**ASSESSMENT OF WATER QUALITY PARAMETERS OF OWALA DAM**

**Abstract**

Water quality monitoring is crucial for managing freshwater resources as it provides valuable data for local action planning and decision-making. This study assessed the water quality of Owala Dam, Osun State, Nigeria. Water samples were collected monthly from three stations along the Oba-Ile River (Owala Dam) in Olorunda between 2021 and 2024, and analyzed in the laboratory following standard protocols. In-situ measurements included water temperature (mercury-in-glass thermometer, 0–110°C, 0.1°C intervals), pH (Mueel meter), and electrical conductivity (Lovibond meter). Dissolved oxygen (DO) was measured using Winkler’s method, while biochemical oxygen demand (BOD) was calculated via the five-day BOD test. Total dissolved solids (TDS) were determined through filtration and evaporation, sulphate by the turbidimetric method, and chloride using the APHA titration method with potassium dichromate and AgNO₃. Phosphate levels were determined colorimetrically using a spectrophotometer after treatment with ammonium molybdate and stannous chloride. Results showed a slight, statistically insignificant rise in temperature (25.85°C in 2021/2022 to 26.39°C in 2023/2024). pH remained within the acceptable range (6.5–8.5) set by the Nigerian Standard for Drinking Water Quality (NSDWQ) and WHO. TDS remained constant at ~0.57 mg/L. BOD decreased significantly (p = 0.016), while DO levels were high (~66 mg/L), exceeding WHO's minimum of 6 mg/L. Transparency declined significantly (p < 0.05). Electrical conductivity was stable (~0.34 ds/m), below the 1000 ds/m limit. Nitrate (~0.07 mg/L) and phosphate levels were consistently low, and chloride levels (~40 mg/L) were within safe limits. Except for DO, all parameters complied with WHO standards. Continuous monitoring is therefore recommended in this dam to ensure sustainable water resource management.

Key words: Water quality, freshwater resource, Sediment Quality, Salinity

**INTRODUCTION**

Water is a crucial resource for human sustenance, agriculture, and industry, ensuring social and economic progress (Taiwo et al., 2012). Despite global access to water, many areas lack safe drinking water and sufficient quantities to meet basic health needs. The World Health Organization (WHO) reports that 1.1 billion people worldwide consume unsafe water, leading to 88% of diarrheal diseases, and the water supply sector faces significant challenges due to climate change and urbanization with the consequences being felt more in the developing countries (WHO, 2011). The United Nations General Assembly has set 2030 as a goal to ensure access to safe, quality water and sanitation for all as a fundamental human right (UNGA, 2018).

Water quality is determined by its physical, chemical, biological, and aesthetic properties, which are influenced by dissolved or suspended constituents and can be influenced by natural processes and human activities (Hubert and Wolkersdorfer, 2015). Consequently, various federal governments and relevant authorities establish national drinking water standards (Patil et al., 2012). They give priority to some qualities while considering others secondary, and these are used to assess the state's water quality. For example, faecal indicator bacteria (FIB), particularly Escherichia coli (*E. coli*) or thermotolerant coliform (TTC), should not be detected in any 100 mL of drinking water sample, according to drinking water quality criteria (WHO, 2011).

Water-related diseases continue to be the leading cause of death among children under the age of five around the world. These issues are most prevalent in poor countries' rural areas. In recent years, efforts by governments and non-governmental organisations to assure water security and safety have failed in many locations due to a lack of sustainability in water supply infrastructures (Tigabu et al., 2013). However, there has been recent progress in tackling this debacle in Nigeria. As part of its efforts to improve water quality monitoring and surveillance, the federal government has established 12 water quality reference laboratories across Nigeria.

This study was conducted in Owala Dam, in which the dam serves several uses, including water supply, flood control, and fishing. However, a study conducted by Oladejo and Olaleye (2006) in the early 2000s discovered a considerable increase in the prevalence of schistosomiasis, both urinary and intestinal, downstream of the dam. Hence, the need to assess the quality of its water bodies.

**METHODOLOGY**

***Study Area***

The study was conducted in Olorunda Local Government Area (LGA), Osun State, Nigeria (Figure 1). The Erinle River Dam (renamed Owala Dam) with latitude 7.75455430N and longitude 4.4500870E (250-450m above mean sea level) is approximately 12 kilometres upstream of Okinni town and is part of the Osogbo-Ede water supply extension system (Figure 2). The enlarged reservoir was constructed to augment the existing water supply system for cities, towns, and rural villages in Osun Central, Osun West, and Ife. The dam's reservoirs span 12 kilometres north along the Erinle River and its Otin River branch, reaching a maximum width of 3.5 kilometres. The reservoir covers around 14 km2 at normal water levels and 15 km2 at high water levels (**Odewumi *et al*., 2019**).

