
STUDIES ON THE ABIOTIC CONDITIONS OF KARIDNA RESERVOIR IN KADUNA STATE, NIGERIA

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Abstract: This study seeks to investigate the Physico-chemical parameters of Karidna Reservoir in Igabi Local Government Area of Kaduna State. The investigation was carried out for a period of one year between October 2013 and September 2014. Five sampling stations were chosen. The physicochemical parameters were determined using standard methods, procedures and instruments. The results showed that pH had a range 6.19-8.63, Temperature 25.94-31.54 °C, Electrical Conductivity 38.20-64.20µS/cm, Total Dissolved Solids 19.20-37.20 mg/l, Transparency 19.40-40.10 cm Dissolved Oxygen 2.40-6.81mg/L, Hardness 3.48-174.4mg/L Calcium 2.14-3.86mg/L, Biological Oxygen Demand 2.91-40.85mg/L, Chloride 2.28-3.58mg/L Phosphate-phosphorus 0.04-0.24mg/L, Nitrate- Nitrogen 0.14-0.30mg/L, Sulphate 0.06-0.21mg/L and Alkalinity with 2.51-5.04mg/l. Phosphate-phosphorus, Nitrate-Nitrogen, Sulphate, Electrical Conductivity, Total Dissolved Solids, Transparency, Dissolved Oxygen and Biological Oxygen Demand were highly significant at ($P \leq 0.01$) between the seasons while non-significant differences were observed in Chloride, Hardness, Alkalinity, Temperature and pH.. Calcium was the only parameter that was significant at $P < 0.05$. Non-significant differences were obtained across the stations. All the physico-chemical parameters revealed monthly and seasonal variations across stations.

Keywords: Abiotic Conditions, Karidna Reservoir, Kaduna State, Sampling Stations, Seasons

INTRODUCTION

Water sustains life. The quality of water is of vital concern for mankind because it directly linked with human health. Life on Earth depends upon water. Water comprises 99% of our own bodies and covers 71% of the earth's surface (WHO, 2014). It serves different functions ranging from its transport function through serving as solvent for most chemicals to serving habitat to many organisms. Many organisms also depend on water for certain stages of their life. For instance, some insects and amphibians use water as their breeding sites while it serves as an agent of dispersal for many plant seeds and fruits. The biological diversity of aquatic areas is neglected world- wide, even in coral reefs that rival tropical rain forests in their extraordinary diversity of life (Ajuzie, 2012). Good quality of water resources depends on a large number of physico- chemical parameters and biological characteristics to assess the monitoring of these parameters is essential to identify magnitude and source of any pollution load. (Venkatesharaju, *et al.*, 2010).

Distribution and productivity levels of organisms in any water body are largely determined by physicochemical factors Adakole *et al.*, 2008. It was observed that most reservoir ecosystems are threatened by anthropogenic activities (Ibrahim *et al.*, 2009).

This study of the physico-chemical parameters of Karidna reservoir was initiated in order to provide baseline information on the quality of the water and proposed best management practice that will enhance the productivity of the water.

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STUDY AREA

Karidna reservoir is located in College of Agriculture and Animal science Mando, Igabi Local Government Kaduna State. The study area occupies some 406.39m² within latitudes 10° 37' 12" - 10° 37' 36" N and longitude 7° 25' 12" - 7° 25' 36" E (figure 1). The reservoir catchment lies within the tropical wet and dry climatic zone, characterized by strong seasonality in rainfall and temperature distributions. It has two distinct seasons, the dry season (October to March) and wet season (April to September). The area has a single maximum rainfall regime with average annual totals ranging from 1050mm to 1250mm.

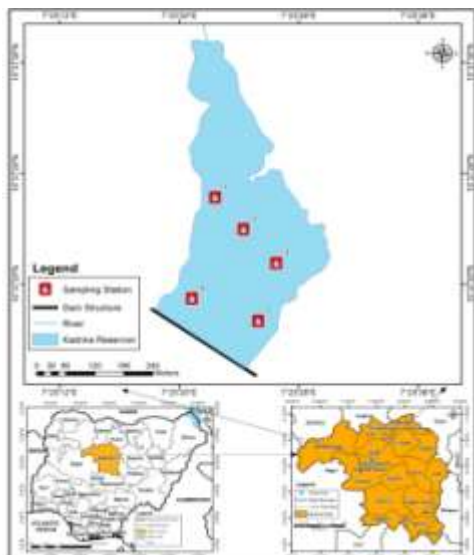


Figure 1: Map of Kadrina Reservoir showing Sampling Stations

Source: Fieldwork/Administrative Map of Igabi L.G.A., Kaduna State.

