



## Fish Diversity and Some Aspects of the Physico-Chemical Parameters of Gurara Water Fall, Niger State, Nigeria

Ibrahim, B.U.

Department of Biology, Ibrahim Badamasi Babangida University, Lapai, Nigeria

### ABSTRACT

Study on the fishery diversity and physico - chemical parameters of Gurara waterfall, Niger State was conducted between June and September, 2015. Six different species belonging to four families were recorded during the period of study. Family Clariidae was the most diverse with three species, including *Clarias anguillaris*, *Clarias gariepinus* and *Heterobranchus longifilis*. *Tilapia zillii* and *Heterobranchus longifilis* recorded the highest and lowest number of fishes caught respectively. There was difference in fish number across the stations during the period of study, which did not differ significantly ( $P < 0.05$ ). There was also difference in fish diversity at the stations and months. Diversity indices showed differences in fish diversity at different location in the waterfall. The diversity of the fish species in the waterfall is low. There were fluctuations in the physico – chemical parameters recorded during the study period. Dissolved oxygen, pH, total dissolved matter, BOD, Phosphate - phosphorus and Nitrate – nitrogen were significant at ( $P < 0.05$ ), while transparency and temperature did not show any significant difference ( $P < 0.05$ ). The range of this parameters fall within the acceptable values for fish survival. There should be routine monitoring of water quality and continuous assessment of the fish caught from the waterfall to ensure better safety of consumers.

Keywords: *Clarias anguillaris*, *Clarias gariepinus*, *Heterobranchus longifilis*, *Tilapia zillii*

### INTRODUCTION

Water is life. It is an important substance of life, which is made up of more than 60% of the human body. About 70% of the body weight is water and many body functions depend on it (FMENV, 2000). According to Mustapha (2009) water covers about 70% of the earth surface, but only one percent of that is fresh water, which is used for domestic, industrial and recreational purposes. The importance of water to living organisms depends on its unique physical and chemical properties. These properties have resulted in large diversity of species of organisms inhabiting the water body. Man has also utilised these properties, and the biotic components it support to his own advantages both for economic and social benefits, and also at the same time misused and abused the water to the detriment of himself, and the biotic communities present in the water bodies (Mustapha, 2009). Thus, the diverse use and increased demand for water and its resources, due to the expanding population has put a greater stress on the supply, quality, quantity and aquatic life it support.

Fresh water ecosystem provide habitat for large number of plant and animal species. Leveque (2005) reported that fish inhabiting fresh water made up 25% of living vertebrates (about 55,000 species described), and represent 13-15% of the 100,000 fresh water animal species currently identified. Among the work already available on the fishery diversity and physico – chemical parameters of fresh water body in Nigeria include the work of Ibrahim *et al.* (2009a) on the fishery diversity of Kontagora reservoir, Ibrahim *et al.* (2009b) on the physico - chemical parameters of Kontagora reservoir, Balogun (2005) on the fish species composition of Kangimi reservoir in Kaduna State, Nigeria, Kolo and Oladimeji (2004) on the water quality status of Shiroro reservoir and Balogun (1986) on the fish distribution on Kainji Lake, Nigeria. The objective of the present study is to investigate the fishery diversity and the physico – chemical parameters of Gurara water fall in

Received 19 October, 2016

Accepted 02 December, 2016

Address Correspondence to:

[ibrahimsayuti@yahoo.com](mailto:ibrahimsayuti@yahoo.com)

Niger State, Nigeria, so as to establish its conformity with international water quality standard, and also to ascertain fish species present in the water body.

## MATERIALS AND METHODS

### Study Area

Gurara water fall is located between latitudes 8°15' and 10°05'N and longitudes 6°30' and 8°30'E, located along Minna – Suleija Road at Kilometer 106 in Northern Nigeria, with a catchment area of 16650Km<sup>2</sup> at Izom and Jere. The climate is characterised by seasonal dry and wet seasons. Five sampling stations were located on the water body for this study (Figure 1), Station I (Izom), Station II (Tapa), Station III (Jere), Station IV (Gbako) and Station V (Kurmin Musa). The samplings cover a period of four months (June – September, 2015).

