6.67mg/l), R_3 (6.27mg/l). The mean concentration of DO for both sampling stations and control were 4.23 mg/l and 5.92 mg/l respectively. DO was significantly ($p < 0.05$) higher in Rumueme station (5.92mg/l) when compared to that of Iwofe station. The observed higher concentration of DO in the control station when compared to the sampling station could be as a result of human interference and organic detritus. Momba *et al* (2006) reported that aquatic organisms may experience a deleterious effect if DO is depleted below 5mg/l in their ecosystem. Hence, the concentrations of DO in the study area are good to sustained aquatic organism. The observed range is however, at variance with the 7.20mg/l to 9.25 mg/l reported by Ali and Micheal (2013) in Lower River Niger, Lokoja but similar or comparable with 4.32mg/l to 6.62mg/l reported by Obire *et al.* (2003) in Elechi Creek, Niger Delta and 0.58 to 10.00mg/l recorded by Ikongbeh *et al.* (2014) in Lake Akata. Generally, the concentration of dissolve oxygen in the study area is low and this is thought to be as a result of human interference organic detritus or it could be as a result of direct discharge of wastewater into river system (Seng *et al.*, 2018).

Total Dissolve Solids (TDS): The concentration of total dissolve solid in the surface water, in Iwofe sampling station were higher than Rumueme control station. Statistical analysis showed that there was no significant difference between the concentration of TDS in the surface water between Iwofe and Rumueme Creek. The TDS range of 42.23-58.67mg/l and 44.67-56.67mg/l were obtained from this study at the both Creeks. Once TDS level exceeds 100mg/l it is considered unfit for drinking. The values of TDS in this study were all below the limits (500mg/l) and (1000mg/l) recommended by DPR/FMEnv and WHO respectively. This is an indication that organic solids in water were negligible compare to the standard limits. Also, the range of TDS obtained in this investigation was lower than 17.500-20.00 mg/l obtained by Olayinka *et al.* (2018) in Atlas Cove Jetty Lagos, and the 21.54-50.03mg/l obtained by Oseji *et al.* (2019) in their study on assessment of physical and chemical characteristics of surface water from River Niger Illushi, Edo State, Nigeria. The range of 75.0-76.70mg/l reported by Elemile *et al.* (2019) is contrary to the present data.

Electrical Conductivity (EC): The highest value of conductivity was recorded at the Iwofe station (R_1) as 157.0 μ S/cm. The total mean of conductivity was 144.87 μ S/cm. Similarly, Rumueme (control station) R_1 had the highest conductivity (112.6 μ S/cm) followed by station 3 (108 μ S/cm) whereas the least were from station 2 (104.3 μ S/cm) with the total mean concentration of 108.30 μ S/cm. Conductivity observed from this study is however below the recommended limit of 500 μ S/cm by WHO (2004). However, the observed mean is lower than 3752.74 μ S/cm reported in New Calabar River (Agbugui and Deekae, 2014) but were higher than 40.80 μ S/cm and 94.0 μ S/cm reported by Iyama *et al.* (2019) in Sagbama

Creek Bayelsa and 6.0-17 $\mu\text{S}/\text{cm}$ observed by Sikoki and Anyanwu (2013) in Pristine Stream Nigeria.

Conclusion

This study has shown that the level of physiochemical characteristic properties of Iwofe River, Niger Delta, Nigeria were below and within the specified limits for drinking water as provided by DPR/FMenv and WHO. The values were also within acceptable limits specified by the regulatory bodies discussed in this paper. The levels of physiochemical parameters investigated suggest that Iwofe Creek is not contaminated by human interference.

Recommendations

- The need for regular and consistent risk assessment of physicochemical properties of river which is used domestically by people is very important year-in, year-out so as to keep abreast of the level of contamination therein.
- Regulatory bodies are encouraged to improve on sensitization of people in various localities most especially the rural areas dwellers, on how to avoid indiscriminate disposal or discharge into major water source which are used both domestically and industrially.

Conflict of Interest

The authors declare, there are no competing interest in submission and publication of this article.

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