

Available online at <http://ajol.info/index.php/ijbcs>

Int. J. Biol. Chem. Sci. 8(2): 596-609, April 2014

ISSN 1997-342X (Online), ISSN 1991-8631 (Print)

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**International Journal  
of Biological and  
Chemical Sciences**

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*Original Paper*<http://indexmedicus.afro.who.int>

## Assessment of the water quality parameters in relation to fish community of Osinmo reservoir, Ejigbo, Osun State, Nigeria

O.O. KOMOLAFE<sup>\*</sup>, A.A. ADEDEJI and B. FADAIRO,*Department of Zoology, Obafemi Awolowo University, Ile-Ife, Nigeria.**<sup>\*</sup>Corresponding author, E-mail: [niyikomolafe2002@yahoo.co.uk](mailto:niyikomolafe2002@yahoo.co.uk); [komolafe@oauife.edu.ng](mailto:komolafe@oauife.edu.ng)*

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### ABSTRACT

Physicochemical indices of water body changed seasonally and this necessitated an investigation to assess the water quality parameters of Osinmo reservoir in relation to its fish species. The water quality parameters were measured using standard methods. Results obtained show that the reservoir is alkaline in nature with dissolved oxygen concentration ( $1.8-7.2 \text{ mg l}^{-1}$ ) and alkalinity ( $64 \text{ CaCO}_3 \text{ mg l}^{-1}-108 \text{ CaCO}_3 \text{ mg l}^{-1}$ ) which were within the optimum range for growth and survival of fish. Four families of fish comprising eight species were encountered. The sex-ratio of five species which were statistically different ( $P < 0.05$ ) indicated reproductive efficiency populations while other fish species whose sex-ratio differed insignificantly ( $P > 0.05$ ) revealed a growing population. The well-being of the fish species was adequate as observed in the least mean condition factor of  $0.666 \pm 0.057$  in *C. gariepinus* and the highest mean of  $2.000 \pm 0.242$  in *S. galilaeus*. The productivity of the reservoir can be improved through proper management of the water body.

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**Keywords:** Water quality, fish abundance, diversity, fish biometrics, sex-ratio, condition factor.

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### INTRODUCTION

Water is an essential natural resource for life sustenance and healthy functioning of any ecosystem because of its continuous interaction with the surrounding air, land and living things (Wetzel, 2001). Water is also not only the survival resource of all living beings but also the main vector for all developmental activities related to all ecological and societal processes (Rosenblatt, 2005).

The quality of treated and untreated water is typically determined by monitoring microbial presence, especially faecal coliforms, bacteria, phytoplankton, parasites, and the physicochemical properties (WHO,

2001). Management of river and reservoir water quality has become increasingly important due to decline in water quality caused by human activities and run off from catchment basins. Successful implementation of efficient management strategies requires the monitoring of water quality changes (UNEP, 2012). The quality of water should be checked at regular intervals to prevent deterioration of water quality and to maintain healthy aquatic biota (Bhalerao, 2012).

A monitoring program and a preventive and reliable estimation of the quality of the surface waters are necessary, as chemical,

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DOI : <http://dx.doi.org/10.4314/ijbcs.v8i2.18>

physical and biological compositions of surface water are the prime factors on which the suitability of the water for drinking, domestic, industrial or agricultural purpose depends (UNEP, 2012). Abundance, distribution and diversity of fish species in a community are also greatly influenced by water quality parameters (Carol et al., 2006; Cheng et al., 2010). However, the most important factors affecting fish composition and survival differs among waterbodies, ranging from physical properties to water chemistry (Cheng et al., 2010). The present study therefore investigates some of the water quality parameters of a newly impounded reservoir and its relationship to the fish diversity and management strategy.

## MATERIALS AND METHODS

### Study site

Osinmo reservoir with a catchment area of about 102km<sup>2</sup> was created in 2005 by impounding Ataro river. It has a surface area of about 0.78 sq km with a mean depth of 3.2 meters. The basin extends in width from Longitude 0.4°21.2'E to 0.4°21.7'E and in length from Latitude 007° 52.8' N to 007°53.2'N. The reservoir occupies an undulating terrain with an altitude of 365.8m above the sea level. The vegetation is mainly of lowland rain forest with patchy derived grassland (Keay, 1959). Rainy season in the catchment area is between April and October while the dry season is between November and March annually.

### Water sampling and laboratory analysis

Water samples were collected monthly from the reservoir between January and December, 2011. Water temperature was measured *in situ* with a mercury-in-glass bulb thermometer while pH was determined on the field using Gowe® multi-function water quality test monitor. Water transparency was also measured *in situ* using a graduated secchi

disc. The samples for the determination of dissolved oxygen (DO) were collected in a 250/125 ml capacity glass reagent bottles, fixed in the field using Winkler's reagents and brought into the laboratory for further processing. Water samples (a total of 36 samples) for the determination of other chemical parameters were collected in two litre polyethylene sample cans. The analysis of the water samples for chemical parameters including acidity, alkalinity, conductivity, and oxygen parameters were all in accordance with standard methods of Golterman et al. (1978) and APHA et al. (1992) as applicable. The conductivity was measured at 25 °C using Jenway conductivity meter (Model 4071).

### Fish sampling and laboratory analysis

Fish species were caught monthly with gill-net 2.54 cm mesh size measuring 100 m long and 3 m deep, set overnight and removed the following morning. Ten funnel-shaped fish traps (made from the plant *Eremospathasp*) whose entrance has a non-return valve were each baited with ripe palm fruits and set randomly under sedges along the shoreline of the reservoir.