### Determination of fish diversity

The fish diversity of the Gurara water fall was conducted using catch assessment survey (CAS) method. This involved the actual counting and weighing of the fishes caught by the local fishermen at each landing site for the period of four months. Fish collected from the landing sites of the fishermen were sorted into various species and counted. The weights were also measured using a weighing balance. Fish samples collected for identification were preserved using 10% formaldehyde solution in a well labelled containers to reduce microbial contamination to the minimum (Ekpo, 2013). The identification was done with the aid of relevant reference materials (Reed *et al.* 2005). Confirmation of the species was done by fishery experts.

### Biodiversity parameters

To understand the diversity of fishes in the study area, the diversity, evenness and richness indices were calculated for understanding the status of diversity using the following formulas:

Shannon - Weaver diversity index,

$$H = - \sum P_i \ln P_i$$

Evenness index,  $e = H / \ln s$

Where,

$H$  is the diversity index,  $P_i$  is the relative abundance ( $s/N$ ),  $s$  is the number of individual

for each species,  $N$  is total number of individuals,  $D$  is the richness index,  $S$  is the total number of species,  $e$  is the similarity or evenness index and  $\ln$  is the natural logarithm.

### Determination of Physico – chemical parameters

Materials used include 250ml glass bottles, 250ml Conical flask, plastic bottles, cooler boxes, non ionic detergents, pH meters, EDTA (titrants), micro computer, conductivity meter, Seechi disc, micro processor turbidity meter, methyl orange, HCl, Manganous sulphate and Sodium thiosulphate. Distilled / deionised water was used throughout the experiment. All field meters and equipments were checked and calibrated according to manufacturers' specification. Water samples were obtained in glass bottle (250ml) for dissolved oxygen analysis. Samples were also collected in plastic bottles for the remaining physico – chemical parameter analysis. The samplings were carried out at the five sampling stations located on the water body, by dipping each sample bottle at approximately 20 – 30cm below the water surface. The samples collected were transported to the Department of Biological Sciences Laboratory, Ibrahim Badamasi Babangida University, Lapai, Niger State, Nigeria for analysis. The analysis was conducted in triplicates.

### Statistical Analysis

Descriptive statistics was employed to calculate the means, range, percentages and standard deviations. Statistical analysis of the results was done using one way analysis of variance (ANOVA) (Mahajan, 1997).