Ekonde Dam is located in Ekonde Town, a rural settlement in Osun State's Ifelodun Local Government Area. The dam is an earth structure that was completed in 1979 and has a capacity of 910,000 cubic meters. The reservoir supplies drinking water to the entire local government. The dam can sustain both commercial fishing and tourism (Odewumi *et al*., 2019). The region is classified as tropical, with an average annual rainfall of around 1400 mm and an eight-month rainy season (April to November).

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**Fig. 1. Map showing Osun State**



**Fig. 2. Map showing study areas with sampling sites**

***Sample collection***

Water samples were collected from the Oba-Ile River (Owala dam) once a month for three years (October 2021 to October 2024) at 9 a.m. at the researched sites (Owala dam) in Olorunda Local Government Area, Osun State, Nigeria. The water was taken from three separate sampling stations inside the water body: upstream, midstream, and downstream. Two and a half litres of water were collected from the subsurface water with white plastic kegs and immediately transported to the laboratory for physicochemical investigation.

***Physicochemical Analysis***

***Temperature***

The water temperature was measured in the field using a simple mercury-in-glass thermometer (0-1100C) graduated at 0.10C intervals. The thermometer was lowered directly into the water body and when the mercury stabilised at a point, the temperature value was read. Three readings were taken and the average was calculated and recorded as the subsurface water temperature for that site (Bilewu *et al*., 2022).

***Hydrogen Ion Concentration (pH)***

This was determined in situ with a conventional pH meter (Mueel). Readings were acquired by lowering the pH meter's probe into the water sample and recording the value on the meter. This was repeated three times, and the average of the measurements was calculated and recorded as the pH of each site (Patil *et al*., 2012).

**The Dissolved Oxygen (DO)**

The dissolved oxygen was determined in the laboratory by utilising the iodmetric (Winkler’s) method (Clesceri *et al*., 1998). The water samples was collected by utilising the dark coloured 250mL BOD bottles which was fixed in the field by adding 1.0 mL of Wrinkler’s solution (manganese (ii) tetraoxosulphate (vi) and 1.0 mL of Wrinkler’s solution II (Sodium Hydroxide and sodium iodide) using a 2.0 mL pipette. In the laboratory, 20.0 mL of water sample was pipetted into 250mL flat bottom conical flasks, and 0.0125 M standardised disodium trioxosulphate (iv) solution was titrated with 2.0 mL of 1.0% starch solution as an indicator (Bilewu *et al*., 2022). The point at which the blue colour first fades represents the conclusion of each titration. The titration was done three times to obtain the average titre value. The average titre value was used to compute the dissolved oxygen concentration in mg/L using the formula.

 $20mg/l=\frac{t×101.6}{20mL of water sample}$

Where t = the titre or volume of thiosulphate to be used101.6 = constant

***Biochemical Oxygen Demand(BOD)***

This was calculated by using the five-day BOD test adapted from Bilewu *et al.* (2022). This analysis uses the sample principle and procedure for the dissolved oxygen determination. The difference was that the water sample collected for BOD under the same condition as DO analysis was tightly stopped and incubated in the dark for five days before analysis. The calculated BOD was recorded as the difference between the initial dissolved oxygen determined after five days of incubation. The result was recorded as BOD mg/L of water sample.

***Electrical Conductivity***

This was determined using in-situ a model cm-21lovibond conductivity meter. Some of the water samples were poured into different 200 mL beakers. The readings was taken from each of the beakers containing the water samples by lowering the probe of meter into the beakers and allowing it for two minutes for the meter to standardize and the readings taken in s/cm and was recorded (APHA, 1992; Bilewu *et al*., 2022).

