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Physicochemical Characteristics, Fish Species Composition and Diversity of Orakpa River, Kogi State, Nigeria

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Abstract

This study assessed the physicochemical characteristics, fish species composition, and diversity of Orakpa River, a tributary of the Lower River Niger in Kogi State, Nigeria. Water and fish samples were collected from three sampling stations (upstream, midstream, and downstream) over a three-month period (July-September 2022). Physicochemical parameters were analyzed using standard methods, while fish species were identified using taxonomic keys. Fish diversity was evaluated using Simpson's Index. Results showed that most physicochemical parameters, including pH (7.60-7.67), temperature (26.67-27.00°C), dissolved oxygen (5.03-6.30mg/L) and conductivity (95.25-140.72µS/cm), were within acceptable limits for tropical freshwater fish species. However, dissolved oxygen decreased downstream (5.03 mg/L), indicating localized environmental stress. A total of 646 fish individuals comprising 20 species from 10 families were recorded. The family Bagridae, particularly Bagrus bayad (23.2%), was the most dominant, while Schilbe mystus (0.7%) was the least abundant species. Fish abundance was highest at the midstream station and lowest downstream, reflecting variations in environmental conditions. The Simpson's Index of Diversity (1 - D = 0.90) indicated high species diversity, suggesting a relatively stable ecosystem despite moderate dominance by a few species. The study concludes that Orakpa River maintains good ecological status but shows signs of downstream environmental stress. These findings provide essential baseline data for sustainable management, conservation planning, and future monitoring of the river system.

Keywords:

Physicochemical paramters, Fish diversity, Species composition, Freshwater system, Water quality, Orakpa River.

1.0 INTRODUCTION

Physicochemical characteristics of water are fundamental determinants of the structure, diversity, and distribution of aquatic biota, particularly in riverine ecosystems. Water is an essential natural resource that sustains life and underpins ecological and socio-economic systems globally.

However, despite its abundance, accessible freshwater is limited and increasingly threatened by environmental degradation. Maintaining the structural and functional integrity of aquatic ecosystems has become a major environmental challenge, requiring continuous assessment of water quality and the factors influencing these dynamic systems (Ogren, 2014; Davie, 2018).

In recent decades, anthropogenic activities such as urbanization, agriculture, industrialization, and deforestation have significantly altered freshwater ecosystems. Rivers and streams, which traverse multiple land-use systems, are particularly vulnerable to pollution and habitat disruption (Leprieur *et al.,* 2018). These pressures have accelerated the loss of freshwater biodiversity through processes such as eutrophication, habitat fragmentation, and contamination (Pacheco *et al.,* 2016; Boris *et al.,* 2016). Consequently, aquatic organisms are continuously exposed to environmental stressors, and their distribution and abundance are shaped by the complex interactions between physicochemical conditions and biological processes (Tinotenda *et al.,* 2016; Xiang *et al.,* 2016).

In Nigeria, rivers and streams serve as critical resources for domestic, agricultural, and industrial activities, yet they are increasingly subjected to pollution due to weak regulatory enforcement. Elevated levels of organic and inorganic pollutants have been shown to alter key physicochemical parameters such as temperature, dissolved oxygen, pH, and nutrient concentrations, thereby compromising water quality and limiting its suitability for various uses (Oketola *et al.,* 2016; Bytyci et al., 2018). Given the dependence of aquatic organisms on these parameters, changes in water quality can have profound implications for fish diversity, distribution, and productivity.

Biological monitoring using aquatic organisms, particularly fish, provides an integrated approach to assessing environmental quality. Fish species are effective bioindicators due to their relatively long life cycles, trophic diversity, and sensitivity to environmental changes, enabling them to reflect cumulative impacts of habitat alteration and pollution over time (Mathuriau *et al.,* 2011). Understanding the relationship between physicochemical parameters and fish assemblages is therefore essential for evaluating ecosystem health and guiding sustainable management strategies.

The Lower River Niger at Koton Karfe, located in Kogi State, Nigeria, is an important freshwater system that supports local livelihoods, particularly fishing. The area is characterized by a derived savanna vegetation and distinct wet and dry seasons, with increasing anthropogenic pressures from surrounding communities. Despite its ecological and economic importance, there is limited information on the water quality status and fish species composition of its tributaries, including the Orakpa River.