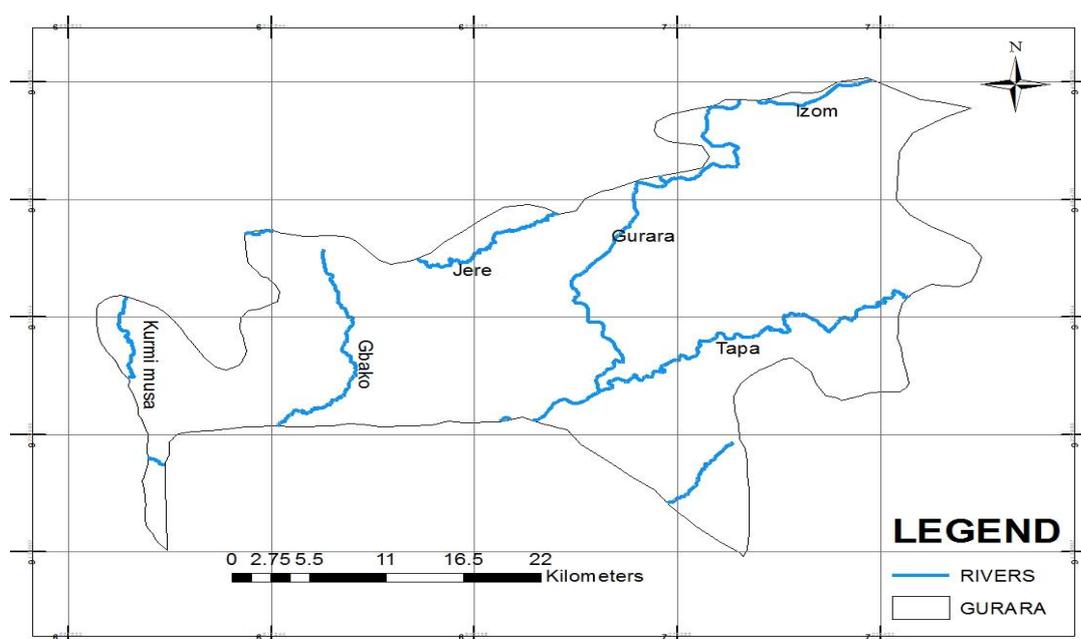


Figure1: Map of Gurara water fall showing sampling stations. (Source: Jimoh and Sule, 1992)

## RESULTS

Table 1: Relative fish composition (%) of Gurara Waterfall, Niger State, Nigeria

Family/species	Number (Total)	% No	Wt (g) (Total)	% Wt
Clariidae				
<i>Clarias gariepinus</i>	22199	35.27	115700	39.85
<i>Clarias anguillaris</i>	144	0.23	21300	7.34
<i>Heterobranchus longifilis</i>	15	0.02	3800	1.31
Claroteidae				
<i>Auchenoglanis occidentalis</i>	16297	25.89	52126	17.95
Cichlidae				
<i>Tilapia zillii</i>	24116	38.32	79700	27.45
Mormyridae				
<i>Hyperopisus bebe</i>	173	0.27	17700	6.10
Total	62944	100	290326	100

Relative fish species composition by percentage in term of number and weight in Gurara water fall was indicated in Table 1. Six different species belonging to four families were recorded in the water fall during the period of study. The families were Clariidae, Claroteidae, Cichlidae and Mormyridae. Clariidae had the most diverse species of 3 (*Clarias gariepinus*, *Clarias anguillaris* and *Heterobranchus longifilis*).

*Clarias gariepinus* was the most abundant in the family Clariidae and *Heterobranchus* species was the last. *Tilapia zillii* recorded the highest number (38.32%), followed by *Clarias gariepinus* (35.27%), while *Heterobranchus* species recorded the lowest number (0.02%). *Clarias gariepinus* recorded the highest weight (39.85%) followed by *Tilapia zillii* (27.45%), with *Heterobranchus* species.(1.31%).

Table 2: Fish composition (%) based on sampling stations of Gurara waterfall, Niger State, Nigeria

FAMILY/SPECIES	(STATION I IZOM)		(STATION II TAPA)		(STATION III JERE)	
	No.	(%) Wt. (%)	No.	(%) Wt. (%)	No.	% Wt. %
<b>CLARIIDAE</b>						
<i>Clarias gariepinus</i>	204	27.06 13600	306	42.5 35300	384	33.16 37600
<i>Clarias anguillaris</i>	24.2		47.96		37.98	
	39	5.17 3700 6.58	24	3.34 4600	31	2.68 3200
			6.25		3.23	
<i>Heterobranchus longifilis</i>	-	- - -	-	- - -	15	1.30 3800
					3.84	
<b>CLAROTEIDAE</b>						
<i>Auchenoglanis occidentalis</i>	142	18.83 15400	77	10.69 15600	108	9.33 17600
	27.4		47.96		17.78	
<b>CICHLIDAE</b>						
<i>Tilapia zillii</i>	311	41.25 17300	271	37.64 14400	547	47.23 29000
	30.80		19.57		29.29	
<b>MORMYRIDAE</b>						
<i>Hyperopisus bebe</i>	58	7.69 6200	42	5.83 3700	73	6.3 7800 7.88
	11.02		5.02			
<b>TOTAL</b>	<b>754</b>	<b>100 56200 100</b>	<b>720</b>	<b>100 73600</b>	<b>1158</b>	<b>100 99000</b>
			100		100	