Specimens of fish caught were put in ice-chest box covered with ice and brought to the laboratory, identified (Reed et al., 1967; Paugy et al., 2003; Adesulu and Sydenham, 2007), the total length, standard length and weight of each fish taken and recorded. The lengths of the fish species were measured using meter rule fixed to a measuring board (expressed to the nearest centimeters) while the weights were measured using Denward weighing balance. Fishes were slit open ventrally from the anus to the pectoral fin to determine sex and stage of gonad maturity by visual inspection (Roberts, 1989). The Pondera index (K) (Weatherley, 1972) primarily expresses the condition of a fish in term of well-being and relative robustness.

$$K = \frac{100,000W}{L^3} \text{ (William, 2000)}$$

Where W = the weight of fish (g)  
L = the length of fish (mm).

### Statistical analysis

Data obtained were analysed using relevant statistics including descriptive statistics and multivariate statistics using SPSS software (SPSS16, 2008).

## RESULTS

### Seasonal variations in the water physicochemical parameters

The results of the physicochemical parameters of water quality in the reservoir are as shown in Table 1. The ambient air temperature varied between a minimum of 16 °C in January, 2011 to a maximum of 26.5 °C in April, 2011 while water temperatures ranged from minimum of 22 °C in December, 2011 to maximum of 29 °C in May, 2011. Water temperature was strongly influenced by the air temperature, increasing with increase in air temperature; hence they both exhibited the same seasonal pattern. The mean water temperature was higher in the rainy season (26.85±1.31 °C) than during the dry season (24.60 ± 1.95 °C) in the reservoir. Likewise, the mean air temperature was higher in the rainy season (24.50 ± 1.22 °C) than during the dry season (20.70 ± 3.52 °C).

The values of dissolved oxygen (DO) in the reservoir ranged from 1.8 mgL<sup>-1</sup> to 7.2 mgL<sup>-1</sup>. The maximum and minimum values were both recorded in the rainy months of July, 2011 (Mid-rainy season) and April, 2011 (Onset of rainy season). There was no significant (P > 0.05) seasonal dissolved oxygen variation with the recorded mean DO of 3.74 ± 1.68 mgL<sup>-1</sup> and 4.00 ± 0.94 mgL<sup>-1</sup> in the rainy and dry seasons respectively. Biochemical oxygen demand (BOD<sub>5</sub>) of the water samples varied from 0.8 mgL<sup>-1</sup> in February, 2011 (late dry season) to 2.8 mgL<sup>-1</sup>

in May, July and October, 2011 (rainy months) (Table 1). The Biological oxygen demand also showed low amplitude of variations over the period of study, hence no significant (P > 0.05) variation occurred in its seasonal values (mean BOD value of 2.00 ± 0.77 mgL<sup>-1</sup> for the rainy reason and 1.36 ± 0.46 mgL<sup>-1</sup> recorded for the dry season).

The reservoir acidity fluctuated through the months of sampling with a range of 40CaCO<sub>3</sub> mgL<sup>-1</sup> in October, 2011 (late rainy season) to 66 CaCO<sub>3</sub> mgL<sup>-1</sup> in March, 2011 (Onset of Rainy Season). The seasonal variation as observed in the mean acidity of 46.57 ± 5.00 mgL<sup>-1</sup> and 51.0 ± 9.00 mgL<sup>-1</sup> during the rainy and dry seasons respectively were however not statistically significant (P > 0.05) while the overall mean acidity was 48.42 ± 7.02 mgL<sup>-1</sup>. Alkalinity of the reservoir varied between 64 mgL<sup>-1</sup> in February, 2011 (late dry season) and 108 mgL<sup>-1</sup> in September, 2011 (late rainy season). There was a significant seasonal variation (P < 0.05) in the mean alkalinity over the two seasons (rainy and dry seasons) with a mean of 93.86 ± 10.75 CaCO<sub>3</sub> mgL<sup>-1</sup> and 77.20 ± 9.01 CaCO<sub>3</sub> mgL<sup>-1</sup> respectively. The overall mean alkalinity recorded during the period of study was 86.92 ± 12.89 CaCO<sub>3</sub> mgL<sup>-1</sup> (Table 1).

During this study, the pH ranged between 6.60 (September, 2011) and 7.55 (February, 2011). The mean pH in the rainy and dry seasons was 7.07 ± 0.41 and 7.46 ± 0.09 respectively while the overall mean pH was 7.24 ± 0.37. The peak value of conductivity of 153 µScm was recorded during mid-dry season (January, 2011) while the minimum value of 76µScm was observed in July, 2011 (mid-rainy season). ANOVA analysis of conductivity mean values showed seasonal statistical significant (P < 0.05 with mean conductivity of 100.86 ± 18.73 µScm and 128.20 ± 22.32 µScm in the rainy and dry seasons respectively and an overall mean conductivity value of 112.25 ± 23.89 µScm.

The transparency of the water in the reservoir also showed statistically significant seasonal variation ( $P < 0.05$ ) with a minimum of 68 cm recorded in August, 2011 and the maximum transparency of 96 cm in February, 2011. The mean transparency of the water in the reservoir was  $84.00 \pm 2.47$  cm.

#### **Fish abundance, diversity, length and weight structure**

Four families of fish comprising eight species were caught during the period of study. The family Cichlidae with five species was the most dominant while other families of fish had one species each. The Cichlids constituted about 83% of the population, followed by Hepsetidae 10%, Channidae 4% and Clariidae was 3% respectively. However, *Tilapia zillii* constituted 40% of all fish specimens caught while *Sarotherodon galilaeus* which constituted 20.0% was the second largest specimen caught in the reservoir. Fish length and weight varied with respect to species. The mean standard length and mean weight of each fish shown in Table 2 revealed that relatively bigger specimens of *C. gariepinus*, *P. obscura* and *O. niloticus* were caught in the reservoir during the period of study.

