

SEASONAL VARIATION IN THE PHYSICO-CHEMICAL PARAMETERS OF OWALLA RESERVOIR, OSUN STATE, NIGERIA

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ABSTRACT

Fishes are threatened due to unwanted changes in the physical, chemical and biological properties of water. The need for efficient monitoring of the Physico-chemical parameters in Owalla reservoir is becoming pertinent with reports of a decline in fish production due to unsustainable exploitation. The water quality of the reservoir was monitored to reveal the extent of its contamination, and suitability for fishes and other aquatic organisms. The Physico-chemical characteristics; temperature, pH, dissolved oxygen, alkalinity, total hardness, turbidity, and conductivity of water samples from selected points in the reservoir were analysed using standard methods for twenty-four (24) months. From the Data obtained the mean values for; temperature was 25.16 ± 0.34 °C, pH 7.44 ± 0.26 , dissolved oxygen 7.31 ± 0.36 mg/L, alkalinity 64.11 ± 0.46 mg/L, total hardness 41.72 ± 0.78 mg/L, turbidity 34.95 ± 5.67 NTU and Conductivity 61.87 ± 7.01 μ Sc. The values obtained indicated that the reservoir is not under heavy stress as the mean values of the determined parameters were found to be within the permissible limits.

Keywords: Water, Alkalinity, Total hardness, Turbidity, Conductivity.

INTRODUCTION

Man has always exploited fish for several purposes, including aesthetics, food, fishmeal production, and scientific studies. However, man's influence on the aquatic environment has contributed to the ecological crisis in fisheries management (Cochrane, 2000). It has, therefore, become pertinent to place much attention on the development, conservation, and sustainable exploitation of fishery resources.

Owalla reservoir is known to contain many freshwater fishes and it contributes significantly to fish production in Osun State, Nigeria. Several studies have been carried out on the reservoir and dam. Olayemi (2001) studied the food and feeding relationships of fishes and Taiwo (2010) studied the taxonomy and some ecological aspects of fish species in the reservoir and reported that the reservoir is rich in fish diversity thereby revealing the importance of the reservoir for conservation and sustainable enhanced fisheries. Adediji and Ajibade (2008), worked on the change detection using remote sensing and reported a sharp decline in the surface area of the reservoir adduced to be due to hydrophytes that colonize the edges of the reservoir and they suggested the urgent evacuation of the weeds to prolong its lifespan. Oladejo and Ofoezie (2006) and Oladejo *et al.*, (2010), studied the associated water-borne diseases of the dam.

Owalla reservoir like other freshwater bodies is utilized for domestic, industrial, and agricultural purposes which, if not properly harnessed are inimical to the continued existence of viable fish stocks. The lack of understanding of the ecological mechanisms regulating the fish population in Owalla reservoir, therefore, may have serious consequences for fisheries in the future.

This study on some physicochemical

parameters of this reservoir was to make information on these parameters available which could serve as a guide for assessing and predicting the fisheries production potential of the reservoir. Knowledge and information obtained from this study are needed for the protection and prediction of the recruitment variability of fishes in the reservoir.

MATERIALS AND METHODS

Study Area

Owalla reservoir which was primarily impounded for water supply has sparse pre-impoundment information. Research efforts are focused on the enhancement of inland fisheries, but baseline data on the reservoir fisheries enhancement are still lacking. Owalla reservoir lies between Latitudes $7^{\circ} 54'N$ and $7^{\circ} 57'N$ and Longitudes $4^{\circ} 32'E$ and $4^{\circ} 34'E$ (Figure1). The reservoir was impounded from Erinle and Owalla rivers to improve the existing water supply to some major towns in Osun State, Nigeria. The reservoir extends some 12km northwards along the Erinle River and its Otin River tributary with a maximum width of 3.5km.