Table 2 indicates the composition of fish based on sampling stations in Gurara water fall, Niger State during the period of study. Sampling station III (Jere) recorded the highest fish diversity of 6, while stations I (Izom) and II (Tapa) recorded 5 each. Station III recorded the highest number of fish caught follow by station I, then station II. While *Clarias gariepinus* recorded the highest number (42.5%) at station II, station I and station III recorded *Tilapia zillii* as the highest. *Heterobranchus longifilis* recorded the lowest number (1.30%) at station III, but absent in stations I and II. Station III also recorded the highest fish weigh, and the lowest recorded in station I. *Clarias gariepinus* recorded the highest weight in both stations II and III, and *Tilapia zillii* in station I. There was no significant difference ( $P < 0.05$ ) in fish numbers recorded in the sampling stations in Gurara water fall during the period of study.

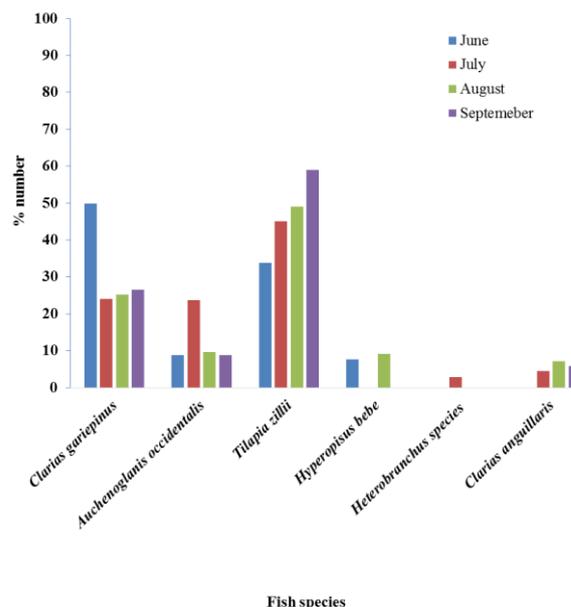


Figure 2: Monthly fish species composition in Gurara waterfall, Niger State, Nigeria

Figure 2 indicates monthly fish species caught from Gurara water fall, Niger State during the period of study. July and August were more diverse in fish species than June and September. *Heterobranchus longifilis* was only recorded in

July, while *Clarias anguillaris* was absent in June, *Hyperopisus bebe* was absent in July and September. *Tilapia zillii* was recorded highest in

July and September in the water fall. *Clarias gariepinus* was recorded highest in June and August, while *Hyperopisus bebe* was the lowest.

Table 3: Fish diversity indices of Gurara waterfall, Niger State, Nigeria

DIVERSITY INDICES	STATION I IZOM	STATION II TAPA	STATION III JERE
Number of specimen	754	720	1158
Fish taxa	5	5	6
Mergalef Index (M)	0.60	0.61	0.71
Shannon Wiener Index (H)	1.38	1.25	1.27
Evenness Index (E)	0.80	0.70	0.59

Table 3 indicates fish diversity indices in Gurara water fall during the period of study. Mergalef index (M) was highest in station III (Jere) and lowest in station I (Izom). In the case

of Shannon Wiener index (H), station I (Izom) and III (Jere) were highest and lowest in station II (Tapa). Evenness was highest in station II (Tapa) and lowest in station III (Jere).

Table 4: Physico-chemical parameters of Gurara waterfall, Niger State, Nigeria

Parameter	Range	Mean±SD
Transparency (cm)	13.00-50.00	27.13±10.25
Temperature (°C)	21.20-28.30	26.21±2.10
pH	6.70-7.54	7.13±0.20
Dissolved Oxygen (mg/l)	7.21-8.91	7.86±0.46
Total alkalinity (mg/l)	44.00-92.00	67.83±12.60
Total hardness (mg/l)	57.00-98.00	74.95±10.38
Electrical Conductivity (µhoms/S)	81.00-142.00	109.63±15.74
Total dissolved matter (mg/l)	40.00-71.00	54.75±7.91
BOD (mg/l)	8.12-9.51	8.73±0.50
Phosphate-phosphorus (mg/l)	0.33-0.79	0.50±0.10
Nitrate-nitrogen (mg/l)	0.22-0.69	0.44±0.11