#### **Sex-ratio and condition factor**

The lowest sex ratio of fish species of 1:0.2 (male to female) was recorded in *S. galilaeus* while the highest of 1:0.8 (male to female) was recorded for *Oreochromis niloticus*. The sex ratio of male to female in *Tilapia zillii*, *S. galilaeus* and *Hemichromis fasciatus* were statistically significant ( $P < 0.05$ ) while for other fish species, the sex ratio were found to be statistically insignificant ( $P > 0.05$ ). The range and mean Condition Factor (K) of each fish was as

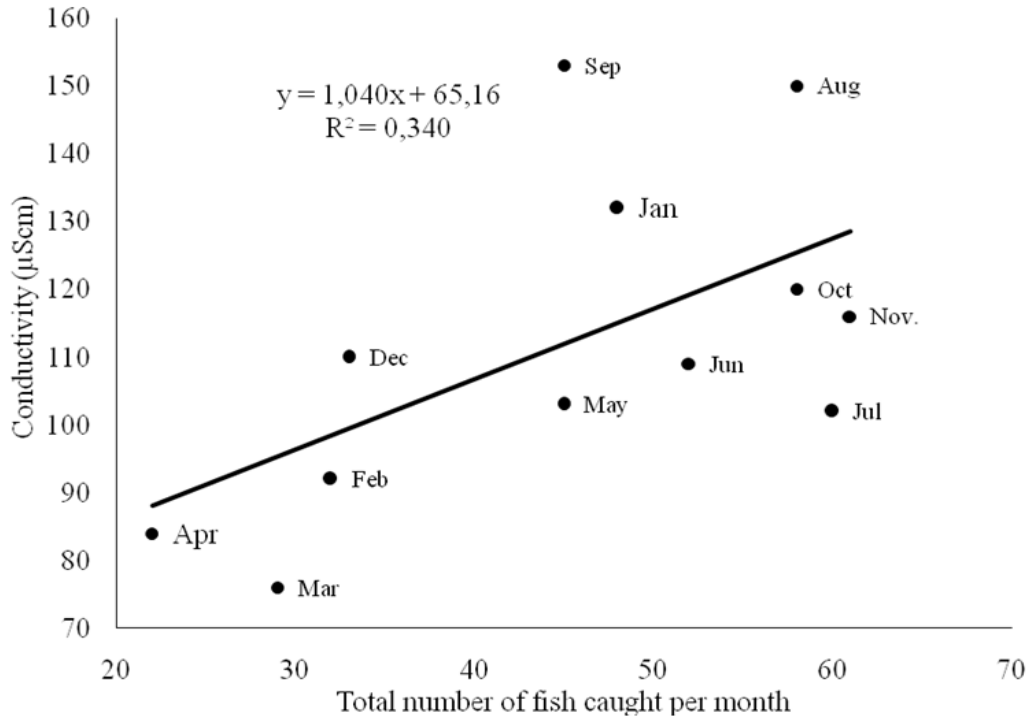
shown in Table 3. *Clarias gariepinus* specimens has the least mean Condition Factor of  $0.666 \pm 0.057$  while the highest mean of  $2.004 \pm 0.242$  was recorded in *S. galilaeus* specimens.

#### **Relationship between water quality and fish biometric characteristic**

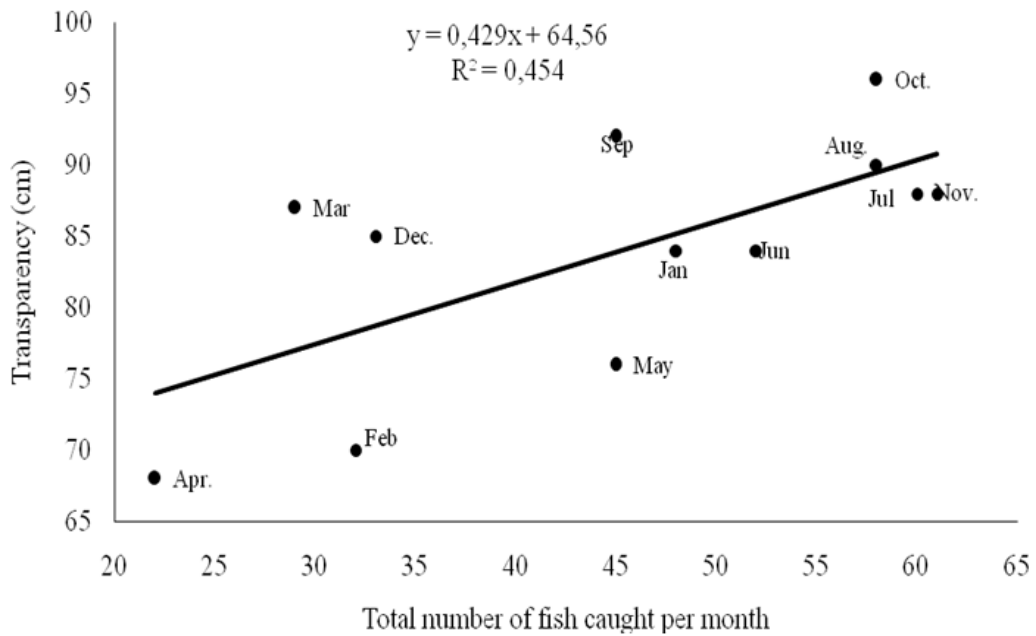
The result of correlation analysis between the water quality and the fish species biometric characteristics (Standard length and weight) is as presented in Tables 4 and 5. Dissolved oxygen, biological oxygen demand and acidity showed positive statistically significant correlation with the body weight of *Sarotherodon galilaeus* and *Parachanna obscura* (Table 4) while *Chromidotilapia guntheri* showed zero correlation with conductivity. Acidity also showed positive significant correlation with the standard length of *O. niloticus* while conductivity had a significant negative correlation with both standard length and weight of *O. niloticus*. The weight of *T. zillii* also showed a positive correlation with water temperature of the reservoir.