***Determination of Total dissolved solid***

The total dissolved solid (TDS) of the surface was determined by filtration and evaporation methods. A filtered sample was evaporated to dryness on a dried dish and on a water bath followed by drying in an oven at 1800C, this dish was cooled in desiccators containing silica gel, weighed again and the increase in weight was recorded this represent the TDS present in the sample (APHA, 1992; Bilewu *et al.*, 2022)

***Determination of Sulphate Content by Turbidimetric Method***

A surface water sample (10 ml) was pipetted into 25 ml volumetric flask and distilled water was added to it to bring the volume to approximately 20 ml. Gelatinous –BaCl2reagent (1 ml) was add and made up to mark with distilled water to form Barium sulphate turbidity. The content was thoroughly mixed and allowed to stand for 30 minutes. The optical density (OD) corresponding to the absorbance of barium sulphate turbidity was measured spectrophotometrically using a HACH DR/2010 portable data logging spectrophotometer at a wavelength of 420 nm. Reading was taken at interval of 30 seconds over a period of 4 minutes and the maximum unit was recorded. A calibration curve was prepared using analytical grade anhydrous potassium sulphate. From the calibration plot, level of sulphate was equivalent to the observed optical densities (absorbance of the test and black solution) which was read off and the level of sulphate in the sample was obtained (Bilewu *et al.*, 2022).

***Determination of Salinity as Chloride***

The sample (100 ml) was pipetted into 250 ml volumetric flak and 2 drop of potassium dichromate indicator was added and was shaking to mix. The mixture was shaken, after that it was titrated with 0.014N AgNO3 solution to a reddish brown which is indicator end point (APHA, 1992; Bilewu *et al.*, 2022).

***Determination of Phosphate Content***

25 ml of the sample was added to 0.5 ml ammonium molybdate (NH4)6MO7O244H20-40.1g/500ml distilled water and two drop of stannous chloride solution (SnCL22H20-2.5g/100 ml glycerol) was mixed by swirling. A blue colour was developed within an hour under acidic condition. The intensity of colour was measured using spectrophotometer. The concentration of phosphate was determined as:

Phosphate, $m/l$=A-B × C

Where A = absorbance of blank sample

 B = absorbance of blank sample

 C = Volume of slandered phosphate

**Data Analysis**

The data collected were analyzed and expressed as mean and standard error. The mean-difference among sampling sites, years and seasons were then subjected to one-way ANOVA and Duncan Multiple Range Test for comparisons using SPSS 25.

**RESULTS**

***Physicochemical Analysis***

Table 1 presents a comprehensive analysis of various physicochemical parameters of water quality at Owala Dam over three consecutive years (2021-2024). Each parameter is measured with its mean and standard error of the mean (SEM), along with p-values to indicate statistical significance, and compared against regulatory limits set by the Nigerian Standard for Drinking Water Quality (NSDWQ) and the World Health Organization (WHO).

The mean temperature showed a slight increase from 25.85°C in 2021/2022 to 26.39°C in 2023/2024, but this variation was not statistically significant (p>0.05). The temperature remains within the ambient range. The pH values fluctuated slightly, with a notable decrease in 2023/2024 to 6.62, which is still within the acceptable range of 6.5-8.5 for both NSDWQ and WHO. The p-value of 0.051 suggests that this change is approaching statistical significance. Total Dissolved Solids (TDS) remained consistent across the three years at approximately 0.57 mg/L, well below the regulatory limit of 500 mg/L, indicating good water quality regarding dissolved solids. Biological Oxygen Demand (BOD) showed a significant decrease from 150.39 mg/L in 2021/2022 to 143.42 mg/L in 2022/2023, with a p-value of 0.016 indicating statistical significance.

Dissolved Oxygen (DO) levels were relatively high across all years, averaging around 66 mg/L, which is above the minimum requirement of 6 mg/L set by WHO. Transparency decreased significantly from 1.41 m to 1.31 m over the study period with a great significant concern (p< 0.05). Electrical conductivity values remained stable around 0.34 ds/m, well below the regulatory limit of 1000 ds/m. Nitrate levels were consistent at approximately 0.07 mg/L across all years, significantly below the regulatory limit of 50 mg/L. Phosphate levels showed minor fluctuations but remained low and without significant concern. Chloride levels were stable around 40 mg/L, which is acceptable as it is below the WHO limit of 250 mg/L.

Table 2 presents the spatial and temporal variations in water quality parameters at Owala Dam across three different sites (Site A, Site B, Site C) over three consecutive years (2021-2024). The average temperature across the three sites showed minor fluctuations over the years, with values ranging from 25.53°C to 26.78°C. The p-values indicate no significant differences in temperature either spatially or temporally.

pH levels ranged from 6.55 to 7.11 across sites and years, remaining within acceptable limits for aquatic life. The p-values (0.919, 0.635, 0.807) suggest that there are no significant differences in pH levels among sites or over time. TDS values were consistent, ranging from 0.54 to 0.59 mg/L across all sites and years, well below the regulatory limit of 500 mg/L. The p-values indicate no significant spatial or temporal variations. BOD showed a significant decrease at Site B from 147.50 mg/L in 2022/2023 to 143.58 mg/L in the same year (p<0.05), although overall comparisons across sites did not show significant differences. DO levels varied slightly among sites, with averages between 62.39 mg/L and 68.88 mg/L, consistently above the WHO minimum requirement of 6 mg/L for aquatic life support. The p-values reflect no significant differences over time or between sites.