The reservoir covers an area of about 14 km² at the normal water level and about 15 km² at the peak of the wet season. The gross capacity of the impounded reservoir on Erinle River was estimated at 94 million cubic metres (Adediji and Ajibade, 2008). The surface area of the reservoir was 493,035.80 m². The dam had a crest length of 677m and a maximum height of 27m at an elevation of 330m above sea level. The reservoir had a total storage capacity of 94 million cubic metres and a dead storage capacity of 1.5 million cubic metres. The spillway discharges at a rate of 800 m³/s during the annual floods (Oladejo and Ofoezie, 2006).

The study area is a typical rainforest region

Aug	25.4	24.0	7.45	8.46	65.5	49.5	33.6	56.95
Sep	26.1	24.1	7.51	7.55	65.7	50.6	34.6	77.28
Oct	25.4	25.9	7.45	7.31	68.0	52.3	34.7	85.79
Nov	25.5	25.2	7.43	8.15	70.3	51.6	36.4	86.82
Dec	26.3	27.7	7.47	6.49	66.1	47.8	36.2	83.60
Jan '19	22.7	25.4	7.45	7.14	61.0	46.4	35.2	73.32
Feb	23.9	23.8	7.47	7.25	58.8	40.1	36.3	70.59
Mar	27.4	27.0	7.48	7.03	55.8	35.4	34.2	64.66
Apr	27.5	25.9	7.47	7.15	60.1	35.0	34.3	54.08
May	24.8	23.7	7.54	7.82	69.7	34.3	34.3	43.80
Jun	23.3	23.2	7.50	7.55	58.6	42.5	33.5	45.21
Jul	20.5	22.1	7.48	7.76	70.6	47.8	33.9	46.64
Aug	24.1	24.4	7.53	8.43	67.8	47.2	32.7	52.79
Sep	23.5	23.7	7.55	8.43	67.2	51.2	33.6	64.64
Oct	24.8	24.5	7.56	7.27	68.0	54.6	33.6	77.25
Nov	24.4	25.1	7.52	6.28	69.0	47.9	34.5	67.80
Dec	22.8	24.0	7.51	6.40	62.5	41.2	36.3	78.00
Jan '20	25.3	27.1	7.50	6.36	64.9	36.3	36.2	84.68
Feb	26.4	28.6	7.65	6.77	59.0	36.3	36.4	71.6
Mar	25.5	26.2	7.60	7.12	59.3	36.2	34.9	66.68

Table 2: Mean variation and F-values of the Analysis of Variance (ANOVA) of Physico-chemical Parameters of Water Determined at the Sampled Sites of the Reservoir

Parameter	Range	Mean	F-value (P>0.05)
Ambient Temp (°C)	20.01-28.50	24.91± 0.036	0.68 ^{NS**}
Water Temp (°C)	20.92-29.57	25.16±0.34	0.87 ^{NS}
pH	7.30-7.65	7.44± 0.26	1.43 ^{NS}
Dissolved oxygen (mg/L)	5.83-8.73	7.31±0.36	0.89 ^{NS}
Alkalinity (mg/L)	56.12-71.42	64.11± 0.46	1.56 ^{NS}
Total hardness (mg/L)	33.14 -55.60	41.72±0.78	1.20 ^{NS}
Turbidity (NTU)	31.81-36.52	34.95±5.67	1.65 ^{NS}
Conductivity (µS/cm)	40..87-88.56	61.87±7.01	1.22 ^{NS}

*Values are mean ± standard error **NS= Not significantly different

Table 3: Seasonal Variation in the Level of Physico-chemical Parameters of Water the Levels of Water from the Sampled Sites

Parameters	Wet Season (Apr. to Oct.)	Dry Season (Nov. to Mar.)
Ambient Temp (°C)	24.98±0.15	24.05±0.54
Water Temp (°C)	25.16± 0.10	25.18± 0.43
Ph	7.60 ± 0.10	7.31± 0.39
Dissolved oxygen(mg/L)	7.16 ± 0.21	7.53± 0.34
Alkalinity (mg/L)	67.15± 1.11	62.68± 0.94
Total hardness (mg/L)	43.03± 0.98	40.71± 1.14
Turbidity (NTU)	43.49± 6.51	23.43± 3.01
Conductivity(µS/cm)	72.19± 4.63	31.25± 6.27