Table 4 indicates the physico-chemical parameters of Gurara waterfall, Niger State. There were fluctuations in the physico-chemical parameters of the water fall during the period of study. Those with wider range include transparency (13.00cm and 50.00cm) of mean

27.13±10.25, total alkalinity (44.00mg/l and 92.00mg/l) of mean 67.83±12.60, total hardness (57.00mg/l-92.00mg/l) of mean 74.95±10.38, and total dissolved matter (40.00mg/l-71.00mg/l) of mean 54.75±7.91.

Table 5: Mean physico-chemical parameters of sampling stations of Gurara waterfall, Niger State, Nigeria

Parameter	Station I Izom	Station II Tapa	Station III Jere	Station IV Gbako	Station V Kurmin musa
Transparency	28.0±11.66	33.00±10.94	25.43±7.98	24.14±7.49	31.86±10.17
Temperature (°C)	26.23±2.22	26.11±2.36	26.16±2.39	26.16±2.39	26.16±2.39
pH	7.02±0.13	7.34±0.08	7.23±0.07	7.05±0.09	7.10±0.31
Dissolved Oxygen (mg/l)	9.1±0.08	8.15±0.05	7.34±0.08	8.35±0.26	7.37±0.07
Total alkalinity (mg/l)	68.25±9.48	56.57±5.00	76.14±9.04	81.90±8.78	66.14±7.13
Total hardness (mg/l)	72.88±8.13	67.57±7.48	80.57±6.00	88.57±6.40	72.43±6.00
Electrical Conductivity (µs/cm)	110±8.65	92.71±7.25	120.86±6.84	129.00±9.70	105.28±8.44
Total dissolved matter (mg/l)	55.13±4.45	46.43±3.82	60.57±3.60	64.43±4.96	52.14±3.13
BOD (mg/l)	8.29±0.07	8.52±0.07	9.31±0.11	9.41±0.10	8.29±0.12
Phosphate-phosphorus (mg/l)	0.47±0.06	0.47±0.07	0.56±0.10	0.62±0.10	0.44±0.07
Nitrate-nitrogen (mg/l)	0.35±0.09	0.45±0.08	0.50±0.08	0.56±0.09	0.44±0.08

Mean physico-chemical parameters of the sampling stations of Gurara water fall, Niger State during the period of study is indicated in Table 5. Station II (Tapa) recorded the highest mean transparency ( $33.00 \pm 10.94$ ), followed by station V (Kurmin Musa) ( $31.86 \pm 10.17$ ) while the lowest was station IV (Gbako) ( $24.14 \pm 7.49$ ). Station II (Tapa) recorded highest pH ( $7.34 \pm 0.08$ ) and the lowest was station I (Izom) ( $7.02 \pm 0.13$ ). Station I (Izom) recorded highest dissolved oxygen ( $9.1 \pm 0.08$  mg/l) and lowest in station III (Jere) ( $7.34 \pm 0.08$  mg/l). Total alkalinity (mg/l), total hardness (mg/l), electrical conductivity ( $\mu\text{s/cm}$ ) and total dissolved matter (mg/l) were all recorded highest in station IV (Gbako) and lowest in station II (Tapa). BOD (mg/l) and Nitrate-nitrogen (mg/l) were recorded highest and lowest in stations IV (Gbako) and station I (Izom) respectively. Phosphate-phosphorus was recorded highest in station IV (Gbako) ( $0.62 \pm 0.10$  mg/l) while station V (Kurmin Musa) recorded lowest ( $0.44 \pm 0.07$  mg/l). Transparency and temperature did not show any significant difference ( $p < 0.05$ ) during the period of study.