SAMPLING PROCEDURES

Five sampling stations were chosen within the water reservoir as follows:

- Station 1: Area round the entrance where human activities like bathing, washing, irrigation farming and animal activities are taking place.
- Station 2: At the lower point where there are less human activities.
- Station 3: At the deepest part of the reservoir
- Station 4-5: At the longest part of the reservoir.

Samples were collected for a period of twelve months running through the dry and wet season. Water samples were collected from six sampling stations between the hours of 8:00 am to 1:00 pm. Water was sampled at surface level by dipping 1 litre plastic sampling bottle and slides over the most upper surface of water with their mouth against passage of the water into the bottle (APHA, 2005). Some parameters were determined *insitu* using Hanan Instrument of model (HI 98129) such as the Temperature, pH, Electrical conductivity and Total dissolved solids while some were transported to the laboratory for the analysis of physico-chemical parameters.

Determination of Water Transparency

The transparency of the water was measured using 20cm diameter Secchi disk, which was dipped into the water till the disk disappeared and the depth was recorded, it was then dipped

further and then withdrawn carefully and the depth at which it became visible was also recorded. Actual measurement was obtained by taking the average of the two readings (APHA, 2005).

Determination of Water Hardness

a. Chemicals

Exactly 0.372g of ethylene diamine tetra-acetic acid disodium salt (EDTA) was dissolved in 100 ml of distilled water (0.1 N) and used as titrate. Buffer solution was prepared by dissolving 16.9g of ammonium chloride in 143 ml in volumetric flask with 1.179 g of magnesium carbonate, 12.6 H₂O in 50 ml distilled water. These two reagents were mixed to make 250 ml as a final volume of buffer solution, Erichrome black-T dye was used as indicator. (APHA, 2005)

b. Procedure

Water sample (10 ml) was taken into conical flask with the help of pipette, 0.5 mg of buffer tablet (Erichrome black-T dye) and 1ml of conc. ammonium hydroxide (NH₄OH) was added as indicator and then titrated with 0.1N (EDTA) solution.

c. Calculation for determination of water hardness

$$\text{Hardness (mg/l)} = \frac{N \times M \times 50,000V}{1000}$$

Where:

N = Normality of titrate 0.1 N

M = Mean of three titre value readings

V = Volume of water sample

50,000 = standard value of equation APHA (2005).

Determination of Dissolved Oxygen (DO)

Two milliliters of MnSO₄ was added at the site of collection of water sample before taken to the laboratory. Water sample was then poured into a 300 ml bottle and two milliliters of alkaline iodide azide reagent was added then stoppered with care to exude air bubbles, it was then mixed gently by inverting the bottle a number of times until a clear supernatant was obtained. It was then allowed to settle for two minutes after which 2ml Concentrated H₂SO₄ was added by allowing the acid run down the neck of the bottle. It was stoppered again and mixed by gentle inversion until dissolution was complete. 100ml of the prepared solution was transferred into a conical flask and then titrated with 0.0125N of Na₂S₂O₃.5H₂O solution to a pale straw yellow color. Two milliliters of freshly prepared starch solution was added and color becomes blue. Titration was continued by adding the thio-sulphate drop wise until the blue color disappeared.

Determination of Biological Oxygen Demand (BOD)

For biochemical oxygen demand the sample tested for Dissolved oxygen was incubated for five days in a cupboard and Dissolved oxygen was also tested, the difference between the initial value of Dissolved oxygen and the value after incubation was used as value of biochemical oxygen demand in the water sample (Mahar, 2003).

Determination of Phosphate-Phosphorus (PO₄)

This was determined using the Denniges method and APHA (2005). One millilitre (1ml) of Denniges reagent and 1 drop of stannous chloride was added to 100ml water sample.

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Absorbance at 690nm was measured with spectrophotometer, model S101 using distilled water as the blank. The phosphate concentration of water sample was read from the calibration curve.