Table 4: Effects of Season on the Physico-chemical Parameters of Owalla Reservoir

Parameter	Wet Season (Apr. to Oct.)		Dry Season (Nov to Mar)		t-value P>0.05
	Mean ± SE	Coefficient of Variation (%)	Mean ± SE	Coefficient of Variation (%)	
Ambient Temp.(°C)	24.98±0.15	5.94	24.05±0.54	9.26	0.87
Water Temp.(°C)	25.16± 0.10	4.29	25.18± 0.43	7.14	0.68
pH	7.60 ± 0.10	8.57	7.31± 0.39	11.56	0.78
Dissolved oxygen (mg/L)	7.16 ± 0.21	21.55	7.53± 0.34	25.73	2.66
Alkalinity (mg/L)	67.15± 1.11	10.62	62.68± 0.94	10.37	2.53

Total hardness (mg/L)	43.03± 0.98	17.52	40.71± 1.14	14.34	1.45
Turbidity (NTU)	43.49± 6.51	58.40	23.43± 3.01	47.11	4.43*
Conductivity (µS/cm)	72.19± 4.63	43.27	31.25± 6.27	68.81	6.23*

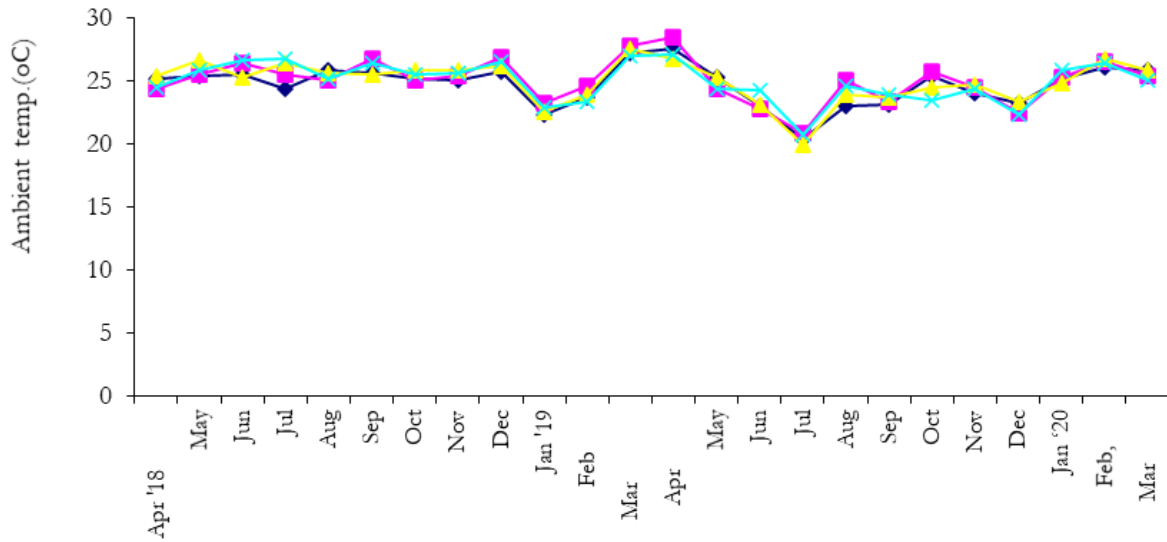


Figure 1a: Variations in the mean values of Ambient temperature

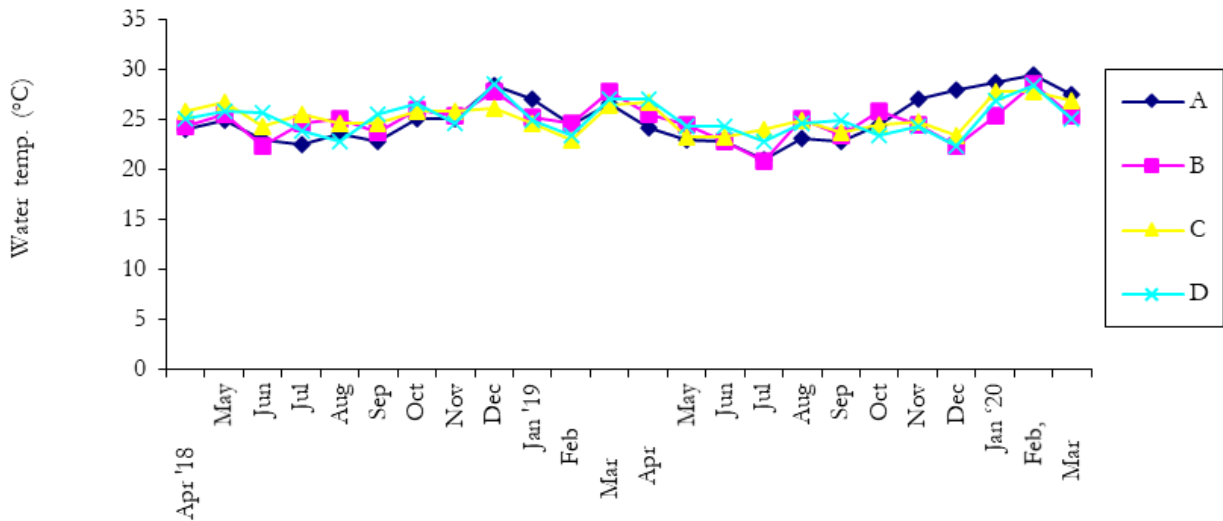


Figure 1b: Variations in the mean values of water temperature

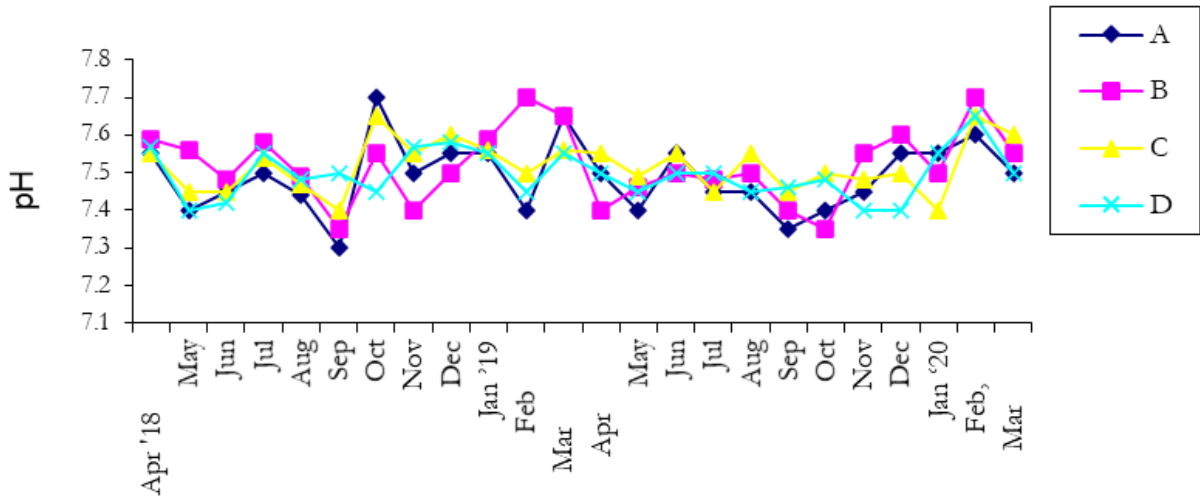


Figure 1c: Variations in the mean values of Hydrogen ion concentration

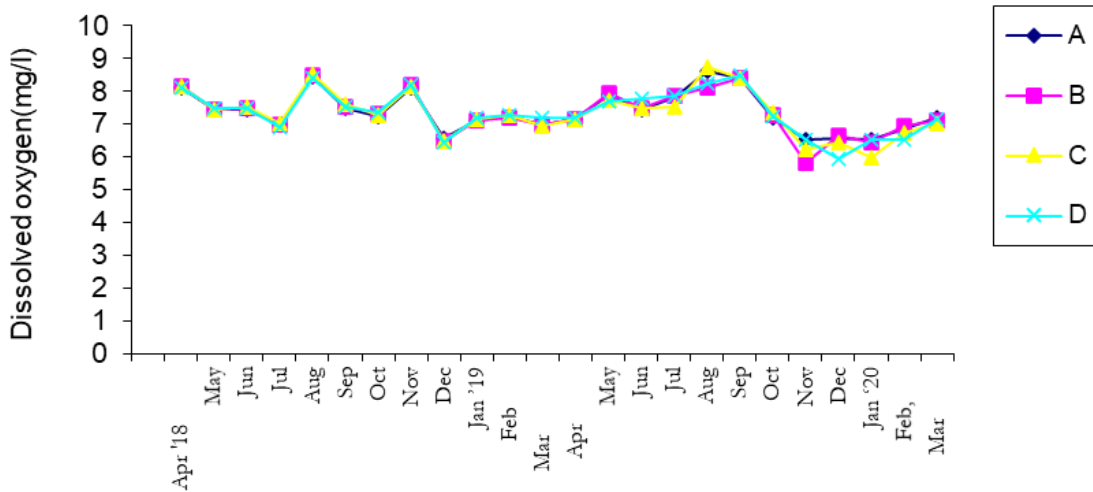