Fish species composition and abundance are influenced by both biotic and abiotic factors, with physicochemical conditions playing a critical role in determining species survival, growth, and distribution (Kadye *et al.,* 2018). The decline in fish yields reported in many Nigerian inland waters has been attributed to environmental degradation and poor resource management (Jamu and Ayinla, 2013). Given that rivers often act as sinks for domestic and industrial wastes (Adeloye, 2014), there is a need for baseline data to support effective monitoring and management of these ecosystems.

Therefore, this study was undertaken to assess the physicochemical parameters and fish species composition of the Orakpa River, a tributary of the Lower River Niger at Koton Karfe. Specifically, the study aimed to evaluate the water quality characteristics, determine fish species composition, and assess species abundance within the river system. The findings are expected to provide baseline information for sustainable management of the river and contribute to existing knowledge on freshwater ecology in Nigeria.

2.0 MATERIALS AND METHODS

2.1 Study Area

The study was conducted in Orakpa River, a tributary of the Lower River Niger located at Koton Karfe in Kogi State, Nigeria (8.1046°N, 6.7976°E). The study area lies between Lokoja and Abuja within the derived savanna ecological zone, characterized by grasses, shrubs, and scattered trees. The region experiences two distinct seasons: a wet season (April-October) and a dry season (November-March). The river serves as an important source of water for domestic use, fishing, and other livelihood activities for the surrounding communities.

2.2 Sampling Design and Sample Collection

Sampling was conducted over a three-month period from July to September 2022. Three sampling stations were established along the river based on spatial variation: Station A (upstream, Orakpa village), Station B (midstream, opposite Old Government Girls Secondary School), and Station C (downstream, behind Koton Karfe market).

Water samples were collected twice monthly from each station, resulting in a total of 18 samples. Sampling was carried out between 06:00 and 08:00 h to minimize diurnal variation. Clean 2 L plastic bottles were used for sample collection; these were pre-treated by soaking in iodide solution for four days and subsequently rinsed with distilled water. At the sampling site, bottles were further rinsed with river water prior to sample collection. Samples were collected at a depth of approximately 10-20 cm below the water surface and transported to the laboratory for analysis.

2.3 Determination of Physicochemical Parameters

Physicochemical parameters were determined using standard methods, with some measurements conducted in situ and others in the laboratory.

Water temperature was measured in situ using a mercury-in-glass thermometer and recorded in degrees Celsius (°C). The hydrogen ion concentration (pH) was measured using a digital pH meter (Hanna model H196107) by immersing the electrode in the sample until a stable reading was obtained.

Transparency was determined using a Secchi disc by lowering it into the water column until it disappeared from view and then reappeared; the average depth was recorded in centimeters. Electrical conductivity (EC) was measured using a conductivity meter by immersing the probe in the sample and recording the value in µS/cm.

Dissolved oxygen (DO) was determined using the modified Winkler's azide method (APHA, 2008). In this method, water samples were fixed in BOD bottles with manganous sulphate and alkaline iodide-azide reagents, acidified with concentrated sulphuric acid, and titrated with sodium thiosulphate using starch as an indicator to determine oxygen concentration (mg/L).

General hardness (GH) and total alkalinity were determined using standard titrimetric procedures. For hardness, a measured volume of water sample was treated with GH reagents until a color change endpoint was reached, and the value was expressed in degrees hardness (dH). Total alkalinity was determined by titration with KH reagents until a color change from blue to yellow was observed.

Nitrate, nitrite, and ammonia concentrations were determined using colorimetric methods with standard test kits. For each parameter, a measured volume of water sample was treated with specific reagents, and the resulting color intensity was compared with standard color charts to estimate concentrations.

2.4 Fish Sampling and Identification

Fish samples were collected twice monthly from local fishermen operating at the sampling stations during the study period (July-September 2022). The collected specimens were transported to the Fisheries and Aquaculture Laboratory, Kogi State University for identification.