Determination of Total Nitrate-Nitrogen (NO₃)

One hundred (100) ml of water sample was poured into a crucible and evaporated to dryness and cooled. Two (2) ml of phenol disulphonic acid was added and smeared around the crucible, after 10 minutes, 10ml of distilled water was added followed by 5ml strong ammonia solution. Setting the spectrophotometer at the wave length 430nm, absorbance of the sample treated was obtained, using water as blank. The concentration of nitrate- nitrogen was obtained from the calibration curve in mg/L. (APHA, 2005)

Determination of Alkalinity

One Hundred (100) ml of water sample was transferred into a conical flask and Two (2) drops of bromo-cresol green and two (2) drops of methyl red were added respectively. The mixture was swirled and titrated with solution of H₂SO₄ until color change. The formula used is Total alkalinity in CaCO₃ mg/l = Titer value X 10 (APHA, 2005)

Determination of Chloride (Cl)

One hundred (100) ml of water sample was transferred into a conical flask and 2-3 drops of potassium chromate was added, and content was swirled for few minutes then titrated against silver nitrate solution until dirty reddish precipitate was obtained. Cl mg/l = volume of AgNO₃ × 10. (APHA, 2005)

Determination of Sulphate (SO₄)

One hundred (100) ml of water sample was poured in a conical flask and 1g of Barium chloride (BaCl) was added and shaken and was allowed to stand for 3minutes and finally the readings was taken at 430nm wavelength.(APHA,2005)

Determination of Calcium (Ca²⁺)

Fifty (50) ml of the water sample was measured and into a conical flask then 1ml of Sodium Hydroxide (NaOH) was added to produce pH of 13-14 and was stirred and 0.2g of murexide indicator was added and stirred and color changes to pink. Titration was done against EDTA and the color changes from pink to purple. (APHA, 2005)

RESULTS

Table 1: Seasonal Variation of the Physico-chemical Parameters of Karidna Reservoir

Parameter	Season		Total	P value
	Dry	Wet		
pH	7.41±0.04	7.57±0.15	7.49±0.08	0.329ns
Temp (°C)	27.78±0.40	28.19±0.44	27.99±0.29	0.497ns
EC (µS/cm)	58.97±1.35	50.53±1.59	54.75±1.17	0.000**
TDS (ppm)	31.53±0.89	24.97±0.76	28.25±0.72	0.000**
Transparency (cm)	31.78±0.89	24.65±0.76	28.22±1.07	0.001**
Cl (mg/L)	3.23±0.15	3.21±0.19	3.22±0.12	0.912ns
PO ₄ ⁻ (mg/L)	0.18±0.01	0.11±0.01	0.14±0.01	0.000**
NO ₃ (mg/L)	0.27±0.01	0.20±0.01	0.24±0.01	0.000**
SO ₄ (mg/L)	0.07±0.002	0.12±0.02	0.09±0.01	0.004**
Hardness (mg/L)	135.2±4.8	126.4±7.6	130.8±4.4	0.311ns
Ca ²⁺ (mg/L)	2.43±0.10	2.85±0.18	2.64±0.10	0.042*
Alkalinity (mg/L)	3.89±0.27	3.71±0.18	3.80±0.16	0.565ns
DO (mg/L)	5.49±1.88	4.00±0.20	4.74±0.15	0.000**
BOD (mg/L)	2.48±0.09	3.28±0.09	2.88±0.07	0.000**