Figure 1d: Variations in the mean values of Dissolved oxygen

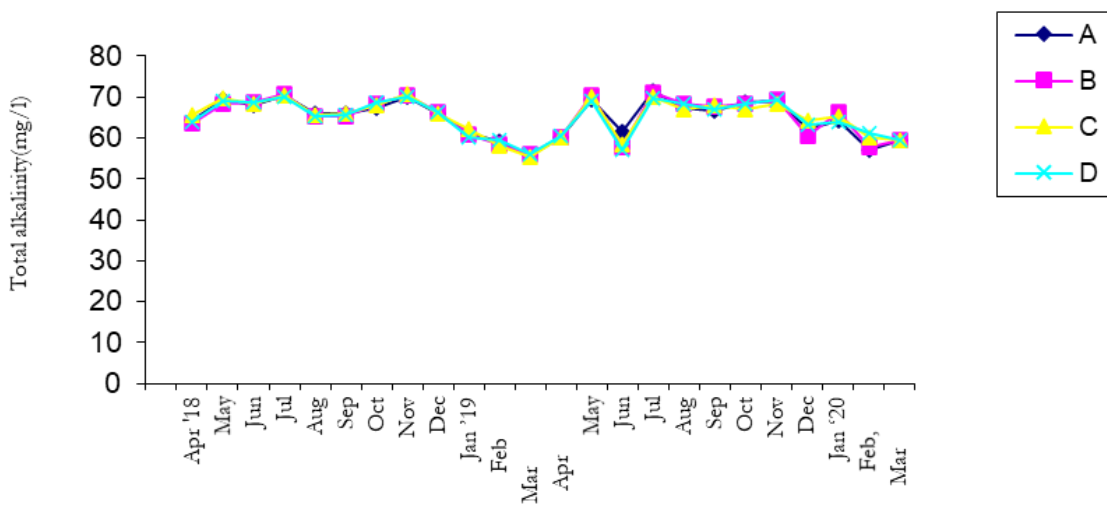


Figure 1e: Variations in the mean values of alkalinity

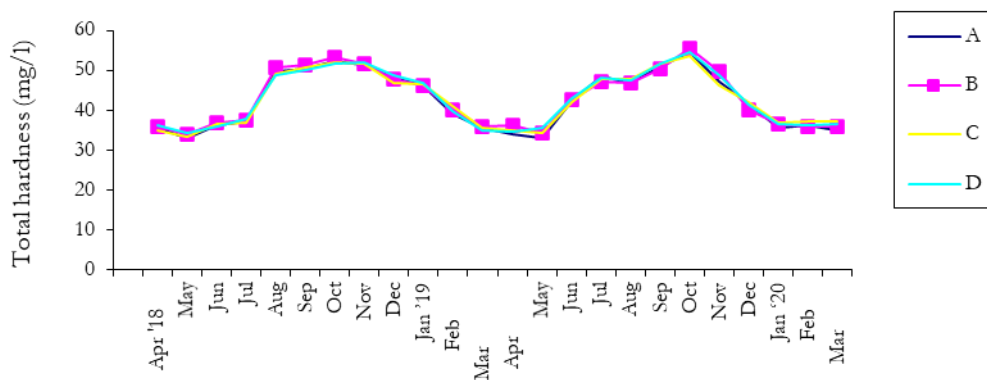


Figure 1f: Variations in the mean values of Total hardness

KEY: *A= Ilie B=Oba-Ile C=Ore D= Owode

The mean ambient temperature over the reservoir during the period of study ranged from 20.01 to 28.50 °C with a mean of 24.91 ± 0.36 °C and that of water temperature ranged from 20.92 to 29.57 °C with a mean of 25.16 ± 0.34 °C (Table 2). The lowest ambient temperature (20.0°C) was recorded in July 2019 at sampling site C while the highest ambient temperature (28.5°C) was recorded in April 2019 at sampling site B. The mean ambient temperature for the wet season 24.98 ± 0.15°C was slightly higher than the dry season value 24.05 ± 0.54°C (t= 0.87, p>0.05) (Table 4). The coefficient of variation for the study period was low (7.67%), however, the coefficient of variation for the wet season (5.94 %) was lower than that of the dry season (9.26%) (Table 4). The peak ambient temperature was recorded between March and April 2009 during the period of study (Figure 1a).