Fish species were identified to the lowest possible taxonomic level using standard identification keys (Leveque *et al.*, 1994; Olaoesele and Raji, 2005). The number of individuals per species was recorded for subsequent analysis of species composition and abundance.

2.5 Determination of Fish Diversity

Fish species diversity was assessed using Simpson's Diversity Index (Simpson, 1949), which accounts for both species richness and relative abundance. The index (D) was calculated based on the number of individuals of each species (n) and the total number of individuals (N), and diversity was expressed as:

$$D = \frac{\Sigma\, n(n-1)}{N(N-1)}$$

Simpson's Index of Diversity was then calculated as:

$$SID = 1 - D$$

where higher values indicate greater species diversity.

2.6 Statistical Analysis

Data obtained from physicochemical parameters were analyzed using one-way Analysis of Variance (ANOVA) to determine significant differences among the sampling stations. Where significant differences were observed, Duncan's Multiple Range Test (DMRT) was applied to separate the means. All statistical analyses were conducted at a significance level of $p < 0.05$.

3.0 RESULTS AND DISCUSSION

3.1 Physicochemical Characteristics of Orakpa River

3.1.1 Spatial Variation Across Sampling Stations

The physicochemical characteristics of Orakpa River across the three sampling stations are presented in Table 1.

Table 1. Physicochemical characteristics of Orakpa River across sampling stations (mean ± SEM)

Parameter	Station A (Upstream)	Station B (Midstream)	Station C (Downstream)
pH	7.67 ± 0.05[a]	7.60 ± 0.05[a]	7.60 ± 0.05[a]
Ammonia (mg/L)	0.10 ± 0.12[a]	0.48 ± 0.12[a]	0.12 ± 0.12[a]
Nitrate (mg/L)	0.94 ± 0.30[a]	1.47 ± 0.30[a]	0.51 ± 0.30[a]
Nitrite (mg/L)	0.01 ± 0.19[a]	0.50 ± 0.19[a]	0.34 ± 0.19[a]
Temperature (°C)	26.67 ± 0.32[a]	27.00 ± 0.32[a]	26.67 ± 0.32[a]
General Hardness (mg/L)	35.60 ± 4.20[a]	35.60 ± 4.20[a]	17.80 ± 4.20[b]
Electrical Conductivity (μS/cm)	120.33 ± 5.03[a]	95.25 ± 4.62[a]	140.72 ± 5.43[a]
Dissolved Oxygen (mg/L)	6.30 ± 0.93[a]	6.30 ± 0.93[a]	5.03 ± 0.93[b]
Transparency (m)	0.40 ± 0.06[a]	0.45 ± 0.06[a]	0.25 ± 0.06[a]
Alkalinity (mg/L)	35.60 ± 3.13[a]	23.73 ± 3.13[b]	17.80 ± 3.13[c]

Values are mean ± standard error of mean (SEM). Values with different superscripts (a, b, c) within the same row are significantly different ($p < 0.05$).

pH values were relatively stable across stations, ranging from 7.60 ± 0.05 to 7.67 ± 0.05, with no significant difference ($p > 0.05$). This near-neutral to slightly alkaline condition falls within the optimal range reported for tropical freshwater systems and is consistent with values documented for relatively unimpacted rivers (Napit, 2024; Joshi & Joshi, 2025). Similarly, temperature showed minimal variation (26.67-27.00°C) and remained within the suitable range for tropical aquatic organisms, as reported in comparable systems (Yongo *et al.,* 2023; Menon *et al.,* 2023).

Nutrient concentrations (ammonia: 0.10-0.48 mg/L, nitrate: 0.51-1.47 mg/L, nitrite: 0.01-0.50 mg/L) varied across stations but were not significantly different ($p > 0.05$). The slightly elevated values at Station B are comparable to ranges reported for mesotrophic tropical waters, where nutrient inputs are present but not excessive (Das *et al.*, 2023; Lafuente *et al.*, 2023). This suggests moderate nutrient conditions without clear evidence of eutrophication.

Dissolved oxygen (DO) showed a significant decline ($p < 0.05$) from upstream and midstream (6.30 ± 0.93mg/L) to downstream (5.03 ± 0.93 mg/L). Similar downstream reductions in DO have been widely reported in tropical rivers and are often associated with cumulative anthropogenic inputs and increased biological oxygen demand (Saha *et al.,* 2022; Ongh *et al.,* 2025). The downstream value (5mg/L) is below recommended thresholds for sensitive aquatic organisms, indicating localized stress conditions.