** - highly significant at P≤0.01, Non-significant at P>0.01

Table 2: Physico-chemical Parameters of Karidna Reservoir Based on Stations

Physico-Chemical Parameters	Stations					Total
	I	II	III	IV	V	
pH	7.73±0.25 ^a	7.54±0.19 ^{ab}	7.28±0.16 ^b	7.48±0.15 ^{ab}	7.41±0.12 ^{ab}	7.49±0.08
Temp (°C)	28.71±0.53 ^a	28.09±0.58 ^{ab}	27.95±0.72 ^b	27.80±0.70 ^b	27.38±0.78 ^b	27.99±0.29
EC (µ/Scm)	58.67±2.09 ^a	54.67±2.61 ^{ab}	53.00±2.98 ^b	53.33±2.66 ^b	54.08±2.79 ^{ab}	54.75±1.17
TDS (ppm)	31.08±1.62 ^a	28.50±1.68 ^{ab}	27.17±1.58 ^b	27.25±1.49 ^b	27.25±1.67 ^b	28.25±0.72
Transparency (cm)	27.71±2.11 ^b	26.29±1.68 ^b	27.04±1.64 ^b	24.96±1.74 ^b	35.08±3.49 ^a	28.22±1.07
Cl (mg/L)	3.10±0.29 ^{ab}	3.35±0.23 ^{ab}	2.91±0.20 ^b	2.89±0.29 ^b	3.85±0.26 ^a	3.22±0.12
PO ₄ ⁻ (mg/L)	0.17±0.23 ^a	0.16±0.02 ^{ab}	0.14±0.02 ^{ab}	0.11±0.01 ^b	0.13±0.01 ^{ab}	0.14±0.01
NO ₃ (mg/L)	0.25±0.02 ^a	0.24±0.02 ^{ab}	0.23±0.02 ^b	0.24±0.02 ^{ab}	0.24±0.01 ^{ab}	0.24±0.01
SO ₄ (mg/L)	0.12±0.04 ^a	0.08±0.01 ^{ab}	0.08±0.01 ^{ab}	0.08±0.01 ^{ab}	0.11±0.03 ^b	0.09±0.01
Hardness (mg/L)	127.6±10.8 ^b	124.4±9.6 ^b	137.2±8.4 ^{ab}	138.8±11.6 ^a	126.4±10.4 ^b	130.8±4.4
Ca ²⁺ (mg/L)	2.72±0.10 ^b	2.53±0.18 ^b	2.42±0.25 ^b	3.03±0.31 ^a	2.53±0.26 ^b	2.64±0.10
Alkalinity (mg/L)	3.44±0.34 ^{ab}	3.20±0.28 ^b	3.99±0.42 ^{ab}	4.36±0.40 ^a	4.01±0.27 ^{ab}	3.80±0.16
DO (mg/L)	4.62±0.30 ^b	4.55±0.38 ^b	4.71±0.36 ^b	4.94±0.31 ^a	4.91±0.39 ^{ab}	4.74±0.15
BOD (mg/L)	2.95±0.13 ^b	2.90±0.12 ^b	3.00±0.12 ^a	2.94±0.18 ^b	2.58±0.23 ^b	2.88±0.07

Table 3a: Physico-Chemical Parameters of Karidna Reservoir Based on Season

Parameters	Dry Season					
	October	November	December	January	February	March
pH	7.30±0.10 ^{bc}	7.60±0.07 ^{bc}	7.47±0.07 ^{bc}	7.44±0.05 ^{bc}	7.41±0.12 ^{bc}	7.24±0.07 ^c
Temp (°C)	26.46±0.74 ^c	26.90±0.60 ^c	26.20±0.72 ^c	26.90±0.53 ^c	28.76±0.19 ^b	31.48±0.19 ^a
EC (µS/cm)	61.60±0.51 ^a	64.20±1.53 ^a	63.20±0.97 ^a	60.60±0.68 ^{ab}	52.20±3.50 ^{bc}	52.00±5.10 ^{bc}
TDS (ppm)	31.00±0.55 ^b	31.60±1.33 ^b	37.20±0.86 ^a	36.00±1.41 ^a	25.60±1.94 ^{bc}	27.80±0.86 ^{bc}
Transparency (cm)	40.10±0.39 ^a	28.10±1.54 ^{bcd}	30.20±1.85 ^{bc}	30.40±1.81 ^{bc}	34.30±5.09 ^{ab}	27.60±5.75 ^{bcd}
Cl (mg/L)	3.58±0.37 ^{ab}	3.18±0.34 ^{abc}	3.00±0.36 ^{abc}	3.06±0.23 ^{abc}	3.46±0.51 ^{abc}	3.12±0.39 ^{abc}
PO ₄ ⁻ (mg/L)	0.15±0.01 ^{bcd}	0.20±0.03 ^{ab}	0.24±0.02 ^a	0.17±0.03 ^{bc}	0.15±0.03 ^{bc}	0.14±0.01 ^{bcd}
NO ₃ ⁻ (mg/L)	0.30±0.01 ^a	0.30±0.01 ^a	0.28±0.03 ^{ab}	0.27±0.19 ^{abc}	0.27±0.02 ^{abc}	0.20±0.02 ^{def}
SO ₄ ⁻ (mg/L)	0.07±0.01 ^{bc}	0.07±0.01 ^{bc}	0.07±0.01 ^{bc}	0.07±0.01 ^{bc}	0.07±0.01 ^{bc}	0.06±0.01 ^{bc}
Hardness (mg/L)	145.6±9.6 ^{abc}	142.4±12 ^{abc}	143.2±10 ^{abc}	3.48±0.25 ^{bc}	144±10.8 ^{abc}	97.6±6 ^{de}
Ca ²⁺ (mg/L)	2.48±0.19 ^b	2.74±0.24 ^b	2.41±0.22 ^b	2.16±0.28 ^b	2.28±0.22 ^b	2.52±0.27 ^b
Alkalinity (mg/L)	4.92±0.64 ^a	2.51±0.14 ^d	4.38±0.80 ^{ab}	3.34±0.39 ^{bcd}	5.04±0.64 ^a	3.16±0.32 ^{bcd}
DO (mg/L)	6.71±0.26 ^a	6.08±0.25 ^{ab}	5.33±0.11 ^{bc}	5.08±0.14 ^c	6.81±0.27 ^a	2.95±0.14 ^c
BOD (mg/L)	32.33±0.13 ^{cd}	28.75±0.10 ^d	29.83±0.17 ^{cd}	27.17±0.13 ^d	40.83±0.33 ^e	23.08±0.14 ^d