The mean water temperature for the study period was 25.16 ± 0.34°C. The lowest mean water temperature (20.92°C) was recorded in July 2019 at sampling site B, while the highest temperature (29.57 °C) was recorded in February 2020 at sampling site A. The mean water temperature of 25.16 ± 0.10 °C for the wet season was about the same as that of the dry season value of 25.18 ± 0.43 °C (t = 0.68, p>0.05). The coefficient of variation of the water temperature for the study period (4.23%) was low; however, the wet season recorded a lower coefficient of variation (4.29%) compared to the dry season (7.14 %). The peak water temperature was recorded in December 2018 and February 2020 during the period of study (Figure 1b).

The mean Hydrogen ion concentration (pH) for the study period ranged from 7.30 to 7.65 with a mean of 7.44 ± 0.26. The lowest mean pH (7.3) was recorded in September 2018 at sampling site A, while the highest pH (7.70) was recorded in February 2019 at sampling site B. The coefficient of variation for the study period (9.65%) was low, however, the wet season recorded a lower coefficient of variation (8.57%) compared to the dry

season (11.56%) (Table 4). The mean pH for the wet season (7.60 ± 0.10) was not significantly higher (t= 0.78, p> 0.05) than the mean pH for the dry season (7.31 ± 0.39). pH values between the four sampling sites were not significantly different (p>0.05). Generally, the pH was considered suitable for fish growth in all the stations;

The dissolved oxygen means ranged from 5.83 to 8.73 (mg/L) with a mean of 7.31 ± 0.36 (mg/L). The lowest mean (5.83mg/L) was recorded in November 2019 at sampling site B, while the highest mean (8.73 mg/L) dissolved oxygen value was recorded in August 2009 at sampling site C. The coefficient of variation for the study period was 25.35%; the wet season had a lower coefficient of variation (21.55 %) compared to the dry season (25.73%). The mean dissolved oxygen for the wet season (7.16 ± 0.21) was not significantly different (t= 2.66, p> 0.05) than the mean dissolved oxygen for the dry season (7.53 ± 0.34).