Transparency measurements showed significant spatial and temporal variation, particularly between years with p-values of 0.005 and 0.000 for the last two years indicating increasing clarity at Site C over time compared to Sites A and B. Conductivity values remained stable across all sites and years (ranging from 0.32 to 0.37 ds/m), with p-values indicating no significant differences (p>0.05). Nitrate levels were low and consistent across all sites and years (ranging from 0.05 to 0.09 mg/L), with no significant differences indicated by p-values (p>0.05). Phosphate levels varied slightly but showed significant changes over time at Site B with a p-value of 0.035 between years indicating a decline in phosphate levels. Chloride levels were stable across all sites and years but showed a near-significant trend at Site B in the second year with a p-value of 0.051.

Table 3 summarizes the seasonal variations in various water quality parameters at Owala Dam across two distinct seasons (dry and rainy) over three consecutive years (2021-2024).

The temperature was significantly higher during the dry season compared to the rainy season across all years, with p-values of 0.000 indicating a strong statistical significance. For example, in 2021/2022, the temperature was 27.24°C in the dry season versus 24.47°C in the rainy season. pH levels were significantly lower during the dry season compared to the rainy season in the first two years (p = 0.000 for 2021/2022 and p = 0.008 for 2022/2023). However, in 2023/2024, the p-value of 0.155 indicates no significant difference between seasons. Total Dissolved Solids was significantly higher during the rainy season in 2021/2022 (p = 0.000) and showed a notable increase in 2023/2024 with a p-value of 0.014.

Biological Oxygen Demand levels were significantly higher during the rainy season across all years (p = 0.000), with values reaching up to 157.89 mg/L in the rainy season of 2021/2022. Dissolved Oxygen levels were significantly lower in the dry season compared to the rainy season for all years analyzed (p = 0.000). Transparency did not show significant differences between seasons in most years, except for a significant difference in 2023/2024 (p = 0.010). Electrical conductivity was significantly higher during the rainy season across all years (p = 0.005 for 2021/2022, p = 0.000 for both subsequent years).

Nitrate levels showed no significant differences between dry and rainy seasons in earlier years (p>0.05) but had a significant difference in 2023/2024 (p = 0.047). Phosphate levels were significantly higher during the rainy season across all years analyzed (p = 0.013 for 2021/2022, p = 0.001 for 2022/2023, and p = 0.013 for 2023/2024). Chloride concentrations were generally higher during the rainy season, particularly significant in the second year (p = 0.001) and third year (p = 0.000).

The monthly variations of physicochemical parameters for Owala Dam over three consecutive years (2021/2022, 2022/2023, and 2023/2024) are presented in figures 3 to 12.

November consistently starts with stable temperatures (26.90°C in 2021 and 2023).March records peak dry-season temperatures (28.73°C in 2021/2022), followed by slight drops in April. Lowest values occur during the peak rainy season (July–August), particularly in 2021/2022. The year 2023/2024 has slightly elevated temperatures in August and September compared to previous years. pH values fluctuate between slightly acidic to neutral during the dry season and increase slightly (more alkaline) during the wet season. March 2022/2023 recorded the highest pH (7.60). A notable drop in 2023/2024 occurs in July (6.33) and August (6.37). Values stabilize in September and October near neutral pH 7.0.

Highest dissolved solids values are consistently recorded in April (0.79 mg/L in 2021/2022).A gradual increase is observed in September–October 2023/2024 compared to earlier years. Biochemical oxygen demand peaks in the wet season (July–September). August records the highest BOD each year, with 171.33 mg/L in 2021/2022 and slightly lower values in 2022/2023 and 2023/2024.February–March shows stable but high BOD across years. Rising BOD values was recorded in September 2023/2024. Dissolved Oxygen peaks in the wet season (July–September). Highest DO observed in July–August 2021/2022 (78.17 mg/L and 78.07 mg/L).DO declines in April–May, particularly in 2023/2024 (e.g., 56.60 mg/L in April).September–October values recover slightly across all years.