#### **Relationship between water quality and fish catch**

The relationship between the physicochemical parameters of water quality and the number of fish caught in the Osinmo reservoir revealed that there was a direct significant ( $P < 0.05$ ) relationship between the numbers of fish caught and water transparency. Conductivity also showed a positive correlation with fish abundance. As shown in Figures 1 and 2, the number of fish caught increases as transparency and conductivity of water in Osinmo reservoir increased. Other water parameters showed no correlation with the fish abundance.



**Figure 1:** Variation in conductivity (µScm) against total number of fish caught per month.



**Figure 2:** Variation in transparency (cm) against total number of fish caught per month.

**Table 1:** Seasonal variation in physicochemical parameters of Osinmo reservoir.

Parameters	Rainy season		Dry season		Overall annual range and mean		Anova test	
	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	F ratio	Probability
	Air Temperature (°C)	23.0 – 26.5	24.50 ± 1.22	16.0 – 24.0	20.70 ± 3.52	16.0 – 26.5	24.5±0.36	7.163*
Water Temperature (°C)	26.0 – 29.0	26.85 ± 1.31	22.0 – 27.0	24.60 ± 1.95	22.0 – 29.0	27.08±0.39	5.814*	0.037
Dissolved Oxygen (DO) mg <sup>l</sup> <sup>-1</sup>	1.8 - 7.2	3.74 ± 1.68	2.8 - 4.8	4.00 ± 0.94	1.8 - 7.2	3.83 ± 1.37	0.094	0.766
Biochemical Oxygen Demand (BOD) mg <sup>l</sup> <sup>-1</sup>	1.2 - 2.8	2.00 ± 0.77	0.8 - 2.0	1.36 ± 0.46	0.8 - 2.8	1.73 ± 0.71	2.745	0.129
Acidity (CaCO <sub>3</sub> mg <sup>l</sup> <sup>-1</sup> )	40 - 56	46.57 ± 5.00	41 - 66	51.00 ± 9.00	40 - 66	48.42 ± 7.02	1.178	0.303
Alkalinity (CaCO <sub>3</sub> mg <sup>l</sup> <sup>-1</sup> )	78 - 108	93.86 ± 10.75	64 - 86	77.20 ± 9.01	64-108	86.92 ± 12.89	7.952*	0.018
Hydrogen Ion concentration (pH)	6.60 - 7.52	7.07 ± 0.41	7.35 - 7.55	7.46 ± 0.09	6.60 - 7.55	7.24 ± 0.37	4.202	0.068
Conductivity (µScm)	76 - 132	100.86 ± 18.73	102 - 153	128.20 ± 22.32	76 - 153	112.25 ± 23.89	5.322*	0.044
Transparency (cm)	68-87	78.17±3.27	85-96	89.83±1.56	68-96	84±2.47	9.770**	0.011

\* = Significant ; \*\* = highly significant

**Table 2:** Abundance, diversity, length and weight structure.

Fish species	No examined	Fish %	Std. length (cm) Range	Mean ± SD of mean	Weight (g) Range	Mean ± SD of mean
<i>Hepsetus odoe</i>	54	10	26.5-30.5	28.5±2.83	282-382	332±70.7
<i>Clarias gariepinus</i>	16	3	24.0-46.2	37.9±12.1	144-1100	698±496
<i>Parachanna obscura</i>	21	4	32.0-40.5	34.88±4.8	418-1055	689±308
<i>Hemichromis fasciatus</i>	32	6	8.2-12.1	10.2±1.30	22-62	38±17.1
<i>Oreochromis niloticus</i>	45	8	21.5-28.5	25.1±3.50	388-876	604±249
<i>Chromidotilapia guntheri</i>	50	9	7.8-12.7	9.4±2.16	14-56	32±20,4
<i>Sarotherodon galilaeus</i>	110	20	9.5-19.0	13.82±2.46	37-300	122±63.6
<i>Tilapia zillii</i>	215	40	11.8-205	15.89±3.24	66-388	185±98.7

**Table 3:** Sex ratio and condition factor.

Fish species	Sex ratio			Condition Factor (K)			
	Male	Female	(Sex ratio)	X <sup>2</sup> value	P(0.05)	Range	Mean ± SD of mean
<i>Hepsetus odoe</i>	36	18	1:0.5	1.12	NS	0.586-1.326	0.773±0.042
<i>Clarias gariepinus</i>	10	6	1:0.6	0.05	NS	0.509-0.878	0.666± 0.057
<i>Parachanna obscura</i>	12	9	1:0.8	0.14	NS	0.789-1.008	0.861±0.049
<i>Hemichromis fasciatus</i>	24	8	1:0.3	8.00	S	1.523-1.974	1.753±0.311
<i>Oreochromis niloticus</i>	25	20	1:0.8	0.12	NS	1.480-1.977	1.708± 0.216
<i>Chromidotilapia guntheri</i>	35	15	1:0.4	0.50	NS	1.424 -2.038	1.677±0.153
<i>Sarotherodon galilaeus</i>	85	25	1:0.2	12.0	S	1.675-2.280	2.004±0.242
<i>Tilapia zillii</i>	165	50	1:0.3	12.3	S	1.275-3.009	1.850±0.278