Table 3b: Physico-chemical Parameters of Karidna Reservoir Based on Season

Parameters	Wet Season						Total	P value
	April	May	June	July	August	September		
pH	6.19±0.21 ^d	7.51±0.13 ^{bc}	7.65±0.17 ^{bc}	7.62±0.10 ^{bc}	8.63±0.31 ^e	7.79±0.26 ^b	7.49±0.08	0.000 **
Temp (°C)	31.20±0.36 ^a	31.54±0.18 ^a	25.94±0.07 ^c	26.30±0.07 ^c	27.04±0.13 ^c	27.10±0.49 ^c	27.99±0.29	0.000 **
EC (µS/cm)	52.00±1.10 ^{bc}	55.80±1.36 ^{abc}	50.20±2.06 ^c	55.80±1.77 ^{abc}	38.20±1.80 ^d	51.20±6.63 ^c	54.75±1.17	0.000 **
TDS (ppm)	25.60±0.60 ^c	27.40±0.40 ^{bc}	25.20±1.32 ^c	26.40±0.81 ^c	19.20±0.74 ^d	26.00±3.30 ^c	28.25±0.72	0.000 **
Transparency (cm)	28.10±3.23 ^{bcd}	27.10±2.05 ^{bcd}	23.10±1.78 ^{cd}	20.80±1.21 ^{cd}	19.40±1.22 ^d	29.40±3.61 ^{bcd}	28.22±1.07	0.002 **
Cl (mg/L)	2.50±0.09 ^{bc}	3.24±0.60 ^{abc}	2.28±0.30 ^c	3.14±0.19 ^{abc}	4.12±0.19 ^a	3.96±0.42 ^a	3.22±0.12	0.067ns
PO ₄ ⁻ (mg/L)	0.12±0.01 ^{cd}	0.15±0.03 ^{bc}	0.09±0.01 ^{dc}	0.04±0.02 ^c	0.13±0.01 ^{cd}	0.14±0.01 ^{cd}	0.14±0.01	0.000 **
NO ₃ ⁻ (mg/L)	0.24±0.02 ^{bcd}	0.17±0.02 ^{cd}	0.15±0.02 ^d	0.22±0.004 ^{cdk}	0.18±0.01 ^{cd}	0.26±0.03 ^{abc}	0.24±0.01	0.000 **
SO ₄ ⁻ (mg/L)	0.14±0.01 ^{ab}	0.06±0.003 ^{bc}	0.21±0.05 ^a	0.04±0.01 ^c	0.19±0.07 ^a	0.09±0.01 ^{bc}	0.09±0.01	0.000 **
Hardness (mg/L)	124±16 ^{cd}	87.2±8.4 ^c	80±6.8 ^c	133.6±5.2 ^{bc}	174.4±14 ^a	158.4±5.6 ^{ab}	3.27±0.11	0.000 **
Ca ²⁺ (mg/L)	2.44±0.36 ^b	2.14±0.24 ^b	2.64±0.70 ^b	2.98±0.20 ^{ab}	3.86±0.26 ^a	3.06±0.40 ^{ab}	2.64±0.10	0.035 **
Alkalinity (mg/L)	3.38±0.45 ^{bcd}	2.62±0.18 ^{cd}	3.28±0.26 ^{bcd}	4.04±0.21 ^{abc}	4.54±0.36 ^{ab}	4.38±0.45 ^{ab}	3.80±0.16	0.001 **
DO (mg/L)	3.86±0.24 ^d	2.40±0.28 ^c	3.89±0.34 ^d	5.22±0.22 ^c	2.80±0.12 ^e	5.81±0.57 ^{bc}	4.74±0.15	0.000 **
BOD (mg/L)	23.83±0.13 ^{bc}	24.25±0.13 ^b	22.75±0.17 ^{bc}	29.33±0.18 ^a	3.03±0.19 ^e	2.91±0.15 ^{cd}	2.88±0.07	0.000 **