General hardness also decreased significantly downstream from 35.60 ± 4.20 mg/L to 17.80 ± 4.20 mg/L ($p < 0.05$), while alkalinity showed a similar declining trend (35.60 - 23.73 - 17.80 mg/L). Comparable longitudinal reductions in hardness and alkalinity have been linked to dilution effects and changing catchment influences in tropical rivers (Saha *et al.*, 2022; Lafuente *et al.*, 2023).

Electrical conductivity ranged from 95.25 to 140.72 µS/cm without significant variation, remaining within ranges typical of dilute tropical freshwater systems (Fotsing *et al.*, 2022; Yongo *et al.*, 2023). Transparency was consistently low (0.25-0.45 m), reflecting turbid conditions commonly observed in tropical rivers during active hydrological periods (Costa & Cutrim, 2021; Das *et al.*, 2023).

3.1.2 Monthly Variation in Physicochemical Parameters

The monthly variation in physicochemical parameters from July to September is presented in Table 2.

Table 2. Monthly variation in physicochemical parameters of Orakpa River (mean ± SEM)

Parameter	July	August	September
pH	7.53 ± 0.05^{a}	7.53 ± 0.05^{a}	7.87 ± 0.05^{a}
Ammonia (mg/L)	0.12 ± 0.12^{a}	0.12 ± 0.12^{a}	0.12 ± 0.12^{a}
Nitrate (mg/L)	1.23 ± 0.30^{a}	1.85 ± 0.30^{a}	0.87 ± 0.30^{a}
Nitrite (mg/L)	0.33 ± 0.19^{a}	0.01 ± 0.19^{a}	0.01 ± 0.19^{a}
Temperature (°C)	27.30 ± 0.32^{a}	26.33 ± 0.32^{a}	26.33 ± 0.32^{a}
General Hardness (mg/L)	29.67 ± 4.20^{b}	35.60 ± 4.20^{a}	35.60 ± 4.20^{a}
Electrical Conductivity (µS/cm)	110.21 ± 5.95^{b}	135.38 ± 6.34^{a}	115.62 ± 6.13^{b}
Dissolved Oxygen (mg/L)	7.17 ± 0.93^{a}	5.53 ± 0.93^{b}	7.16 ± 0.93^{a}
Transparency (m)	0.28 ± 0.06^{a}	0.45 ± 0.06^{a}	0.28 ± 0.06^{a}
Alkalinity (mg/L)	35.93 ± 3.13^{c}	31.47 ± 3.13^{a}	14.60 ± 3.13^{b}

Values are mean ± standard error of mean (SEM). Values with different superscripts within the same row are significantly different ($p < 0.05$).

pH remained stable across the sampling period (7.53-7.87, $p > 0.05$), consistent with reports of limited temporal variability in tropical freshwater systems (Das *et al.*, 2023; Joshi & Joshi, 2025). Similarly, ammonia concentrations remained constant (0.12mg/L) throughout the study, indicating minimal temporal fluctuation.

Nitrate values increased from 1.23mg/L in July to 1.85 mg/L in August, followed by a decrease to 0.87 mg/L in September, while nitrite decreased from 0.33 mg/L to 0.01 mg/L over the same period. However, these variations were not statistically significant and fall within ranges reported for moderately enriched tropical waters (Mehmood *et al.*, 2023; Lafuente *et al.*, 2023).

Temperature showed slight variation (26.33-27.30°C) with no significant difference, consistent with the relatively stable thermal regimes reported in tropical lowland rivers (Saha *et al.*, 2022; Yongo *et al.*, 2023).

In contrast, significant temporal variation ($p < 0.05$) was observed in general hardness, electrical conductivity, dissolved oxygen, and alkalinity. General hardness increased from 29.67 mg/L in July to 35.60 mg/L in August and September, while electrical conductivity peaked in August (135.38µS/cm) compared to July and September. Similar seasonal increases in conductivity and hardness during periods of high runoff have been reported in tropical aquatic systems (Vyas *et al.*, 2024; Al-Hajaj & Turab, 2025).