NS = not significant ; S = significant

**Table 4:** Correlation coefficient between fish species' standard length and physicochemical water parameters.

Parameters	Spearman's Rho	<i>Clarias gariepinus</i>	<i>Tilapia zillii</i>	<i>Parachanna obscura</i>	<i>Sarotherodon galilaeus</i>	<i>Oreochromis niloticus</i>	<i>Hepsetus odoe</i>	<i>Hemichromis fasciatus</i>	<i>Chromidotilapi a guntheri</i>
Dissolved oxygen (mg l <sup>-1</sup> )	Correlation Coefficient	0.08	0.048	-0.155	0.495	-0.392	-0.551	0.082	-0.360
	Sig. (2-tailed)	0.806	0.882	0.632	0.102	0.207	0.063	0.8	0.427
Biological oxygen demand (mg l <sup>-1</sup> )	Correlation Coefficient	0.213	0.09	-0.111	0.467	-0.39	-0.527	0.032	-0.378
	Sig. (2-tailed)	0.506	0.78	0.731	0.126	0.21	0.078	0.922	0.403
Acidity (CaCO <sub>3</sub> mg l <sup>-1</sup> )	Correlation Coefficient	-0.01	0.085	0.312	-0.231	<b>0.610*</b>	0.37	-0.018	-0.107
	Sig. (2-tailed)	0.974	0.792	0.323	0.471	<b>0.035</b>	0.236	0.956	0.819
Alkalinity (CaCO <sub>3</sub> mg l <sup>-1</sup> )	Correlation Coefficient	-0.02	0.095	0.044	-0.011	-0.039	0.207	-0.141	0.393
	Sig. (2-tailed)	0.948	0.768	0.892	0.974	0.905	0.519	0.662	0.383
pH	Correlation Coefficient	0.2	0.41	0.427	-0.018	0.414	0.304	0.086	0.445
	Sig. (2-tailed)	0.532	0.185	0.166	0.955	0.181	0.337	0.79	0.317
Conductivity (µScm)	Correlation Coefficient	-0.25	-0.09	-0.312	-0.512	<b>-0.663*</b>	0.533	-0.357	0.000
	Sig. (2-tailed)	0.424	0.781	0.323	0.088	<b>0.018</b>	0.074	0.255	1.000
Air Temperature (°C)	Correlation Coefficient	-0.31	-0.08	-0.208	-0.337	-0.298	0.223	0.235	-0.408
	Sig. (2-tailed)	0.328	0.814	0.517	0.284	0.347	0.487	0.462	0.364
Water Temperature(°C)	Correlation Coefficient	-0.17	0.267	-0.105	0.127	0.06	0.258	0.478	-0.360
	Sig. (2-tailed)	0.601	0.401	0.745	0.693	0.853	0.417	0.116	0.427

\*\*Correlation is significant at the 0.01 level

\*Correlation is significant at the 0.05 level



**Table 5:** Correlation coefficient between fish species' weight and physicochemical water parameters.

Parameters	Spearman's Rho	<i>Clarias gariepinus</i>	<i>Tilapia zillii</i>	<i>Parachanna obscura</i>	<i>Sarotherodon galilaeus</i>	<i>Oreochromis niloticus</i>	<i>Hepsetus odoe</i>	<i>Hemichromis fasciatus</i>	<i>Chromidotilapia guntheri</i>
Dissolved oxygen (mg l <sup>-1</sup> )	Correlation Coefficient	0.138	0.101	-0.29	<b>0.750**</b>	-0.35	-0.491	0.216	-0.234
	Sig. (2-tailed)	0.669	0.754	0.355	<b>0.005</b>	0.265	0.105	0.501	0.613
Biological oxygen demand (mg l <sup>-1</sup> )	Correlation Coefficient	0.2	0.037	-0.2	<b>0.729**</b>	-0.334	-0.467	0.172	-0.252
	Sig. (2-tailed)	0.532	0.909	0.534	<b>0.007</b>	0.289	0.125	0.592	0.585
Acidity (CaCO <sub>3</sub> mg l <sup>-1</sup> )	Correlation Coefficient	-0.18	0.082	<b>0.567*</b>	-0.34	0.501	0.342	-0.18	-0.250
	Sig. (2-tailed)	0.568	0.801	<b>0.054</b>	0.277	0.097	0.276	0.583	0.589
Alkalinity (CaCO <sub>3</sub> mg l <sup>-1</sup> )	Correlation Coefficient	0.147	0.056	0.09	0.057	-0.018	0.308	-0.16	0.429
	Sig. (2-tailed)	0.648	0.862	0.781	0.861	0.957	0.33	0.609	0.337
pH	Correlation Coefficient	0.171	0.169	0.485	-0.11	0.368	0.4	0.064	0.259
	Sig. (2-tailed)	0.594	0.599	0.11	0.742	0.239	0.198	0.843	0.574
Conductivity (µScm)	Correlation Coefficient	-0.2	-0.171	-0.05	-0.36	<b>-0.698*</b>	0.537	-0.32	0.054
	Sig. (2-tailed)	0.533	0.594	0.883	0.251	<b>0.012</b>	0.072	0.312	0.908
Air Temperature (°C)	Correlation Coefficient	-0.35	0.04	-0.25	-0.25	-0.374	0.04	0.237	-0.334
	Sig. (2-tailed)	0.267	0.902	0.431	0.437	0.232	0.903	0.458	0.465
Water Temperature (°C)	Correlation Coefficient	-0	<b>0.578*</b>	-0.28	0.28	-0.042	0.166	0.396	-0.270
	Sig. (2-tailed)	0.991	<b>0.049</b>	0.379	0.377	0.896	0.605	0.202	0.558