## DISCUSSION

Fish diversity gives an idea of the fish species composition and level of productivity of a water body, which are important tool in fisheries management. Six species of fish belonging to four families were recorded during the period of study. The family Clariidae was the most diverse among the families recorded with observed three species. This could be due to the ability of tolerating wide range of changes in the environment, better adaptation and availability of food. According to Welcomme (2000) several catfishes are widely spread and common in Afro - tropical waters. This agreed with the results of this study because members of the family Clariidae are catfishes, and also recorded the highest diversity. Omotosho (1996) reported 21 species from 10 families in Asa Reservoir, while Yem and Sanni (2005) recorded 41 species from 15 families from Kainji Lake, which are higher than the findings of the present study. Thus, among the factors which influence species diversity include size of the water body, migration, water current and favourable conditions such as availability of food, and better physico- chemical parameters. In the present study, although family Clariidae recorded the highest diversity, Cichlidae (i.e.

*Tilapia zillii*) was the most dominant in term of number in the water fall. The result from this study agrees with the result of Balogun (1986) on the dominance of Cichlidae on Kainji Lake. This could be due to feeding habits, prolific nature and adaptability to changes in environmental conditions. However, the low population of *Heterobranchus longifilis* reported in the present study may be as a result of inability of the species to tolerate the conditions of the water fall. Komolafe and Arowomo (2008) also reported *Tilapia zillii* as the most dominant fish species in Osinmo Reservoir. This is in line with the findings of this study. Fish diversity vary by months during the study period. The higher diversity recorded in July and August could be due to better physico – chemical parameters, availability of foods, rise in water level and fishing activities. While, the low and absence of *Heterobranchus longifilis*, *Hyperopisus bebe* and *Clarias anguillaris* in some months in the water fall clearly indicates variation in availability in the fish species diversity and abundance in the water fall during the period of study. Similar observation were reported on Kainji Lake and Erinle Lakes (Yem and Sanni, 2005; Komolafe and Arowomo, 2011). This could also be as a result of fluctuation in water level at that particular period, spawning, migration, abundance of food and favourable physico – chemical parameters. Diversity indices indicate species richness and evenness to understand fish species distributed across locations in any study. Mergalef Index which describe species richness in this study increased from 0.60 in station I to 0.70 in station III. This revealed that station I recorded the least richness and the poorest in species diversity. This may be as a result of the differences in the topology and the location of the water body among other factors. Shanon Wiener Index reveals intermediate fish diversity. Values close to zero indicates station with the highest diversity. Station II could be said to have the highest diversity while the lowest was station I. Evenness index measures diversity of low, high, even and uneven fish species that exist in a particular station. If the value is higher, even of fish diversity is high. Station I was the most even (0.80), while the least even (0.59) was station III. Physico - chemical parameter is important because it reflects the abundance, distribution, presence and absence of living organisms in the aquatic environment including fish. It also

gives an insight of the relationship between an organism and the environment, as well as represents the quality of water and its productivity. The water in Gurara waterfall showed wide variations of most of these parameters. This include transparency, total alkalinity, total hardness and total dissolve matter. This could be due to mixing of pollutants as a result of agricultural activities around the waterfall, in addition to domestic activities which include laundry activities and garbage dumping. The values of these parameters obtained in this study though fluctuated, was within the limits that supports aquatic life, particularly fish are reported (Boyd, 1979). pH, dissolved oxygen, BOD and Phosphate - phosphorus did not exhibit wide range of fluctuations. This might be as a result of high flow and continuous mixing of the water as a fall. Adakole *et al.* (2003) reported the study of Lake Kubanni and Aremu *et al.* (2011) on Mada River as similar to this study. Mean physico - chemical parameters at different sampling stations on the waterfall indicated variations during the study period. This might be due to human activities, which includes farming, laundry activities, and bathing, dumping of domestic wastes and seasonal effects, as this study was conducted during the rainy seasons. As station II recorded the highest transparency and pH value, station I recorded highest dissolved oxygen, which differ significantly ( $P < 0.05$ ) in other stations. Also there was coincidental high level of total alkalinity, total hardness, dissolved matter, Nitrate – nitrogen and Phosphate - phosphorus at station IV. This might be as a result of the flow and turbulence of the water at the location, in addition to the farming activities around the location.

