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Physicochemical and microbiological analysis of water quality of Nworie river in Imo State, Nigeria.

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Abstract

Water can be a threat to public health when the chemical constituents or pollutants exceed certain standards or thresholds. To have safe drinking water, there is need for assessment of the water quality and regular monitoring. This study aimed to investigate the physicochemical and microbiological water quality of Nworie river, Imo State, Nigeria. Water samples were collected from two sampled points: upstream point 1 at Egbeada bridge and downstream point 2 at Umezurike hospital of Nworie river. The following Physicochemical parameters [Temperature, pH, DO, Colour, Turbidity, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Electrical Conductivity (EC), Biological Oxygen Demand (BOD_5) and ammonia concentration (AC)] were measured at the river with their specific meters, while the biochemical oxygen demand (BOD_5) was measured and microbiological analysis (total bacteria count and total coliform count), carried out in the laboratory with nutrient and MacConkey agars respectively. The result of the mean values of the Physicochemical parameters were measured as follows; Temperature (29.60±0.25 and 29.60±0.36 ^oC), pH (6.40±0.12 and 6.35±0.24), DO (6.6±0.73 mg/L and 5.35±0.68 mg/L), Colour (82.5±1.46 PCU and 130.50±1.23 PCU), Turbidity (34.49±1.92 NTU and 71.93±1.03 NTU), TDS (66.95±0.56 mg/L and 53.63±0.58(mg/L), TSS (32.55±1.04 mg/L and 63.88±1.09 mg/L), EC (103.00±0.51 µS/cm and 82.50±0.72 µS/cm), BOD5 (2.8±0.94 mg/L and 1.55±1.6) and ammonia (1.43 mg/L and 1.560 mg/L) for Egbeada and Umezurike hospital respectively. The results of the microbiological analysis showed values for both total bacteria count and total coliform count as 8.1×107 cfu/ml and 1.48×108 cfu/ml and 9.8×107 cfu/ml from point 1 and point 2 respectively. Some of the results gotten were above the permissible limits set by the Federal Ministry of Environment (FME). This indicated that the water from the river were unsuitable for drinking, swimming, irrigation or other domestic activities.

Keywords: Water; Physicochemical; Microbiological; Nworie River; Imo State

1. Introduction

Water resources are necessary for human consumption, environmental systems, sustainable agriculture, economic growth, and life as we know it. The primary causes of surface water pollution, particularly in rivers and streams, are industrial discharge, agriculture, open defecation and urbanization (Okey-Wokeh *et al*., 2021, Akpabio *et al*., 2024).

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Drinkable water for human use needs to be free of biological contaminants such bacteria, viruses, and protozoan parasites. It should not have any taste, smell, or colour as recommended for home use (WHO, 2017). In order to have a safe drinking water, there is need that the quality of the water be assessed and monitored (Bekele *et al*., 2019, Essien *et al*., 2024).

Once water is contaminated, it is very difficult, costly, and often impossible to remove the pollutants. Still today, 80 per cent of global wastewater releases untreated into the water bodies, containing everything from human waste to highly toxic industrial discharges (UNEP. 2019, Essien *et al*., 2025). It has been reported that, worldwide, around two million people die annually due to water-related diseases (UNESCO, 2017). Diarrhea, which is mostly spread by enteroviruses in the aquatic environment, is the most prevalent illness brought on by water pollution (Lin *et al*., 2022). Therefore, the physicochemical properties of surface water are constantly changing due to activities within and around it such as farming, fishing, indiscriminate dumping of wastes, exploration and exploitation of solid minerals etc. (Fagorite *et al.,* 2019).

The most common diseases caused by water pathogens are diarrheal diseases, such as cholera, typhoid, amoebiasis, giardiasis, and cryptosporidiosis. Waterborne infectious diseases are linked through fecal-oral transmission, and infections can be direct (human to human, animal to human) or indirectly through contaminated drinking, recreational water, and food with infectious cysts or inhalation (Okere *et al*., 2024). According to Essien *et al*., (2025), water pollution causes significant public health implications and has raised numerous concerns. Hence, the need to assess the physicochemical and microbiological water quality of Nworie River in Imo State, Nigeria.

2. Methodology

2.1. Study Area

Nworie River is a freshwater river in the south-eastern part of Nigeria that passes through Owerri and drains into the Otamiri River at Nekede. The length of the river from its source to its confluence is 9.2 km and it runs approximately 5.0 km course through Owerri, the capital of Imo State in Nigeria. The river is of enormous economic importance to inhabitants of Owerri as it serves as a water source for various domestic uses and also supports a substantial recreational and part-time fishing for youths.

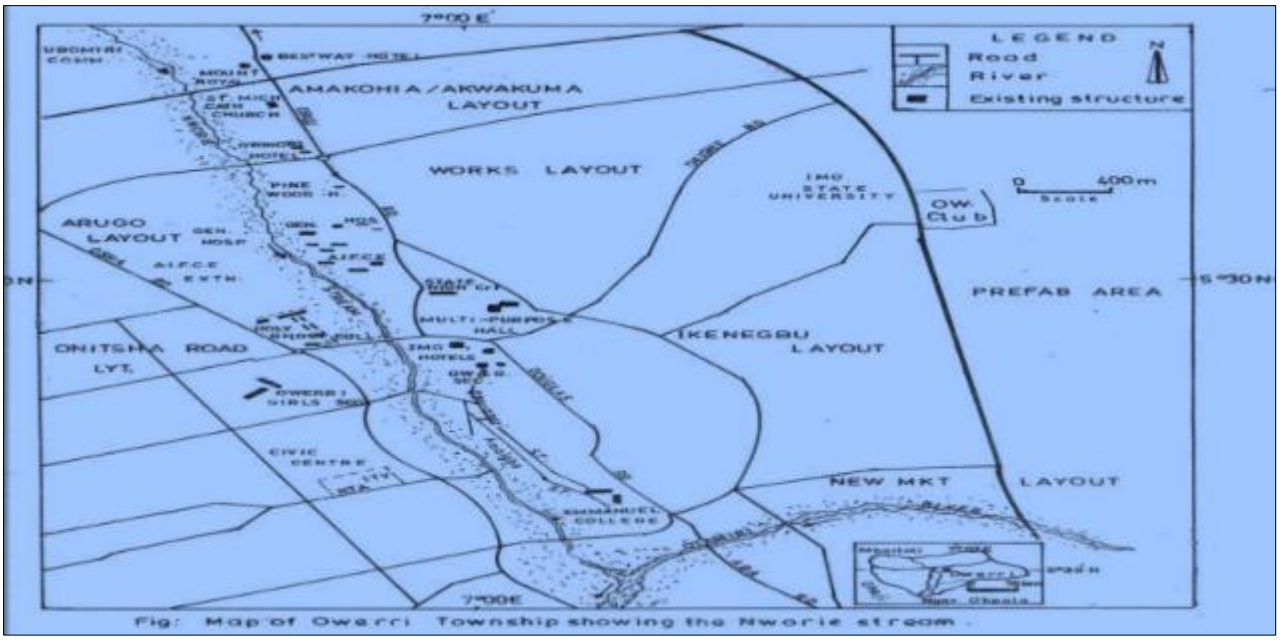

Figure 1 Map of Owerri Township showing the Nworie River (Udensi *et al*., 2014).

Figure 2 Image of the upstream of Nworie river along Egbeda bridge

Figure 3 Image of the downstream of Nworie river along Umezurike hospital

2.2. Physicochemical parameters

Some of the physicochemical parameters were measured on site. They include the following and their respective instruments temperature (mercury-in-glass thermometer), pH (pH metre), EC (conductivity meter), DO (Model Harman DO metre), turbidity (turbidimeter) and ammonia concentration at the river. While, ex-situ parameters such as BOD and TDS were measured in the laboratory using the respective instruments

For BOD_5, the water samples were incubated in an amber bottle and stored in a dark place for 20^oC for 5 days, after which a DO meter was used to measure the amount of dissolved oxygen in the water samples. For AC, 25 ml of water sample was added into 100 ml conical flask, then 1ml of phenol solution, 1ml of sodium nitroprusside, and 2.5 ml of oxidizing reagent were added and was kept inside a fume cupboard for 1 hour to develop a blue colour. The readings of the absorbance were measured using a spectrophotometer.

2.3. Bacteriological/Microbiological Analysis

2.3.1. Preparation of Media

Microbial analyses were conducted immediately to avoid increase of bacterial load in the water samples. Two media, Nutrient agar (for total bacteria count) and MacConkey agar (for total coliform count) were prepared and used to analyze the samples.

2.3.2. Innoculation of the water sample

Innoculation was carried out by the use of micro pipette, 0.1ml and poured into the petri dish with media, then, the spread plate method was used for the innoculation. After inoculation of the samples, the petri dishes were incubated in the incubator at 37 ^oC for 18-48 hours, using colony counter to count the colonies on the petri dishes.

3. Results

3.1. Physicochemical parameters of the water samples collected from Nworie River

These results revealed that both upstream (Egbeada) and downstream (Umezurike hospital) points had a temperature of 29.6°C, which is within the FME limit (20-30°C). The upstream pH (6.40) and downstream pH (6.35) were slightly acidic and below the recommended range (6.50-8.50). The DO level for upstream (6.6 mg/L) and downstream (5.35 mg/L) were below the required minimum (>7.50 mg/L). For colour and turbidity, 82.5 PCU and 130.5 PCU and 34.49 NTU and 71.93 NTU were recorded for upstream and downstream respectively. Which exceeded the acceptable limits (5 PCU and 10 NTU, respectively). For TSS, both upstream (32.55 mg/L) and downstream (63.88 mg/L) exceeded the acceptable limit (<10 mg/L). TDS and EC values were within permissible limits. BOD_5 recorded 2.8 mg/L and 1.55 mg/L values for upstream and downstream. Ammonia levels for both points exceeded the limit (0.30 mg/L), with 1.43 mg/L upstream and 1.56 mg/L downstream.

Table 1 Mean values of the Physicochemical Parameters of water samples collected from the sampled points

Physicochemical Parameters	Upstream Point 1 (Egbeada)	Downstream Point 2 (Umezurike hospital)	FEM. Limit
Temperature (^oC)	29.60±0.25	29.60±0.36	20.00-30.00
pH	6.40±0.12	6.35±0.24	6.50-8.50
DO (mg/L)	6.6±0.73	5.35±0.68	>7.50
Colour (PCU)	82.5±1.46	130.50±1.23	5.00
Turbidity (NTU)	34.49±1.92	71.93±1.03	10.00
Total Dissolved Solids (mg/L)	66.95±0.56	53.63±0.58	500.00
Total Suspended Solids (mg/L)	32.55±1.04	63.88±1.09	<10.00

Electrical Conductivity (µS/cm)	103.00±0.51	82.50±0.72	1000.00
BOD_5 (mg/L)	2.8±0.94	1.55±1.6	NS
Ammonia (mg/L)	1.43±0.08	1.560.06	0.30

(NS-Not stated, FEM. - Federal Ministry of Environment)

3.2. Microbiological Analysis

The Total Bacteria Count values (8.10×10^7 cfu/ml) at both locations exceed the FME limit (<2.2 cfu/ml). While the Total Coliform Count value for upstream (1.48×10^8 cfu/ml) and downstream (9.80×10^7 cfu/ml) coliform counts were significantly high, whereas the acceptable limit is 0.

Table 2 Microbiological Analysis of the water samples collected from Nworie River

Microbiological Analysis	**Upstream Point 1 (Egbeada)**	**Downstream Point 2 (Umezurike hospital)**	**FME**
Total Bacteria Count (cfu/ml) (in the nutrient agar) showed the presence of a creamy color and a size of 2-3mm regular shape	8.10×10^7	8.10×10^7	<2.2
Total Coliform Count (cfu/ml) (in the MacConkey agar) showed the presence of a pale pinkish color of size 2-4mm with a round shape	1.48×10^8	9.80×10^7	0

Key: FME - Federal Ministry of Environment.

4. Discussion

River water is used for different purposes such as swimming, washing clothes and as a result can be used as a medium to spread diseases. Nworie River is used for domestic and recreation purpose, fishing, washing clothes and cooking when there is inadequate water supply. Furthermore, when it rains water run-offs carrying agricultural and human wastes are discharged directly into the river, hence a channel of sewage and solid waste disposal.

The temperature of the water samples collected from both point 1 and point 2 (upstream and downstream) were within the FME standard which was in comparison to the values recorded by Ogolo *et al*., (2017) which had mean values between 30.0°C and 31.0°C. These values indicate that the water is within the permissible temperature range for aquatic life and domestic use.

The pH value recorded from the water samples collected from the river at point 1 and point 2 during this study were within the FME standard which was supported by a previous study (Njoku–Tony *et al*., 2016). The colour of the water samples was higher and above the accepted limit set by FME standard. These were similar to Umedum *et al*., (2013) that reported a light yellowish colour. A slightly acidic nature of the water can have ecological implications, potentially affecting aquatic organisms and the solubility of metals, making some toxic to aquatic life.

The DO values obtained from point 1 and point 2 during this research had the averages of 6.50 mg/l and 5.30 mg/l, respectively, and they were within the FME standard, but were higher in comparison to the results of the study by Ogolo *et al*., (2017) which showed a mean DO value of 0.75±0.9 mg/l in one station and 2.55±1.1 mg/l in another. The decline in DO downstream suggests increased organic matter decomposition, likely due to pollution from anthropogenic sources such as hospital waste and domestic discharges.

The increase in colour intensity downstream suggests pollution from effluents, suspended solids, and possibly organic or industrial contaminants.

The turbidity values were above the FME standard, which were in contrast to results recorded from Otamiri River (Okeke and Adinna, 2013), which had a higher value of 96.2 NTU in the rainy season. O High turbidity values indicate a high level of suspended particles, which may reduce light penetration, affecting aquatic photosynthesis and overall ecosystem health.

The TDS recorded from point 1 and point 2 were below the FME standard and which was different from to the findings of Murhekar (2011), who also reported higher TDS values of 221.00 mg/l to 3534.00 mg/l for river water. The primary causes of a higher TDS value in river water might be due to the discharge of domestic waste, sewage and other human activities like washing of clothes with detergent, parking vehicles near the river, etc. The river flow rate and volume also play a part in the level of total dissolved solids of the river. The TSS values obtained during this study from in point 1 and point 2 were above the FME standard. These results were higher than the study conducted by Umedum *et al*., (2013) of 0.14±0.12mg/L to 0.32± 0.01mg/L. The significant decrease in the TSS and TDS content of water samples observed at the upstream section could be linked to the observed correspondingly low count of heterotrophic bacteria enumerated at these sampling points. This result suggests low levels of dissolved ionic substances, making the water suitable for various applications. This suggests low levels of dissolved ionic substances, making the water suitable for various applications. However, high TSS levels may result from runoff, sedimentation, and organic matter accumulation, which could negatively impact aquatic organisms by clogging fish gills and reducing water clarity.

The values for EC were within the acceptable limit set by FME standard, but were lower than the values recorded by Ogolo *et al*., (2017) (438.00±86.49 µs/cm and 4793.50 ±1394.324 µs/cm) from a river. This suggests low levels of dissolved ionic substances, making the water suitable for various applications.

BOD_5 is a measure of microbial activities that consume dissolved oxygen in the water. The value obtained from this study were similar with the mean value of 3.27 ± 1.76 mg/l recorded in the study by Okey-Wokeh *et al*., (2021). A low BOD value at the downstream site might indicate reduced microbial degradation of organic matter, which could be attributed to lower DO levels.

The recorded value of ammonia obtained in this study were above the FME standard. On like result from similar study, Osokpor *et al*., (2014) reported very low values within the ranges of 0.09 mg/L - 0.26 mg/L.

The TBC indicates severe microbial contamination, likely from human activities such as sewage discharge, hospital waste, and runoff. While the presence of TCC indicates fecal contamination, making the water unsafe for direct consumption without treatment.

Previous studies have demonstrated that water quality and feed composition significantly influence the growth and nutritional quality of aquatic species (Okon et al., 2020; Essien *et al.,* 2024; Inyang *et al.,* 2024). Therefore, maintaining good water quality is crucial for sustaining aquatic biodiversity and local fisheries, making it imperative to assess the physicochemical and microbiological characteristics of rivers like the Nworie."

5. Conclusion

The result submits that as a result of pollution from hospital waste, sewage, and organic matter decomposition there is water quality deterioration downstream, which is evidenced by the increased turbidity, colour, TSS, and microbiological contamination beyond permissible limits. High bacterial counts pose serious health risks, indicating that the water is unsafe for direct human consumption.

Therefore, the water from Nworie river in Imo State, Nigeria requires treatment before use, including filtration, disinfection, and pH correction.

In furtherance, environmental health scientists/officers and stake holders should regularly monitor water bodies and drinking water sources, to prevent water-borne diseases. Indigenes of various communities around the river should embark on good water sanitary and hygiene (WASH) practices for a healthy and sustainable environment to prevent environmental pollution.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declared that NO conflict of interest was disclosed.

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