DISCUSSION

pH values ranged between (7.41 -7.57) with mean \pm SE value of 7.49 ± 0.08 . pH value recorded was high in the month of August which was non-significant from September, June, July, November and the lowest was recorded in the month of April. This was probably within the recommended range (6.0 - 9.0) for aquatic life (Chapman and Kimstach, 2006). The highest value recorded in the wet season could be attributed to enhanced rate of evaporation coupled with human interference are partly to enhanced photosynthetic activity. Also, low pH indicates low acidity possibly due to presence of CO₂ in the water, this was also in congruence with the findings of Inuwa (2007), and Mustapha (2008a) and (2008b).

The water temperature variation indicated mean \pm SE value of ($27.99 \pm 0.16^{\circ}\text{C}$). The maximum value of temperature for this study was obtained in the month of May (early wet season (31.54°C)) and the lower temperature recorded in the wet season could be as a result of seasonal changes in air temperature, humidity and solar radiation. Temperature has no direct effect on aquatic life up to 39°C in the river. The result of temperature for these findings was also similar with Fafioye *et al.*, (2005).

The low water temperature values recorded during the period of the study was attributed to the rainy season due to the effect of cloud cover, the extensive submerged macrophytes, water hyacinths (*Eichhorniacrassipes*) and the white and red mangroves which are characteristic of the study area particularly in station 1. The turbid nature of the River contributed to the reduction in temperature due to absorption of heat by the silts. This water temperature range is suitable for the production of plankton (Iloba, 2012).

Total dissolved solids in the reservoir have the mean \pm SE value of $28.25 \pm 0.72 \text{mg}^{-1}$. The highest TDS obtained in the month of December (dry) could be due to decaying of vegetation, higher rate of evaporation caused by increase in air temperature and wind during dry season leading to increase in water turbidity, this in turn decreases the light penetration, thus affects the photosynthesis, thereby suppressing the primary producers in the form of algae and microphytes. Similar observation was made by Atobatele and Ugwumba (2008) when they reported increase in the values of total dissolved solids during the dry season which may be due to most of the vegetation was decaying so there was a rise in amount of dissolved solids.

The electrical conductivity ranged from $38.20 \mu\text{S}/\text{cm}$ to $64.20 \mu\text{S}/\text{cm}$ with mean \pm SE of $54.75 \pm 1.17 \mu\text{S}/\text{cm}$. Electrical Conductivity was maximum in the month of November (dry) while lowest was recorded in the month of August (wet). The high dry season value may be due to the reduction in the water level and increases in nutrient due to runoff of inorganic fertilizer from nearby farmland. Atobatele and Ugwumba (2008) suggested that decrease in conductivity values during raining season might be due to dilution of rainfall. The higher values may be due to dilution of rainfall. The higher values may be due to chemical fertilizers from irrigated farmlands around the reservoir coupled with higher rate of evaporation that reduces the level of water during the dry season. Thus, conductivity of water depends upon the concentration of ions and its nutrients status. The value obtained for this study ($64.20 \mu\text{S}/\text{cm}$) is also FEPA (2005) acceptable limit for conductivity of water supply ($70 \mu\text{S}/\text{cm}$).

Transparency of the reservoir fluctuated with mean \pm SE value of $28.22 \pm 1.07 \text{ cm}$. The highest value for transparency was obtained in December and the lowest was obtained in August. Kadam *et al* (2009) reported observation from Masoli reservoir that high water transparency as

a result of dry season and temperature increases the euphotic zone in an aquatic ecosystem which in turns favours phytoplankton growth and primary productivity.