Total alkalinity ranged from 56.12 to 71.42 (mg/L) with a mean of 64.11 ± 46 (mg/L). The lowest mean alkalinity value (56.12 mg/L) was recorded in March 2008 at sampling sites B and D, while the highest (71.42 mg/L) was recorded in July 2019. The coefficient of variation for the study period (9.13%) was low; the wet season recorded a slightly higher coefficient of variation (10.62%) compared to the dry season (10.37%).

Total hardness ranged from 33.14 to 55.60 (mg/L) with a mean of 41.72 ± 0.78 (mg/L). The lowest mean total hardness (20.14 ± 6.11mg/L) was recorded in May 2019 at sampling site A, while the highest value (55.60 mg/L) was recorded in October 2019 at sampling site B. The coefficient of variation for the study period was low (18.56%); the coefficient of variation for the wet season (17.52%) was higher than that of the dry season (14.34%).

Turbidity values ranged from 31.81 to 36.52NTU. The mean turbidity value was 34.95 ± 5.67NTU. The lowest mean turbidity (37.81NTU) was recorded in January 2008 while the highest value (31.03NTU)

was recorded in August 2019. The coefficient of variation for the study period was high (62.76%); the coefficient of variation for the wet season (58.40 %) was higher than that of the dry season (47.11%). The mean turbidity value for the wet season (43.79 ± 6.51 NTU) was significantly higher ($t=4.43, p>0.05$) than the mean value for the dry season (23.43 ± 3.01 NTU).

Conductivity values ranged from 40.87 to 88.56 μ S/cm. The mean conductivity value was 61.87 ± 7.01 μ S/cm. The lowest mean conductivity (40.87) was recorded in May 2019 at sampling site B, while the highest value (94.00 ± 7.27 μ S/cm) was recorded in November 2018 at sampling site B. The coefficient of variation for the study period was high (54.26%); the coefficient of variation for the wet season (43.27%) was lower than that of the dry season (68.81%). The mean conductivity value for the wet season (72.19 ± 4.63 μ S/cm) was significantly higher ($t = 6.23, p > 0.01$) than the mean value for the dry season (31.25 ± 6.27 μ S/cm).

The pattern of variations in the mean values of all the Physico-chemical parameters determined at the four sampling sites was uniform as shown in Figures 1a to 1h. Significant seasonal variation in the Physico-chemical parameter of the reservoir was observed with the wet season values of turbidity and conductivity. However, dry season values of water temperature and dissolved oxygen were higher than wet season values with no significant differences (Table 4). The hydrogen ion concentration was fairly constant and there was no significant variation throughout the study.

DISCUSSION

The Physico-chemical parameters of the water had a low amplitude of variations during the period of study. These variations may be related to patterns of rainfall. In the reservoir, the analysed parameters were generally similar except for turbidity and conductivity which showed significant differences. The variations in the Physico-chemical parameters of water observed at the reservoir were probably influenced by different environmental conditions such as the amount and duration of rainfall.

Temperature which is an important factor that influences primary production is dependent on the climate, sunlight, and depth of water (Lewis, 2000). Ambient and water temperatures recorded for Owalla reservoir were relatively lower during the wet season (April to October) than during the dry season (November to March). Differences recorded between the ambient and water temperature could be attributed to the sampling time, which was between 8.00 am and 10.00 am, a period when the water is expected to be warmer than air. The strong correlation between air and water temperature in the reservoir was an indication of the positive interaction at the air-water interphase facilitated by

the mixing of the water induced by the wind condition. The range of water temperature recorded during the study period fell within limits of 20.00 °C and 32.50 °C reported by Komolafe and Arawomo (2008) for Osinmo Reservoir and Okayi *et al.* (2011) for River Benue.

The pH values of the water in Owalla Reservoir were within the range (5.5-9.0) suggested by Boyd (1979), as being most suitable for fish production. The mean pH of 7.44 recorded in the reservoir water showed that the water was slightly alkaline. Ayoade *et al.* (2006), recorded a pH range of 6.2–8.5 while Komolafe and Arawomo (2008), recorded a pH range of 7.5–7.6 in Osinmo reservoir which they adduced, fell within the range of 6.6 and 8.5 known for most streams and lakes of the world (Boyd, 1979).