\*\*Correlation is significant at the 0.01 level ; \*Correlation is significant at the 0.05 level

## DISCUSSION

### Physicochemical water quality

Osinmo reservoir is alkaline in nature with dissolved oxygen concentration (1.8-7.2 mg $l^{-1}$ ) and alkalinity (64 CaCO<sub>3</sub> mg $l^{-1}$ -108 CaCO<sub>3</sub> mg $l^{-1}$ ) which were within the optimum range for growth and survival of fish (Bhatnagar and Devi, 2013). However the rate of primary productivity in the reservoir is low as indicated by low water transparency value which is greater than 50 cm. While the low level of BOD<sub>5</sub> (0.8 mg $l^{-1}$  - 2.8 mg $l^{-1}$ ) as recorded from the reservoir shows that the water body is much more within the desirable limit and is less polluted (Uzukwu, 2013).

The observed significant seasonal variation in the physicochemical water quality of the reservoir according to Ayoade et al. (2006) is due to rainfall and water use. The water temperature was greatly influenced by the air temperature which decreased with rains hence the water temperature were generally low during the rainy season. This, according to Akinbuwa (1999 cited Adedeji, 2011) is a phenomenon common to the West African aquatic system owing to time lag between the onset of rains and the time run-offs get into the aquatic system. These patterns of results were similar to the observation of Atobatele and Ugwumba (2011) and Komolafe and Arawomo (2011) in Aiba and Erinle reservoirs which were in the same axis with the present reservoir. Low transparency of 68 cm and maximum of 96 cm during rainy season and dry season is as a result of heavy rainfall which brought about abundance of decayed organic matter in suspension, while surface runoff from streams and rivulets also carried particulate matters which influenced water transparency as was reported by Mustapha (2008). The hydrogen ion concentrations (pH) recorded for the reservoir were generally above pH 7 during the period of study, was within the range of 6.5 - 8.5 known for most lakes and streams of the

world (Tepe et al., 2005). Moreover, the recorded range of pH values (6.60 – 7.55) in the study is ideal for fish growth and development (Uzukwu, 2013). A low pH value had been observed to lower fish blood pH in the gills and hence the capacity to function during respiration (Carmona et al., 2004). The minimum value of pH as recorded during the rainy season was as a result of influx of acidic flood and re-suspension of bottom sediment during the rains (Russell and Helmke, 2002). According to Gupta and Gupta (2006), accumulation of free carbon dioxide due to little photosynthetic activities of phytoplankton (during rainy season) will lower the pH values of waterbody while intense photosynthesis by phytoplankton (during dry season) will increase pH values. Tropical water-bodies had been observed to show a wide range of fluctuations in total alkalinity as a result of location, bottom deposits and season, while high alkalinity values above 300 ppm had been reported to adversely affect spawning and hatching of freshwater fish (Gupta and Gupta, 2006). The mean alkalinity of  $85.75 \pm 3.50$  CaCO<sub>3</sub> mg $l^{-1}$  recorded in this study was within the optimum tolerance limits for freshwater fish which were 50 CaCO<sub>3</sub> mg $l^{-1}$  to 700 CaCO<sub>3</sub> mg $l^{-1}$  (Uzukwu, 2013). The mean of alkalinity of  $85.75 \pm 3.50$  CaCO<sub>3</sub> mg $l^{-1}$  in the present study suggested that Osinmo reservoir could be considered good for fishery development. The mean overall acidity level of  $49.92 \pm 2.14$  CaCO<sub>3</sub> mg $l^{-1}$  for the reservoir also reflects the level of pH and alkalinity of the reservoir. Acidity of water has capacity to neutralize a strong base and is mostly due to the presence of strong mineral acids, weak acids and the salts of strong acid and weak base (Uzukwu, 2013). Acidity and Alkalinity of Osinmo reservoir might probably be due to the area being underlain by pre-Cambrian basement complex rocks containing carbonate, bicarbonate and hydroxide compounds.

Minimum and maximum conductivity of 76  $\mu\text{Scm}$  and 153  $\mu\text{Scm}$  were within the range of African most dilute water body known to be poor in ionic concentration (Kemdirim, 2005). Conductivity level of the reservoir seemed fairly high when compared to Aiba reservoir (Atobatele and Ugwumba, 2008) who reported conductivity range of 49.4  $\mu\text{Scm}$  to 78  $\mu\text{Scm}$ . The significant seasonal variation in the conductivity values, might be attributed to dilution by influx of rain water and runoff from farmlands containing fertilizers and herbicides during the rainy season and the reduction in water level due to evaporation during the dry season as reported by (Oben, 2000). Hence, the present study is consistent with Egborge (1994 cited Atobatele and Ugwumba, 2008) who reported conductivity levels of inland water bodies of Nigeria to be less than 500  $\mu\text{Scm}$  at the peak of dry season and less than 100  $\mu\text{Scm}$  in the rainy seasons.