Highest transparency is recorded in August 2021/2022 (1.60 m) but declines in subsequent years. November and December consistently show clearer water (1.37–1.43 m). September and October 2023/2024 show higher electrical conductivity values (0.64–0.71 mS/cm). March records minor fluctuations, with 0.63 mS/cm in 2022/2023.Highest nitrate (NO₃) values are recorded in August–October across years, with peaks at 0.06 mg/L. June and July show minimal concentrations (0.03–0.04 mg/L).August and September show stable phosphate (PO₄)values (0.37–0.45 mg/L) across years. March 2021/2022 records the highest phosphate (0.44 mg/L). A steady increase in Chloride levels was noted in September–October 2023/2024 (49.28 mg/L).Lowest values occur in December 2021/2022 (30.08 mg/L).

**Table 1: Physico-chemical Analysis of Water Quality Parameters of Owala Dam across Three Consecutive Years (2021–2024) with Regulatory Limits**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| PARAMETERS | 2021/2022 | 2022/2023 | 2023/2024 | P-VALUE | Regulatory Limits |
| Mean±SEM | Mean±SEM | Mean±SEM |  **NSDWQ (2017)** | **WHO (2011)** |
| Temperature | 25.85±0.30 | 26.02±0.21 | 26.39±0.22 | 0.301 | Ambient | - |
| Ph | 6.93±0.14 | 6.98±0.10 | 6.62±0.10 | 0.051\* | 6.5-8.5 | 6.5-8.5 |
| Total Dissolved Solids (mg/L) | 0.57±0.03 | 0.57±0.01 | 0.56±0.02 | 0.930 | 500 | 500 |
| Biological Oxygen Demand (mg/L) | 150.39±2.20 | 143.42±1.32 | 146.03±1.44 | 0.016\* | 250 | 10 |
| Dissolved Oxygen (mg/L) | 66.33±1.38 | 64.15±1.15 | 64.23±1.18 | 0.373 | - | 6 |
| Transparency (m) | 1.41±0.02 | 1.31±0.02 | 1.38±0.02 | 0.007\* | - | - |
| Electrical Conductivity (ds/m) | 0.35±0.01 | 0.33±0.01 | 0.34±0.01 | 0.519 | 1000 | 25 |
| Nitrate (mg/L) | 0.07±0.02 | 0.07±0.02 | 0.07±0.02 | 1.000 | 50 | 50 |
| Phosphate | 0.35±0.01 | 0.33±0.01 | 0.34±0.01 | 0.172 | - | 0.05 |
| Chloride (mg/L) | 39.11±1.10 | 40.79±0.74 | 40.80±1.11 | 0.391 | - | 250 |

**Table 2: Spatial and Temporal Variations in Water Quality Parameters of Owala Dam across Three Sites Over Three Consecutive Years (2021–2024)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| PARAMETERS | 2021/2022 |  | 2022/2023 |  | 2023/2024 |  |
| **Site A** | **Site B** | **Site C** | **P-VALUE** | **Site A** | **Site B** | **Site C** | **P-VALUE** | **Site A** | **Site B** | **Site C** | **P-VALUE** |
| Temperature | 25.99±0.53 | 26.04±0.47 | 25.53±0.58 | 0.751 | 26.15±0.40 | 26.47±0.33 | 25.44±0.31 | 0.122 | 26.78±0.41 | 26.63±0.33 | 25.76±0.38 | 0.134 |
| Ph | 6.90±0.23 | 6.88±0.22 | 7.01±0.28 | 0.919 | 6.96±0.16 | 6.88±0.14 | 7.11±0.20 | 0.635 | 6.60±0.18 | 6.55±0.17 | 6.71±0.17 | 0.807 |
| Total Dissolved Solids (mg/L) | 0.56±0.05 | 0.56±0.04 | 0.59±0.05 | 0.923 | 0.56±0.01 | 0.54±0.02 | 0.59±0.02 | 0.139 | 0.57±0.03 | 0.54±0.03 | 0.58±0.02 | 0.639 |
| Biological Oxygen Demand (mg/L) | 154.75±3.82 | 150.75±3.93 | 145.67±3.50 | 0.245 | 147.50±2.12 | 143.58±2.10 | 139.17±2.13 | 0.031 | 149.17±2.62 | 146.25±2.36 | 142.67±2.34 | 0.186 |
| Dissolved Oxygen (mg/L) | 64.60±2.37 | 65.52±2.16 | 68.88±2.62 | 0.421 | 62.39±1.97 | 64.12±1.56 | 65.94±2.39 | 0.465 | 62.94±2.09 | 64.16±1.80 | 65.58±2.34 | 0.673 |
| Transparency (m) | 1.41±0.04 | 1.36±0.03 | 1.45±0.05 | 0.284 | 1.24±0.03 | 1.29±0.03 | 1.41±0.05 | 0.005 | 1.30±0.03 | 1.38±0.02 | 1.47±0.03 | 0.000 |
| Electrical Conductivity (ds/m) | 0.37±0.01 | 0.34±0.02 | 0.33±0.02 | 0.296 | 0.36±0.02 | 0.33±0.01 | 0.32±0.02 | 0.297 | 0.36±0.02 | 0.34±0.02 | 0.32±0.02 | 0.386 |
| Nitrate (mg/L) | 0.05±0.00 | 0.09±0.04 | 0.08±0.03 | 0.616 | 0.05±0.00 | 0.09±0.04 | 0.08±0.03 | 0.687 | 0.05±0.00 | 0.08±0.04 | 0.08±0.03 | 0.669 |
| Phosphate | 0.38±0.02 | 0.35±0.02 | 0.34±0.02 | 0.25 | 0.36±0.01 | 0.33±0.02 | 0.29±0.02 | 0.035 | 0.38±0.02 | 0.33±0.01 | 0.31±0.01 | 0.006 |
| Chloride (mg/L) | 40.28±1.92 | 40.32±1.52 | 36.74±2.16 | 0.318 | 42.77±1.33 | 41.13±1.30 | 38.47±0.93 | 0.051 | 43.13±2.18 | 40.26±2.09 | 39.03±1.38 | 0.313 |

**Table 3: Seasonal Variations in Water Quality Parameters of Owala Dam across Three Consecutive Years (2021–2024)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Parameters | 2021/2022 |  | 2022/2023 |  | 2023/2024 |  |
| **Dry Season** | **Rainy Season** | **P-Value** | **Dry Season** | **Rainy Season** | **P-Value** | **Dry Season** | **Rainy Season** | **P-Value** |
| Temperature | 27.24±0.35 | 24.47±0.14 | 0.000 | 26.72±0.26 | 25.32±0.24 | 0.000 | 27.41±0.18 | 25.37±0.22 | 0.000 |
| pH | 6.31±0.15 | 7.55±0.09 | 0.000 | 6.73±0.14 | 7.23±0.10 | 0.008 | 6.48±0.17 | 6.76±0.09 | 0.155 |
| Total Dissolved Solids (mg/L) | 0.47±0.04 | 0.67±0.01 | 0.000 | 0.56±0.02 | 0.57±0.01 | 0.953 | 0.52±0.02 | 0.60±0.02 | 0.014 |
| Biological Oxygen Demand (mg/L) | 142.89±1.83 | 157.89±3.15 | 0.000 | 138.50±1.12 | 148.33±1.75 | 0.000 | 140.00±1.12 | 152.06±1.74 | 0.000 |
| Dissolved Oxygen (mg/L) | 60.46±1.44 | 72.21±1.29 | 0.000 | 58.98±1.04 | 69.32±1.10 | 0.000 | 57.98±0.67 | 70.47±0.86 | 0.000 |
| Transparency (m) | 1.44±0.02 | 1.38±0.04 | 0.164 | 1.32±0.03 | 1.30±0.03 | 0.7 | 1.43±0.02 | 1.34±0.02 | 0.010 |
| Electrical Conductivity (ds/m) | 0.32±0.01 | 0.38±0.01 | 0.005 | 0.30±0.01 | 0.37±0.01 | 0.000 | 0.30±0.01 | 0.37±0.01 | 0.000 |
| Nitrate (mg/L) | 0.04±0.00 | 0.10±0.03 | 0.107 | 0.04±0.00 | 0.10±0.03 | 0.061 | 0.04±0.00 | 0.10±0.03 | 0.047 |
| Phosphate | 0.33±0.02 | 0.38±0.01 | 0.013 | 0.29±0.02 | 0.36±0.01 | 0.001 | 0.32±0.01 | 0.36±0.01 | 0.013 |
| Chloride (mg/L) | 37.64±1.80 | 40.59±1.20 | 0.182 | 38.49±0.94 | 43.09±0.86 | 0.001 | 36.80±1.59 | 44.81±0.82 | 0.000 |

**Figure 3: Monthly Variations in Temperature of Owala Dam across Three Consecutive Years (2021–2024)**

**Figure 4: Monthly Variations in pH Values of Owala Dam across Three Consecutive Years (2021–2024)**

**Figure 5: Monthly Variations in Total Dissolved Solids of Owala Dam across Three Consecutive Years (2021–2024)**

**Figure 6: Monthly Variations in Biological Oxygen Demand Levels of Owala Dam across Three Consecutive Years (2021–2024)**

**Figure 7: Monthly Variations in Dissolved Oxygen Levels of Owala Dam across Three Consecutive Years (2021–2024)**

**Figure 8: Monthly Variations in Transparency Values of Owala Dam across Three Consecutive Years (2021–2024)**

**Figure 9: Monthly Variations in Electrical Conductivity Values of Owala Dam across Three Consecutive Years (2021–2024)**

**Figure 10: Monthly Variations in Nitrate Levels of Owala Dam across Three Consecutive Years (2021–2024)**

**Figure 11: Monthly Variations in Phosphate Levels of Owala Dam across Three Consecutive Years (2021–2024)**

**Figure 12: Monthly Variations in Chloride Levels of Owala Dam across Three Consecutive Years (2021–2024)**

**DISCUSSIONS**

**Yearly Variations**

The water quality analysis of Owala Dam (2021–2024) shows a number of important results. The temperature increased slightly from 25.85°C to 26.39°C (p>0.05), staying within WHO and national guidelines (Ojelabi *et al*., 2018), like other Nigerian water bodies (Adejuwon and George, 2024; Akpan *et al*., 2024). The pH values (6.62-7.11) remained within the NSDWQ/WHO standards (6.5-8.5), although the decline in 2023/2024 (p=0.051) neared significance, reflecting trends observed in unpolluted Nigerian waters (Akpan *et al*., 2024).

Compared to occasionally polluted surface waters (Dimowo, 2013), TDS levels (≈0.57 mg/L) were significantly below the 500 mg/L limit, which is consistent with the majority of Nigerian studies (Namadi *et al*., 2024). Reduced organic pollution was indicated by a significant drop in BOD (150.39 to 143.42 mg/L, p=0.016) (Ojelabi *et al*., 2018; Bennett and MarkManuel, 2024). In contrast to polluted sites (Edegbene *et al*., 2025), DO remained abnormally high (≈66 mg/L), exceeding WHO standards (Ojelabi *et al*., 2018; Karki and Thapa, 2022).

As observed in sediment-impacted waters, transparency dramatically decreased (1.41m to 1.31m, p<0.05), necessitating monitoring (Edegbene *et al*., 2025). Nitrate (0.07 mg/L) and conductivity (0.34 ds/m) remained well below limits, consistent with uncontaminated sites (Karki and Thapa, 2022; Edegbene *et al*., 2025). Minimal agricultural/urban influence was confirmed by stable phosphate and chloride levels (≈40 mg/L) (Namadi *et al*., 2024).

**Spatial and Temporal Variations**

The water samples' temporal and spatial variations are displayed in Table 2. In line with findings from Owena Dam, where regional climate minimised spatial variations, the water temperature at Owala Dam stayed constant (25.53–26.78°C) across all sites (A–C) and years, with no significant temporal or spatial differences (p > 0.05) (Irenosen *et al*., 2012).
Similar to the stability seen in Owalla Reservoir, pH levels (6.55–7.11) were continuously within safe ranges and did not significantly vary (p > 0.5) (Omoboye, 2022). Similar to Owena Dam's consistent conductivity patterns, total dissolved solids (TDS: 0.54–0.59 mg/L) stayed extremely low with no discernible variations (Irenosen *et al*., 2012).

Although overall spatial differences were negligible, biochemical oxygen demand significantly decreased at Site B (p < 0.05), indicating a reduction in organic pollution locally. Runoff-induced seasonal variations in BOD have been observed in Eastern Niger Delta rivers (Ebong *et al*., 2023). There were no notable fluctuations in the dissolved oxygen (DO: 62.39–68.88 mg/L), which was consistently high and above WHO standards, similar to well-aerated Nigerian reservoirs (Omoboye, 2022).

Significant changes in transparency were observed both spatially and temporally, with Site C displaying notable improvements in clarity (p = 0.005, 0.000), most likely as a result of lower sediment or algal loads. In Owella Reservoir, where clarity fluctuated with agricultural runoff, similar patterns were noted (Aduwo *et al*., 2023). Echoing the minimal ionic variation at Owena Dam, conductivity (0.32–0.37 ds/m) was stable (Irenosen *et al*., 2012).

Nigerian freshwater systems typically have low and stable nitrate levels as shown in this study (0.05–0.09 mg/L) during periods of low runoff (Ebong *et al*., 2023). In line with post-runoff decreases observed elsewhere, phosphate drastically decreased at Site B (p = 0.035) (Aduwo *et al*., 2023). Although Site B displayed a nearly significant trend (p = 0.051), which may indicate slight salinity or human influence, as observed in Owella Dam, chloride levels were largely stable (Aduwo *et al*., 2023).

**Seasonal Variations**

The seasonal changes in the physicochemical parameters are displayed in Table 3. Owala Dam (2021–2024) shows distinct seasonal variations in water quality, which are in line with trends seen in other tropical reservoirs (Eneogwe *et al*., 2022; Odewade *et al*., 2021). Due to less cloud cover and more solar radiation, dry-season temperatures were noticeably higher (e.g., 27.24°C vs. 24.47°C in 2021/2022, p = 0.000) (Eneogwe *et al*., 2022).
In previous years, pH levels were generally lower during the dry season; however, in 2023/2024, there was no discernible difference, which could be attributed to buffering effects or climatic variability (Odewade *et al*., 2021). Due to runoff that is rich in minerals, total dissolved solids (TDS) and electrical conductivity (EC) peaked during the rainy season (p ≤ 0.014) (Eneogwe *et al*., 2022).

While dissolved oxygen (DO) decreased in dry seasons as a result of less re-aeration and warmer temperatures, biochemical oxygen demand increased dramatically in wet seasons, suggesting organic pollution from runoff (Odewade *et al*., 2021). With the exception of 2023–2024 (p = 0.010), transparency stayed constant, indicating either algal blooms or periodic sediment influx (Odewade *et al*., 2021).

While nitrate only became significant in 2023/2024 (p = 0.047), which may have been a result of shifting agricultural inputs, phosphate levels were consistently higher in rainy seasons (p < 0.05), consistent with nutrient runoff (Eneogwe *et al*., 2022). Wet seasons also saw an increase in chloride, most likely due to fertilisers or runoff.
Overall, seasonal hydrology and climatic influences drive the water quality at Owala Dam, which follows typical tropical reservoir dynamics (Odewade *et al*., 2021; Eneogwe *et al*., 2022).

**Monthly Variations**

The monthly variations across the sampling sites are displayed in Figures 1 through 12. Significant seasonal variations in physicochemical parameters are revealed by the three-year study of Owala Dam, which is in line with patterns seen in other tropical freshwater systems (Atobatele *et al*., 2008; Araoye, 2009). Similar to patterns in Nigeria's Aiba Reservoir, where wet-season cooling is caused by decreased solar radiation, temperatures peak in March during the dry season and fall during the July–August rainy season (Atobatele *et al*., 2008). Climate variability may be the cause of slightly higher temperatures in 2023–2024.

In this study, pH changes from being slightly acidic during the dry season to becoming more alkaline during the wet season. This pattern is also observed in Asa Lake, where runoff and the breakdown of organic matter cause the wet-season acidity (Araoye, 2009). The significant drop in pH (6.33–6.37) during July–August 2023–2024 points to increased acidic inflow.

Dissolved solids and conductivity peak in April and September/October, respectively, most likely due to watershed runoff (Atobatele *et al*., 2008). Wet-season BOD spikes (July-September) suggest organic pollution from decomposition and runoff, which is consistent with research defining BOD levels above 5 mg/L as moderate pollution (Aliyu *et al*., 2025). Paradoxically, dissolved oxygen (DO) levels peak during the wet season, probably because to aeration from turbulent inflows (Atobatele *et al*., 2008), yet decreasing clarity reflects increased turbidity from silt and suspended particles.

Nitrate and phosphate levels grow during the rainy season (August–October), most likely due to agricultural and domestic runoff, while from a similar study, Owala's nitrate (0.06 mg/L) remains below harmful levels (Adesuyi *et al*., 2015). These patterns highlight periodic nutrient influxes, which may promote long-term ecological changes.

**CONCLUSION**

The water quality at Owala Dam is generally satisfactory, with stable dissolved solids, pH, and temperature. However, rising BOD levels and decreasing transparency highlight new risks posed by organic pollution and sedimentation. Seasonal increases in conductivity and nutrient levels highlight the impact of runoff and land use. As a result, it is recommended that sources of organic contamination, such as urban and agricultural runoff, be monitored.

**Disclaimer (Artificial intelligence)**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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