Variations observed in dissolved oxygen content of water in the reservoir showed higher values during the wet season which could be attributed to lower water temperature and increased aeration due to water turbulence.

The oxygen content of natural waters has been reported to vary with temperature, turbulence, atmospheric pressure, and photosynthetic activity of algae and other aquatic plants. The dissolved oxygen content which ranged between 5.83 mg l^{-1} and 8.73 mg l^{-1} recorded during the current study were however well within the acceptable range of 1.75 - 11.20 mg l^{-1} obtained by Atobatele and Ugwumba (2008), which are suitable for fisheries development in the reservoir.

A wide range of fluctuations in total alkalinity values of tropical water bodies depends on the location, season, plankton population, and nature of bottom deposits. Idowu and Ugwumba (2005), reported high alkalinity values in Oyan Lake during the dry season. The mean alkalinity of 64.11 ± 0.46 mg/L (range: 56.12 - 71.42 mg/L) obtained during the present study was similar to the findings of Idowu and Ugwumba (2005), and such high alkalinity value has been considered suitable for fisheries development in the Reservoir because it is an indication of high natural food production which ultimately supports fishery development (Komolafe and Arawomo, 2008).

The low water transparency observed in the reservoir during the rainy season could be attributed to influx from run-offs with high allochthonous materials from adjacent catchment areas into the reservoir which decreased light penetration. Lewis (2000), observed that phytoplankton biomass influences water transparency and therefore turbidity. He also reported a positive correlation between turbulence nutrient influx and nutrient availability. However, Secchi disc transparency values recorded for the reservoir were within the range considered suitable for fish growth (Atobatele and Ugwumba, 2008). This finding suggested that the turbid water in the reservoir during the rainy

season is good for fish production.

The conductivity range (40.87 to 88.56 μ S/cm) with the mean value (61.82 \pm 7.01 μ S/cm) for Owalla reservoir during the period of study can be regarded to be relatively low, probably due to the low dissolved solid contents of the water body. According to Egborge (1994), conductivity levels below 50 μ mhos/cm are regarded as low; those between 50 – 600 μ mhos/cm are medium while those above 600 μ mhos/cm are high. Many inland water bodies of Nigeria have been reported to have conductivity much less than 500 μ S/cm at the peak of the dry season and much less than 100 μ S/cm during the rainy season, and Owalla Reservoir was not an exception in this regard. The significantly higher conductivity values recorded for the reservoir during the wet season suggested that allochthonous materials brought in by streams draining into the catchment areas probably played major roles in the limnology of the reservoir (Ikenweiwe and Otubusin, 2005). High conductivity values have been reported to be indicative of an increase in the 'number of polluting particles' (Oben, 2000), since the conductivity of the water body is sensitive to variations in the number of dissolved solids, mostly mineral salts. The lower conductivity values recorded for the dry season were probably due to the utilization of nutrients in the allochthonous materials by the phytoplanktonic organisms in the reservoir as well as lack of or reduced influx of dissolved solids from the catchment inflow.

CONCLUSION

The Physico-chemical parameters of the water in Owalla Reservoir had low amplitudes of variations and were within the range suggested as being most suitable for fisheries development as seen in other reservoirs in the same region. The findings of this study have provided some vital site-specific information and insights into the extent to which the Physico-chemical parameters of the water can affect fish production in the reservoir. The study also established that, based on the water quality, the reservoir provides a good environment for fish species to thrive. Knowledge obtained from the study of the Physico-chemical parameters of the reservoir could be used to predict new species recruitment variability. The information from this study can also be useful for predicting fisheries production potential of the reservoir and providing a useful tool for fisheries development in Osun State and augmenting available data on inland freshwater bodies in the state and Nigeria. Considering the size of the reservoir, there is a need to develop strategies for effective monitoring of the Physico-chemical parameters of the reservoir for optimum fish production as the reservoir is known to be of great importance in the development of a sustainable fishery in Osun State, Nigeria.

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