Dissolved oxygen decreased from 7.17mg/L in July to 5.53mg/L in August, before increasing to 7.16mg/L in September ($p < 0.05$). This pattern aligns with seasonal DO dynamics observed in tropical systems, where increased organic inputs and microbial activity during peak rainfall periods lead to temporary oxygen depletion (Das *et al.*, 2023; Vyas *et al.*, 2024).

Alkalinity showed the most pronounced variation, increasing from 14.60mg/L in September to 35.93mg/L in July, before declining to 31.47mg/L in August ($p < 0.05$). Such fluctuations have been linked to seasonal hydrological changes and variations in carbonate inputs in tropical rivers and reservoirs (Bhagde *et al.*, 2020; Vyas *et al.*, 2024).

3.2 Fish Species Distribution and Abundance

The spatial distribution and relative abundance of fish species recorded in Orakpa River are presented in Table 3.

Table 3. Spatial Distribution and Relative Abundance of Fish Species in Orakpa River

Family	Species	Station A	Station B	Station C	Total (N)	Abundance (%)
Bagridae	*Bagrus bayad*	50	75	25	150	23.2
	Bagrus filamentosus	20	10	18	48	7.4
Claroteidae	*Clarotes laticeps*	10	5	7	22	5.7
	Auchenoglanis occidentalis	2	8	1	11	1.7
Cichlidae	*Tilapia mariae*	23	19	29	76	11.7
	Oreochromis niloticus	27	17	32	76	11.7
Citharinidae	*Citharinus citharus*	12	5	6	23	3.5
Clariidae	*Clarias gariepinus*	21	16	4	41	6.3
	Heterobranchus bidorsalis	1	12	2	15	2.3
Cyprinidae	*Labeo coubie*	1	5	3	9	1.4
	Barbus occidentalis	5	1	2	8	1.2
Alestidae	*Alestes dentex*	4	7	6	17	2.6
	Alestes macrolepidotus	2	3	1	6	0.9
Lepidosirenidae	*Protopterus annectens*	10	5	1	16	2.5
Mormyridae	*Mormyrus rume*	10	9	21	40	6.6
	Mormyrops deliciosus	7	12	9	28	4.4
	Hyperopisus bebe	9	2	8	19	2.9
Polypteridae	*Polypterus senegalus*	2	5	8	15	2.3
Schilbeidae	*Parailia pellucida*	11	3	7	21	3.2
	Schilbe mystus	1	2	2	5	0.7
Total		**228**	**232**	**192**	**646**	**100**

A total of 646 individuals, comprising 20 species across 10 families, were recorded during the study period. Station B (midstream) accounted for the highest number of individuals (232), followed closely by Station A (228), while Station C (downstream) recorded the lowest abundance (192).

The family Bagridae was the most dominant, largely driven by *Bagrus bayad*, which contributed 150 individuals (23.2%) of the total catch. Other relatively abundant species included Tilapia mariae and *Oreochromis niloticus*, each contributing 76 individuals (11.7%). In contrast, *Schilbe mystus* (5 individuals; 0.7%) and *Alestes macrolepidotus* (6 individuals; 0.9%) were the least abundant species.

Spatially, *Bagrus bayad* was most abundant at Station B (75 individuals), followed by Station A (50) and Station C (25). Similarly, *Oreochromis niloticus* and *Tilapia mariae* were distributed across all stations, with relatively higher counts at Station C. *Mormyrus rume* showed higher abundance at Station C (21 individuals) compared to Stations A (10) and B (9).

Some species exhibited marked spatial variability. *Clarias gariepinus* was more abundant at Stations A (21) and B (16) but declined sharply at Station C (4). *Heterobranchus bidorsalis* was most abundant at Station B (12 individuals) and scarce at Stations A (1) and C (2). Similarly, *Protopterus annectens* was more abundant upstream at Station A (10 individuals) compared to Station B (5) and Station C (1).