The Dissolved Oxygen values in the reservoir ranged from 2.40mgL^{-1} to 6.81mgL^{-1} ; with the mean \pm SE of $4.74 \pm 0.15\text{mgL}^{-1}$. The highest value for Dissolved Oxygen was obtained in the month of February (dry). This similar value for D.O. was also observed by Ibrahim *et al.* (2009) reported that the cool harmattan wind which increases wave action and decrease surface water temperature might have contributed to the increased oxygen concentration during the dry season. The high oxygen value for the dry season coincides with periods of lowest turbidity and temperature. In this study, the cool harmattan wind which increases wave action and decrease surface water temperature might have contributed to the increased oxygen concentration during the dry season, while the torrential rains, created increased turbidity and decreased oxygen concentration during rainy season Oniye *et al.* (2002) made similar observation for Zaria dam. The higher fluctuations of dissolved oxygen during dry season than in the rainy season periods could also be attributed to the peak of human activities along the catchment area of Karidna Reservoir during this season. The decomposition of organic matter, metabolic activities of epiphytic organisms could also be responsible for reduced oxygen concentration in the river (Uka and Chukwuka, 2007). This also agrees with report of Araoye (2008) that high O_2 concentration recorded during the dry season was due to enhanced photosynthetic activities during the this season.

Alkalinity has the mean value of $3.80 \pm 0.16 \text{ mg}^{-1}$; Sulphate of the reservoir have the mean \pm SE values of $0.09 \pm 0.01 \text{ mg}^{-1}$. The maximum alkalinity was obtained in the month of February (5.04 mg/l) and the minimum value was obtained in November (2.51 mg/l). The alkalinity values are an indication of low carbonate and bicarbonate ions in the water reflecting the absence of limestone in the water basin. The alkalinity higher in the dry season and lower in the rainy season could be due to low water levels with its attendant concentration of salts and the lower value in the rainy season could be due to dilution. Ufodike *et al.* (2001) recorded similar results for Dokowa mini lake. The high level alkalinity during dry season also agrees with the findings of Ibrahim *et al.*, (2009).

Nitrate-nitrogen indicated mean \pm SE values of $3.27 \pm 0.01 \text{ mg}^{-1}$ during the period of study. The maximum value for nitrate was obtained in the month of November (dry) and October while the lowest value was obtained in the month of June. This finding was similar to that of Dimowo (2013) in Ogun River.

Chloride with the mean + SE $3.22 \pm 0.12 \text{ mgL}^{-1}$. Chloride value was higher in wet season (4.12 mg/l). The chloride ions are introduced into the river system via sewages. The higher value during the rainy season could be attributed to an increase in the flow sewage finding their way into the river during the rainy season. This observation also coincides with the findings of Farombi *et al.*, (2014) in their study of Variations of biotic Conditions Of water Quality of river Osun, Osun state, Nigeria.

Sulphates of the reservoir have the mean \pm SE values of $0.09 \pm 0.01 \text{ mg}^{-1}$. The highest rate of sulphate recorded during rainy season compare to the lower value for dry season could be attributed to the effluents which result to increase in oxidation of sulphate from the waste entering into the river.

Phosphate-phosphorus was $0.14 \pm 0.01\text{mg}^{\text{L}^{-1}}$. The high dry season mean value for phosphate phosphorus could be due to concentration effect because of reduced water volume.

The relatively high values of Phosphate recorded in this study could be attributed to incoming effluents and human activities such as washing, bathing, fishing and fish farming. The values of phosphate in station 1 were considerably higher than other Stations. This may be due to the biodegradation of organic matter by bacteria. It could also be due to lower water hardness, thus less co-precipitation of phosphate with calcium carbonate, a phenomenon that has often been reported to occur in many freshwater lakes.

Water hardness was higher during the dry season than the rainy season. This could be as a result of low levels and concentration of ions and lower rainy season value could be due to dilution. It could be attributed to the decrease in water volume and increase in the rate of evaporation at high temperature. This agrees with the findings of Kolo and Oladimeji (2004) for Shiroro Lake and Ufodike *et al.*, (2001) for Dokowa mine lake.

Biological Oxygen Demand (BOD) value was recorded during wet season (4.15 mg/l) could be as a result of massive amount of waste flowing into the river during rainy season hence oxygen will be consumed faster by microbial population. The biodegradation of organic materials exerts oxygen tension in the water and increases the BOD (Abida and Harikrishna, 2008).

Calcium the high rate of calcium during hardness could also be as a result of low level and concentration of ions (magnesium and calcium).

CONCLUSION

This study has revealed monthly and seasonal variations of physico-chemical parameters across the sampling stations.

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