In conclusion, Gurara waterfall recorded six species belonging to four families with Clariidae being the most diverse having only three species. Therefore, fish diversity of the waterfall is low compared to other water bodies in the country. Fluctuations occur in the physico – chemical parameters of waterfall during the study period, though they were within the fish tolerable level.

The following recommendations are hereby provided from the outcome of the study: - that similar study should be conducted to cover the dry seasons, as the present findings are limited to the rainy season during which the study was conducted. The water quality parameters need

to be monitored on routine basis, because higher variations of these parameters indicate the occurrence of pollution. Farming activities that might involve the use of herbicides and pesticides that can pollute the water should also be monitored and controlled. Assessment of the fish caught (farming) should be done on routine basis in order to ascertain any changes that might occur in the fish diversity of the waterfall.

## REFERENCES

- Adakole, J. A., Mbah, C. E. and Dalla, M. A. (2003). Physico-chemical limnology of Lake Kubanni, Zaria, Nigeria. *29<sup>th</sup> WEDC International Conference towards the millennium development goals, Abuja, Nigeria*, 165-168.
- Aremu, M. O., Gav, B. L., Opaluwa, O. D., Atolaiye, B. O., Madu, P. C., and Sangari, D.U. (2011). Assessment of physico - chemical contaminants in waters and fishes from selected rivers in Nasarawa State, Nigeria. *Research Journal of Chemical Science*, 1 (4): 6-17.
- Balogun, J. K. (1986). Fish distribution in Kainji Lake, Nigeria. *Journal of Fish Biology*, 29: 489-498.
- Balogun, J. K. (2005). Fish distribution in Zaria reservoirs: A typical small and shallow African domestic water supply reservoir. *Nigerian Journal of Scientific Research*, 5 (1): 21-27.
- Boyd, C. E. (1990). *Water Quality Management for Pond Fish Culture*. Agriculture Experimental Station, Auburn University, Alabama. 215.
- Ekpo, I. E. and Essien – Ibok, M. A. (2013). Development, Prospects and Challenges of Artisanal Fisheries in Akwa Ibom State, Nigeria. *International Journal of Environmental Science, Management and Engineering Research*, 2 (3), 69 – 86.
- Federal Ministry of Environment (FMENV) (2000). National Guidelines and Standards for Water Quality in Nigeria (First Edition).
- Ibrahim, B. U., Auta, J. and Balogun, J. K. (2009a). Fish Productivity on the Kontagora Reservoir, Niger State, Nigeria in relation to Physico - chemical characteristics and Morpho- Edaphic Index. *The Zoologist* 7: 12 – 20.
- Ibrahim, B. U., Auta, J. and Balogun, J. K. (2009b). An assessment of the physico –

- chemical parameters of Kontagora reservoir, Niger State, Nigeria. *Bayero Journal of Pure and Applied Sciences*, 2(1): 64 – 69.
- Kolo, R. J. and Oladimeji, A. A. (2004). Water quality and some nutrient levels in Shiroro Lake, Niger State, Nigeria. *Journals of Aquatic Sciences* 19(2): 99.
- Komolafe, O. O. and Arawomo, G. A. O (2011). Observations on the Composition, Physiological Condition and Fisheries in Erinle Lake, Osun State, Nigeria. *West African Journal of Applied Ecology*, 18:71-78.
- Leveque, C. B. (2005). An assessment of animal species diversity in continental waters. . *Hydrobiologia*, 20(3): 39-67.
- Mahajan, B.K. (1997). *Significance of differences in means. In: Methods in Biostatistics for Medical and Research Workers*, 6th edition. New Delhi: JAYPEE Brothers Medical Publishers. 130-155.
- Mustapha, M. (2009). Limnology and Fish Assemblages of Oyun Reservoir, Offa, Nigeria. A Thesis submitted to the University of Ilorin, Ilorin, Nigeria.
- Omotosho, J. S. (1996). Ichthyofauna diversity of Asa Reservoir, Ilorin, