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RESEARCH ARTICLE



Water Characteristics, Pollution Status and Its Implication on Tropical Suburb River, Ago-Iwoye, Ogun State, Nigeria

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Abstract

Water is a vital resource essential for sustaining life and maintaining healthy ecosystems. However, increasing pollution threatens water quality, disrupts aquatic environments, endangers aquatic organisms, and poses serious health risks to humans who depend on contaminated sources. This study assessed the physico-chemical parameters and heavy metal concentrations in the Ome River, Ago-Iwoye, Ogun State, Nigeria, with consideration for the river's socio-economic importance to the region. Water samples were collected from five locations along the river. Physico-chemical parameters were measured in situ using a digital water testing probe, while heavy metal concentrations were determined using Atomic Absorption Spectrophotometry. The results showed that pH was slightly alkaline (7.71-7.96), and other parameters such as dissolved oxygen, total dissolved solids, oxidation-reduction potential, electrical conductivity, and temperature were within acceptable ranges. Heavy metal analysis revealed concentrations of iron (0.05-0.36 mg/kg), lead (0.03-0.16 mg/kg), copper (0.05-0.18 mg/kg), and zinc (1.14-1.28 mg/kg). While most parameters fell within acceptable thresholds, lead levels exceeded WHO limits at all sampling points, and iron levels exceeded permissible limits at some locations, raising serious concerns about environmental and public health risks. Overall, the Ome River exhibits generally good water quality; however, the elevated levels of lead and iron highlight the need for regular monitoring and pollution control to safeguard the river's ecological integrity and ensure long-term safety.

KEYWORDS: Heavy Metals, Ome River, Physico-chemical Parameters, Pollution, Water Quality

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1.0 Introduction

Water is a fundamental resource essential for sustaining life and supporting ecosystems (Boyd, 2012; Vannevel *et al.*, 2020). It is abundant in nature, covering about two-thirds of the Earth's surface (Mishra *et al.*, 2023). However, increasing demand and pressure on water resources are becoming global concerns (Grafton & Hussey, 2011). Rapid population growth, industrialization, poor sanitation, uncontrolled pollutant discharge, indiscriminate use of agricultural fertilizers, and other anthropogenic activities have led to widespread aquatic pollution, resulting in unsafe water quality and biodiversity loss (Ogidi & Akpan, 2022).

Monitoring water quality is essential because human activities have been linked to the spread of several water-borne diseases (Joshi *et al.*, 2009; Manjare *et al.*, 2010). Among water pollutants, heavy metals such as zinc, lead, arsenic, and copper are particularly hazardous. Their presence often indicates both natural and anthropogenic sources (Klavins *et al.*, 2000). These metals bioaccumulate in aquatic organisms, especially fish, and can be transmitted to humans through consumption (Fafioye *et al.*, 2017). Heavy metals can also alter the physico-chemical properties of water, reduce aquatic biodiversity, disrupt fish life cycles, and even cause mortality (Baby *et al.*, 2010; Oladunjoye *et al.*, 2024).

Water bodies that exceed permissible limits set by organizations like the World Health Organization (WHO) and the Federal Environmental Protection Agency (FEPA) pose significant risks to public health and ecological balance (Giri, 2021). While several studies have investigated the physico-chemical characteristics and heavy metal contamination of rivers in Nigeria, data on the Ome River remain scarce. To date, the only known study on this river is that of Fafioye et al. (2005), which focused primarily on selected physico-chemical parameters such as total dissolved solids, dissolved oxygen, and temperature among others. However, no data currently exist on the accumulation of heavy metals in this water body. This study, therefore, seeks to address this gap by assessing the water quality of the Ome River through comprehensive analysis of both physico-chemical parameters and heavy metal concentrations in Ogun State, Nigeria.

2.0 Materials and Methods

2.1 Description of the Study Site

The Ome River is located in Ago-Iwoye, Ogun State, southwestern Nigeria, between latitude 6° 51′ 54″ N and longitude 3° 49′ 56″ E (Figure 1). It is a major freshwater body serving the local community for agricultural, fishing, and domestic uses, including drinking water (Fafioye *et al.*, 2005).

2.2 Collection of Water Samples

Surface water samples were collected from five sampling points (Points 1–5), each spaced at least 200 meters apart, using the grab sampling method (Abui *et al.*, 2017). At each point, 1-liter plastic bottles (previously cleaned and rinsed) were used to collect water at a depth of 20–30 cm, following standard procedures (APHA, 2017). The samples were immediately transported to the laboratory for analysis.

2.3 Determination of Physico-chemical Parameters

In-situ measurements were conducted for physico-chemical parameters. Water depth was measured using a calibrated meter rule. pH was measured with a portable digital pH meter (Model pH-009), and temperature, conductivity (μ S/cm), and total dissolved solids (mg/L)

were measured using a Lamotte tracer pocket tester (Model 1766). Dissolved oxygen (DO) was measured using a portable digital DO probe (Model HI9146).

2.4 Determination of Metals Composition

A 10 cl water sample was placed in a Pyrex beaker with 0.1 cl concentrated HNO₃ and heated until the volume reduced to approximately 0.2 cl. After cooling, 0.05 cl HNO₃ was added and heated again to complete digestion. The solution was further treated with 0.05 cl HCl and cooled before adding 0.05 cl NaOH. The mixture was filtered, diluted with distilled water, and transferred into volumetric flasks. Concentrations of lead (Pb), iron (Fe), zinc (Zn), and copper (Cu) were analyzed using an atomic absorption spectrophotometer (VGB210, Bulk Scientific), following the method described by Oladunjoye *et al.* (2024).

2.5 Statistical Analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics were used to summarize the data, while one-way Analysis of Variance (ANOVA) was employed to assess significant differences (p < 0.05) in physico-chemical parameters and heavy metal concentrations across the five sampling points.

3.0 RESULTS AND DISCUSSION

3.1 Physico-chemical Parameters

The levels of pH in water samples collected from five different points along the Ome River in Ago-Iwoye, Ogun State, Nigeria, are illustrated in Figure 2. The results revealed that there was no statistically significant difference (p > 0.05) in the pH values recorded across the sampling points, indicating relative uniformity in the river's acid-base balance throughout the study area. The measured pH values ranged from 7.71 to 7.96, falling within the acceptable standards (6.5–8.5) recommended by the Federal Environmental Protection Agency (FEPA). This suggests that the water is slightly alkaline and suitable for most aquatic organisms, as extreme pH levels can adversely affect biological functions and aquatic biodiversity.

These findings align with those reported by Fafioye *et al.* (2005), who recorded pH values ranging from 6.7 to 7.2 in a previous study conducted on the same river. While slight differences exist between the two studies, these variations may be attributed to anthropogenic influences such as agricultural runoff, domestic waste discharge, and land use changes, as well as seasonal fluctuations in rainfall and temperature that affect water chemistry. Despite these potential influencing factors, both studies confirm that the pH levels of the Ome River remain within the safe and acceptable range established by regulatory standards. This consistency in pH values over time may indicate a relatively stable water chemistry in the river, although continuous monitoring is necessary to detect any emerging trends or deviations that could compromise ecological health.

3.2 Total Dissolved Solids

Table 1 shows that there was no statistically significant difference (p > 0.05) in the levels of Total Dissolved Solids (TDS) recorded in the water samples from the five sampling points. The observed TDS values, ranging from 264 to 287 mg/L, fall within the recommended limits (\leq 500 mg/L) set by the Federal Environmental Protection Agency (FEPA) and the World Health Organization (WHO) for domestic use and the survival of aquatic organisms. This suggests that the Ome River contains a low concentration of dissolved substances and can be considered to have good water quality (WHO, 2003). However, this result contrasts with the findings of

Adeshina *et al.* (2024), who reported lower TDS values between 56.50 mg/L and 85.23 mg/L in the Ogun River. The difference may be attributed to varying environmental conditions, land use patterns, or anthropogenic influences between the two river systems.

3.3 Electrical Conductivity

Table 1 shows that the level of Electrical Conductivity (EC) was significantly higher (p < 0.05) in the water samples from Point 1 compared to the other four sampling points. However, the EC values recorded at the remaining four points did not differ significantly from one another. The EC values ranged from $456.50 \pm 21.64 \, \mu \text{S/cm}$ to $501.75 \pm 14.55 \, \mu \text{S/cm}$, all of which fall within FEPA's permissible limit of 1,000 $\mu \text{S/cm}$. This indicates that the river contains a moderate level of dissolved salts and ions, likely originating from natural sources or minimal anthropogenic activities (Al Dahaan *et al.*, 2016). These levels are typical of freshwater bodies with moderate ionic content, possibly influenced by natural mineral deposits or light agricultural runoff, and are not indicative of severe pollution (Chebet *et al.*, 2020).

3.4 Dissolved Oxygen

The observed dissolved oxygen (DO) levels, ranging from 12.87 to 18.00 mg/L, fall within the permissible limits set by FEPA (\geq 4 mg/L), indicating that the Ome River has an adequate oxygen concentration to support aquatic life. These values suggest a well-oxygenated environment, which is essential for the survival and metabolic functions of aquatic organisms. However, the DO levels recorded in this study are considerably higher than those reported by Fafioye *et al.* (2005), who observed a range of 1.4 to 4.8 mg/L in the same river. This discrepancy also contrasts with the findings of Andem *et al.* (2012), who reported a mean dissolved oxygen level of 2.80 \pm 0.50 mg/L, indicating low oxygen availability for aquatic organisms in their study area. The higher DO levels observed in the present study may be attributed to seasonal variations, sampling time, or reduced organic pollution, all of which can influence oxygen dynamics in freshwater ecosystems.

3.5 Oxidation Reduction Potential

The level of oxidation-reduction potential (ORP) was observed to be significantly higher at Point 5, while no significant differences were found among Points 1 to 4. The recorded ORP values, ranging from 243.00 mV to 317.67 mV, showed a progressive increase from Point 1 to Point 5, reflecting increasingly oxidative conditions along the river course. These values exceed the 200 mV threshold typically associated with well-oxygenated environments and indicate favorable oxidative conditions. Such conditions are beneficial for supporting aerobic biological processes and reducing the bioavailability and toxicity of heavy metals like iron and lead, as high ORP levels are often associated with the presence of oxidizing agents that stabilize these contaminants in less harmful forms (Otiasah *et al.*, 2023). The observed oxidative state aligns with both FEPA and WHO standards, which underscore the importance of oxygen-rich aquatic environments in maintaining water quality, ecological balance, and reducing contaminant mobility.

3.6 Water Temperature

Temperature showed no statistically significant differences across the five sampling points. The recorded temperatures, ranging from approximately 29.50°C to 29.75°C, are typical of tropical aquatic environments and do not pose any threat to the homeostatic balance of the ecosystem (Igbinosa *et al.*, 2012). These values fall well within the acceptable range of 26–40°C established by the World Health Organization (WHO) and the Federal Environmental Protection Agency

(FEPA) for freshwater ecosystems. The stable temperature conditions observed across the sampling points suggest minimal thermal pollution and indicate that the river environment is conducive to the survival and proper physiological functioning of various freshwater species.

Table 1: Physico-Chemical parameters of water samples at five different points of Ome River, Ago-Iwoye, Ogun State, Nigeria

Parameter	Point 1	Point 2	Point 3	Point 4	Point 5	FEPA
TDS (ppm)	264.25±39.	272.00±45.	279.25±45.	293.50±51.	287.00±60.	
	41 ^a	51 ^a	40 ^a	06 ^a	73 ^a	≤500
EC (μScm ⁻¹)	501.75±14.	483.75±32.	456.50±21.	469.00±7.3	459.50±16.	
	55ª	50 ^b	64 ^b	9 ^b	30 ^b	1000
S. G	1.00±0.00 ^a	1.00±0.00a	1.00±0.00a	1.00±0.00a	1.00±0.00a	
Salt (ppm)	0.01±0.01 ^a	0.0000 01				
ORP (vM)	243.00±20.	251.00±17.	259.00±27.	259.67±34.	317.67±21.	
	66 ^b	09 ^b	22 ^b	39 ^b	08 ^a	≥200
Temp (ºC)	29.73±1.58°	29.63±1.35°	29.68±1.06°	29.75±1.75°	29.50±1.08 ^a	
DO (mgl ⁻¹)	12.87±3.23 ^a	13.87±1.97 ^a	18.00±2.23 ^a	14.90±2.39 ^a	15.10±3.39 ^a	≥4

^{abc}Mean (\pm Standard deviation) in the same row having similar superscripts are not significantly different (p > 0.05)

Keys; DO - Dissolved oxygen, EC - Electrical conductivity, TDS - Total dissolved solutes, SG - Specific gravity, ORP - Oxygen Reduction Potential

3.7 Levels of Heavy Metals

3.7.1 Levels of Iron

The concentrations of iron (Fe) in water samples collected from five different points along the Ome River in Ago-Iwoye, Ogun State, Nigeria, are presented in Figure 3. The results showed a statistically significant increase in iron levels (p < 0.05) from sampling Point 1 to Point 5. Notably, the highest concentration of iron was recorded at Point 4, followed by Points 5 and 3, respectively. In contrast, there was no significant difference (p > 0.05) in iron levels between Points 1 and 2. Iron concentrations at Points 1, 2, and 3 were below the permissible limit set by the World Health Organization (WHO), indicating relatively safe conditions at these locations. However, the elevated iron levels observed at Points 4 and 5 exceeded WHO guidelines, raising concerns about potential health risks and negative impacts on aquatic life.

3.7.2 Levels of Lead

Figure 4 shows the concentration of lead (Pb) in water samples collected from five different points along the Ome River in Ago-Iwoye, Ogun State, Nigeria. The highest Pb levels were observed at Points 1 and 5, with no significant difference between them (p > 0.05). This pattern suggests the possibility of localized sources of lead contamination at these locations, potentially from industrial discharges or surface runoff containing lead-based materials. However, the Pb concentration at Point 1 was significantly higher (p < 0.05) than those recorded at Points 2, 3, and 4, where the levels were relatively lower and showed no significant differences among themselves. Importantly, Pb concentrations at all five sampling points exceeded the WHO permissible limit, indicating a critical public health concern. Lead is a highly toxic heavy metal known to cause severe health issues, including neurological impairments and developmental delays, particularly in children (Olufemi *et al.*, 2022). Although the Pb levels recorded in this

study surpass regulatory thresholds, they remain lower than those reported by Alani *et al.* (2014), who documented Pb concentrations of 0.109 mg/kg in Ogun River water.

3.7.3 Levels of Copper

Figure 5 presents the concentrations of copper (Cu) in water samples collected from five different points along the Ome River in Ago-Iwoye, Ogun State, Nigeria. The results showed significantly lower copper levels at Points 1 and 2 compared to the other sampling locations. This distribution may suggest the presence of localized sources of copper contamination further downstream in the river. Conversely, the Cu levels at Points 3, 4, and 5 were not significantly different from one another but were significantly higher than those recorded at Points 1 and 2. Despite the variation observed across sampling points, all recorded copper concentrations remained below the permissible limit set by the World Health Organization (WHO), indicating that the current levels do not pose significant health risks. While copper is an essential trace element required for various biological functions, elevated levels can result in gastrointestinal irritation and, in severe cases, liver or kidney damage (Prashanth *et al.*, 2015).

3.7.4 Levels of Zinc

The levels of zinc (Zn) in the water sample at five different points of Ome River, Ago-Iwoye, Ogun State, Nigeria are represented in Figure 6. Zinc reported no significant difference (p > 0.05) in the water at each sample points. The zinc concentrations fell below the WHO permissible limit. Zinc is an essential nutrient with wide range of biochemical functions (Plum *et al.*, 2010) considered generally non-toxic to human, but its extreme levels can be toxic (Shankhla *et al.*, 2019). The observed Zn levels indicated that zinc contamination is not a major concern for the Ome River at the time of this study.

Conclusion

The study assessed key water quality parameters of Ome River, Ago Iwoye, Ogun State, Nigeria including pH, dissolved oxygen, total dissolved solids, electrical conductivity, oxidation-reduction potential, temperature, salinity, specific gravity and heavy metals concentrations (copper, iron, zinc, and lead). Conclusively, most physico-chemical parameters of the river water such as pH, dissolved oxygen, and total dissolved solids, fall within world standard recommended acceptable range. However, elevated lead levels at all sampling points and iron at specific locations (point 4 and 5) exceeded safety standards, raising concerns about potential health risks and the need for targeted contamination monitoring and control.

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APPENDICES: FIGURES

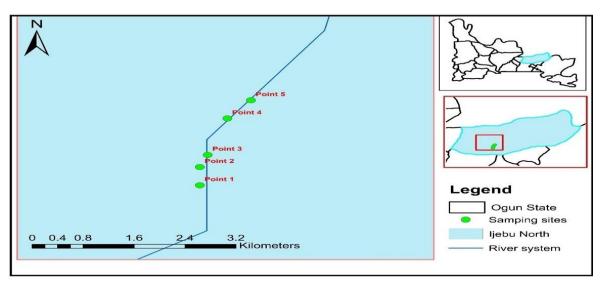


Figure 1: Map of Ome River, Ago – Iwoye Ogun State showing the sampling locations

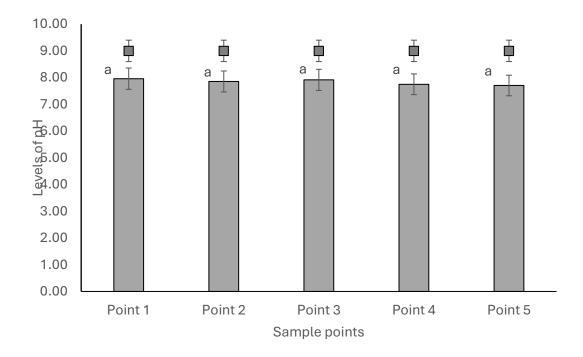


Figure 2: Levels of pH of the water samples. ^{ab}Bars with similar alphabets are not significantly different (p > 0.05)

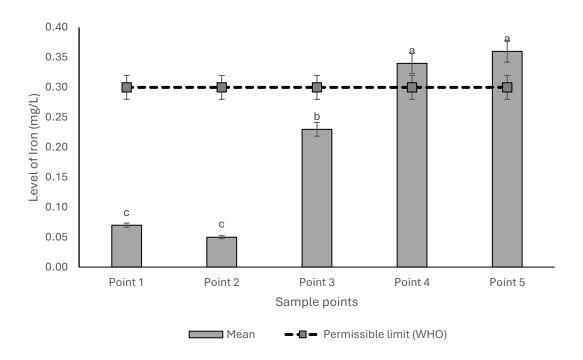


Figure 3: Levels of iron in water at five different points of Ome River, Ago-Iwoye, Ogun State, Nigeria

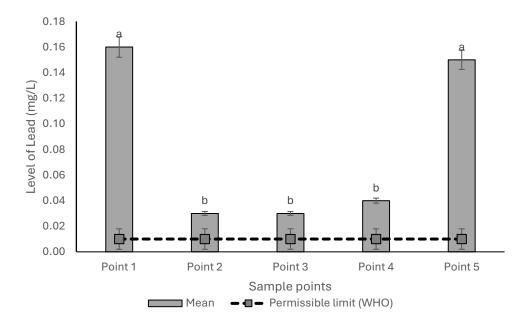


Figure 4: Levels of lead in water at five different points of Ome River. ab Bars with similar alphabets are not significantly different (p > 0.05)

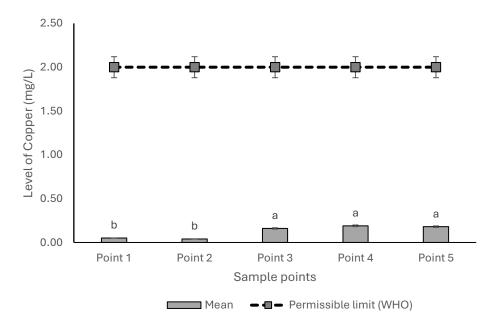


Figure 5: Levels of copper in water at five different points of Ome River. ab Bars with similar alphabets are not significantly different (p > 0.05)

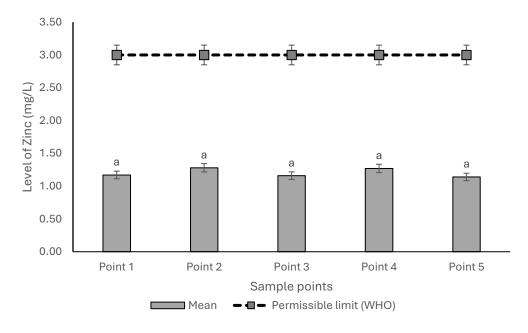


Figure 6: Levels of zinc in water at five different points of Ome River. ab Bars with similar alphabets are not significantly different (p > 0.05)