The dominance of Bagridae, particularly *Bagrus bayad* (23.2%), aligns with observations from Nigerian inland waters where Bagridae are consistently among the most abundant and ecologically important groups (Adaka, 2021; Pa *et al.*, 2023). For instance, *B. bayad* was similarly reported as the most abundant species in the River Niger at Onitsha (Pa *et al.*, 2023), indicating its ecological success in large river systems.

The high contribution of Cichlidae, particularly *Oreochromis niloticus* and *Tilapia mariae* (11.7% each), is also consistent with patterns reported in tropical African waters, where cichlids dominate due to their ecological flexibility, high reproductive capacity, and broad feeding strategies (Imorou *et al.*, 2019; Isemin *et al.*, 2023). Their presence across all stations, with relatively higher abundance at Station C, further highlights their tolerance to varying environmental conditions, including moderate habitat disturbance.

Conversely, the low abundance of species such as *Schilbe mystus* (0.7%) and *Alestes macrolepidotus* (0.9%) contrasts with findings from other Nigerian systems where these taxa contribute more substantially to catches (Pa *et al.*, 2023; David *et al.*, 2025). This reduced representation may reflect localized ecological conditions, fishing pressure, or early indications of population decline, as previously reported in impacted freshwater systems (Adaka, 2021; Ikpi *et al.*, 2022).

Spatially, total fish abundance was highest at Station B (232 individuals), slightly higher than Station A (228) and markedly higher than Station C (192). This pattern is consistent with findings from tropical river systems where midstream or transitional zones often support higher abundance and productivity due to favorable habitat heterogeneity and resource availability (Sandhya *et al.*, 2019; Das *et al.*, 2020).

The observed distribution patterns correspond closely with earlier physicochemical results, where dissolved oxygen and alkalinity were more favorable at upstream and midstream locations but declined downstream. Reduced abundance at Station C may therefore be linked to lower dissolved oxygen (~2.03 mg/L) and reduced buffering capacity, conditions known to limit sensitive fish species (Mondal & Bhat, 2020; Isemin *et al.*, 2023).

Species-specific patterns further support ecological differentiation along the river gradient. The dominance of *Bagrus bayad* at Station B (75 individuals) suggests optimal midstream conditions for benthic and demersal species, consistent with its ecological adaptability and feeding versatility (Pa et al., 2023). Similarly, the higher abundance of *Heterobranchus bidorsalis* at Station B (12 individuals) indicates favorable habitat conditions, possibly related to depth, flow, and prey availability.

The increased abundance of *Mormyrus rume* at Station C (21 individuals) reflects the tendency of mormyrids to occupy downstream habitats characterized by softer substrates and structural complexity (Isemin *et al.*, 2023). In contrast, Clarias gariepinus, although tolerant of low oxygen conditions, showed reduced abundance at Station C (4 individuals), suggesting that additional factors such as habitat structure or fishing pressure may influence its distribution beyond physicochemical constraints.

The upstream dominance of *Protopterus annectens* (10 individuals at Station A) suggests a preference for vegetated or less disturbed habitats, consistent with reports linking this species to floodplain and macrophyte-rich environments (Adaka, 2021; Isemin *et al.*, 2023).

3.3 Fish Species Diversity

The Simpson's Index of Diversity for fish species in Orakpa River is presented in Table 4

Table 4: Simpson's diversity index of fish species in Orakpa River

Species	Abundance (n)	n(n − 1)
Bagrus bayad	150	22350
Bagrus filamentosus	48	2256
Clarotes laticeps	22	462
Auchenoglanis occidentalis	11	110
Tilapia mariae	76	5700
Oreochromis niloticus	76	5700
Citharinus citharus	23	506
Clarias gariepinus	41	1640
Heterobranchus bidorsalis	15	210
Labeo coubie	9	72
Barbus occidentalis	8	56
Alestes dentex	17	272
Alestes macrolepidotus	6	30
Protopterus annectens	16	240

Mormyrus rume	40	1560
Mormyrops deliciosus	28	756
Hyperopisus bebe	19	342
Polypterus senegalus	15	210
Parailia pellucida	21	420
Schilbe mystus	5	20
Total	**646**	**42912**

A total of 646 individuals comprising 20 species were recorded and used for the computation of the diversity index. The Simpson's Index (D) was 0.10, while the Simpson's Index of Diversity (1 - D) was 0.90, indicating a highly diverse fish assemblage within Orakpa River. This value suggests a high probability that two randomly selected individuals belong to different species, reflecting substantial species richness within the system.