The low concentration of dissolved oxygen (DO) recorded in the reservoir was as a result of suspended materials brought into the aquatic system by rains which increased oxygen demand while oxygen production by photosynthesis was reduced by turbidity (Tepe and Mutlu, 2005). The observed result is in agreement with what were obtained in some African waters as reported in Opa reservoir (Akinbuwa, 1988 cited Adedeji, 2011) and Oyun Reservoir (Mustapha, 2008). However, the range of dissolved oxygen recorded in the reservoir which was between 1.8  $\text{mgL}^{-1}$  – 7.2  $\text{mgL}^{-1}$  was within the optimum performance range for fish (Uzukwu, 2013). Boyd (1979 cited Pillay, 2008) also reported that dissolved oxygen concentration of 3  $\text{mgL}^{-1}$  to 12  $\text{mgL}^{-1}$  will promote the growth and survival of fish reservoir.

#### **Fish abundance, diversity, length and weight structure**

There were four families of fish comprising eight species in this study. The

Cichlidae with 83% of the population was the most abundant while Hepsetidae, Canninidae and Clariidae followed with 10%, 4% and 3% respectively. The diversity of fish was low when compared to Opa and Erinle reservoirs with eleven and nineteen species made up of five and ten families (Komolafe and Arawomo, 2007, 2011). The mean standard length of *C. guntheri* at  $9.4 \pm 2.16$  cm was the least when compared to *C. gariepinus* of  $37.9 \pm 12.1$  cm. This pattern of result was also recorded in the mean weight of the species with  $32 \pm 20.4$  g as the least mean weight of *C. guntheri* while *C. gariepinus* had a mean weight of  $698 \pm 496$  g. Other fish species with appreciable mean standard length and mean weight were *P. obscura*, *H. odoe*, *O. niloticus* and *T. zillii*. The mean standard length and mean weight varied according to species as was also reported for the nineteen species of fish in Erinle reservoir (Komolafe and Arawomo, 2011).

#### **Sexratio and condition factor**

The sex-ratio of *T. zillii*, *S. galilaeus* and *H. fasciatus* were statistically significant ( $P < 0.05$ ) indicating a growing population while the sex ratio of five fish species viz; *H. odoe*, *C. gariepinus*, *P. obscura*, *O. niloticus* and *C. guntheri* were not statistically significant ( $P > 0.05$ ) also indicating populations with reproductive efficiency towards optimum as reported by Obadia and Waltia (2003) in Tona reservoir. The mean condition factor of  $0.666 \pm 0.057$  observed for *C. gariepinus* was the least while *S. galilaeus* with a mean condition factor of  $2.00 \pm 0.242$  was the highest. High condition factors were recorded for all the fish species contrary to low condition factor observed for *Chrysichthys nigrodigitatus* in Aiba reservoir (Atobatele and Ugwumba, 2008). Low condition factor as recorded for *C. gariepinus* might be attributed to poor environmental conditions and weight loss during reproductive activities. While high condition factor observed for fish

species in this study indicated the presence of adequate food and other essential materials for the well-being of the species in the habitat.

#### Effect of water quality on fish biometric characteristic and abundance

The dissolved oxygen, biological oxygen demand, acidity, conductivity and water temperature were observed to have direct impact on the well-being the fish species. These water quality parameters showed either positive or negative correlation with either the standard length or weight of the fish species as reported for *S. galileaus*, *O. niloticus* *P. obscura* and *T. zillii* which constituted the main catch during the period of study. Water transparency and conductivity also had direct relationship with the fish species abundance. This could be as a result of great influence that these water quality parameters have on fish composition, distribution and abundance (Muyodi et al., 2011).

#### Conclusion

Based on the result of water quality parameters of Osinmo reservoir examined, the sex ratio of the fish species recorded which showed a growing population and the well-beings of the fishes which were very adequate with respect to their condition factors. The productivity of the reservoir can be improved through proper management of the water body such as the control of aquatic weed, enhancement of primary productivity and controlling fishing activities.

#### REFERENCES

- Adedeji AA. 2011. The water quality, zooplankton and macrobenthic invertebrate faunae in relation to aquacultural practice and management of fishponds in Ife North Area, Osun State, Nigeria. Ph.D thesis, Obafemi Awolowo University, Ile Ife, p. 284.
- Adesulu EA, Sydenham DHJ. 2007. *The Freshwater Fishes and Fisheries of Nigeria*. Macmillan Nigeria: Lagos; 397.
- APHA, AWWA, WEF. 1992. *Standard Methods for the Examination of Water and Wastewaters* (18th edn). American Public Health Association: Washington D.C. ; 1134.
- Atobatele OE, Ugwumba OA. 2008. Seasonal variation in the physicochemistry of a small tropical reservoir (Aiba Reservoir, Iwo, Osun, Nigeria). *Afr. J. Biotechnol.*, **7**(12): 1962-971.
- Atobatele OE, Ugwumba OA. 2011. Condition factor and diet of *Chrysichthys nigrodigitatus* and *Chrysichthys auratus* (Siluriformes-Bagridae) from Aiba Reservoir, Iwo, Nigeria. *Rev. Biol. Trop. (Int. J. Trop. Biol.)*, **59**(3): 1-12.
- Ayoade AA, Fagade SO, Adebisi AA. 2006. Dynamics of limnological features of two man-made lakes in relations to fish production. *Afr. J. Biotechnol.*, **5**(10): 1013-1021.
- Bhalerao SN. 2012. Study of fish diversity and water quality of Kasar Sai Dam, Hinjewadi Pune, MS India. *International Research Journal of Biological Sciences*, **1**(4): 51-55.
- Bhatnagar A, Devi P. 2013. Water quality guidelines for the management of pond fish culture. *International Journal of Environmental Sciences*, **3**(6): 1980-2009.
- Carmona R, A-Gallego MG, Sanz A, Domezain A, Ostos-Garrido MV. 2004. Chloride cells and pavement cells in gill epithelia of *Acipenser naccarii*: ultrastructural modifications in seawater-acclimated specimens. *J. Fish Biol.*, **64**: 553-566.
- Carol J, Benejam L, Alcaraj C, Vila-Gispert A, Zamora L, Navaro E, Armengol J,