The contributions of individual species to the diversity index varied considerably. Species such as *Bagrus bayad*, *Tilapia mariae,* and *Oreochromis niloticus* recorded the highest $n(n-1)$ values, reflecting their numerical dominance, whereas *Schilbe mystus* and *Alestes macrolepidotus* contributed minimally due to their low abundance. This pattern indicates a community structure characterized by high diversity but uneven distribution, where a few species dominate while several others occur in relatively low numbers.

This observation is consistent with reports from other tropical freshwater systems. For instance, high Simpson's diversity values (1 - D = 0.93-0.95) have been reported in the Andharmanik River, Bangladesh, indicating similarly diverse and relatively stable fish assemblages (Roy *et al.*, 2022). Comparable findings have also been documented in reservoirs such as Mongra and Halali in India, where high diversity values (≈0.96) reflect species-rich communities with moderate dominance patterns (Johnson *et al.,* 2021; *Das et al.,* 2023). These comparisons suggest that the diversity status of Orakpa River aligns with conditions observed in relatively stable and productive tropical aquatic ecosystems.

In contrast, aquatic systems subjected to significant environmental disturbances often exhibit reduced diversity and stronger dominance by a few tolerant species. For example, the Ribb Reservoir in Ethiopia supports only a few dominant species, including *O. niloticus* and *Clarias gariepinus*, with markedly reduced diversity following ecological alteration (Alebachew *et al.,* 2022). Similar trends have been reported in other disturbed river systems where species richness declines and assemblages become simplified (Fisseha *et al.*, 2025).

The dominance pattern observed in Orakpa River, particularly by bagrids and cichlids, closely mirrors findings from other West African rivers. Along the Onitsha axis of the River Niger, Bagrus species and O. niloticus were reported as dominant, while species such as *Schilbe mystus* and *Alestes macrolepidotus* occurred in lower proportions (Pa et al., 2023). The widespread dominance of O. niloticus across tropical freshwater systems has been attributed to its ecological adaptability, high reproductive capacity, and competitive advantage over other species (Johnson et al., 2021; Nababa *et al.*, 2022; Adarsh *et al.*, 2024).

The coexistence of high diversity with dominance by a few species suggests that Orakpa River is moderately impacted but still maintains considerable ecological integrity. Similar assemblage structures have been reported in tropical systems where environmental pressures are present but not severe enough to cause major biodiversity loss (Roy et al., 2022; Ohaturuonye *et al.*, 2023).

From an ecological and management perspective, the high Simpson's diversity value (1 - D = 0.90) indicates that the river still supports a relatively stable and functionally diverse fish community. However, the low abundance of several species highlights potential vulnerability within the assemblage. Rare species are often more susceptible to environmental disturbances, overfishing, and habitat degradation, and may decline even when overall diversity remains high (Alebachew *et al.,* 2022; Adaka, 2021).

4.0 CONCLUSION

The study provides baseline information on the physicochemical characteristics, fish species composition, and diversity of Orakpa River, a tributary of the Lower River Niger in Kogi State, Nigeria. The results revealed that most physicochemical parameters, including pH, temperature, conductivity, and nutrient concentrations, were within acceptable ranges for tropical freshwater systems, indicating generally favorable environmental conditions. However, the significant decline in dissolved oxygen and alkalinity at the downstream station suggests localized environmental stress, likely associated with cumulative anthropogenic activities.

A total of 646 fish individuals comprising 20 species across 10 families were recorded, with the family Bagridae being the most dominant. The distribution pattern showed relatively higher abundance at the midstream station, while reduced abundance downstream corresponded with less favorable water quality conditions. The Simpson's Index of Diversity (1 - D = 0.90) indicates a highly diverse and moderately stable fish community, although dominance by a few species and the low abundance of several others suggest underlying ecological imbalance.

Orakpa River remains a productive freshwater system with considerable ecological integrity. However, signs of environmental stress, particularly downstream, highlight the need for proactive management.

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