- Garcia-Berthou E. 2006. The effects of limnological features on fish assemblages of 14 Spanish reservoirs. *Ecology of Freshwater Fish*, **15**: 66-77.
- Cheng L, Sovan L, Geraldine L, Sithan L, Zhongjie L. 2010. Variations of fish composition and diversity related to environmental variables in shallow lakes in the Yangtze River basin. *Aquatic Living Resources*, **23**: 417-426.
- Golterman RI, Clymo RS, Ohnstad MAM. 1978. *Methods for Physical and Chemical analysis of freshwater* (IBP Handbook No. 8). Blackwell Scientific Publication Oxford: UK; 214.
- Gupta SK, Gupta RC. 2006. *General and Applied Ichthyology (Fish and Fisheries)*. S. Chad and Company Ltd. Ram Nagar: New-Delhi; 1130.
- Keay RWJ. 1959. *An Outline of Nigerian Vegetation*. Federal Government Printer: Lagos; 46
- Kemdirim EC. 2005. Studies on the hydrochemistry of Kangimi Reservoir, Kaduna State, Nigeria. *Afr. J. Ecol.*, **43**: 7-13.
- Komolafe OO, Arawomo GAO. 2007. Reproductive strategy of *Oreochromis niloticus* (Pisces: Cichlidae) in Opa reservoir, Ile-Ife, Nigeria. *Revista de Biologia Tropical*, **55**(2): 595-602.
- Komolafe OO, Arawomo GAO. 2011. Observation on the composition, physiological and condition of fisheries in Erinle Lake, Osun State, Nigeria. *West Afri. J. Applied Ecology*, **18**: 71-78.
- Mustapha KK. 2008. Assessment of the water quality of Oyun reservoir, Offa, Nigeria, using selected physico-chemical parameters. *Turkish Journal of Fisheries and Aquatic Sciences*, **8**: 309-319.
- Muyodi FD, Mwanuzi FL, Kapiyo R. 2011. Environmental quality and fish communities in selected catchments of Lake Victoria. *The Open Environmental Engineering Journal*, **4**: 54-65.
- Obadia EA, Waltia SC. 2003. Preliminary observation's on fishing activities in the Tona reservoir Upper-East Region, Ghana. *Journal of Ghana Science Association*, **5**: 69-76.
- Oben BO. 2000. Limnological assessment of the impact of Agricultural and domestic effluent on three man-made lakes in Ibadan, Nigeria. Ph.D. Thesis, University of Ibadan, 334p.
- Paugy D, Lévêque C, Teugels GG. 2003. *The Fresh and Brackish Water Fishes of West Africa* (vol 1-2). IRD-MNHN-MRAC Editions. Publications Scientifique du Museum: Paris, Turvuren; 457 and 815.
- Pillay TVR. 2008. *Aquaculture and the Environment* (2<sup>nd</sup> edn) John Wiley & Sons: NY; 208.
- Reed W, Burchard J, Hopson AJ, Jenness J, Ibrahim Y. 1967. *Fish and Fisheries of Northern Nigeria*. Ministry of Agriculture, Northern Nigeria: Zaria; 226.
- Roberts CD. 1989. Reproductive mode in the percomorph fish genus *Polyprion* Oken. *J. Fish. Biol.*, **34**: 1-9.
- Rosenblatt RA. 2005. Ecological change and the future of the human species: Can Physicians Make a Difference? *Ann. Fam. Med.*, **3**(2): 173-176.
- Russell DJ, Helmke SA. 2002. Impacts of acid leachate on water quality and fisheries resources of a coastal creek in northern Australia. *Marine and Freshwater Research*, **53**(1): 19 - 33.
- SPSS16. 2008. Statistical Package for the Social Sciences Base 11 for windows. SPSS Inc., Chicago
- Tepe Y, Mutlu E. 2005. Physico-chemical characteristics of Hatay Harbiye Spring water. *Turkey. J. Inst.*

- Sci. Tech. Dumlupinar University*, **6**: 77-88.
- Tepe Y, Turkmen A, Mutlu E, Ates A. 2005. Some physicochemical characteristics of Yarselli Lake, Turkey. *Turkish Journal of Fisheries and Aquatic Sciences*, **5**: 35-42.
- UNEP. 2012. The UN-water Status Report on the application of integrated approaches to Water Resources management. DEP/1532/NA. UNEP, Division of Communications and Public Information, Nairobi: Kenya.
- Uzukwu PU. 2013. Water quality management in warm water fish ponds: a systems approach. *Continental J. Biological Sciences*, **6**(1): 16 – 25.
- Weatherley AH. 1972. *Growth and Ecology of fish populations*. Academic Press: New York; 293.
- Wetzel RG. 2001. *Limnology: Lake and River Ecosystems* (3rd edn). Academic Press: New York;1006
- WHO. 2001. *Guidelines for Drinking water quality. Addendum: Microbiological Agents in Drinking Waters*. World Health Organisation: Geneva.
- William JE. 2000. The coefficient of condition of fish. In *Manual of Fisheries Survey Methods II*, Schneider JC (ed). Michigan Dept. of Natural Resources, Fisheries Special Report; p.25.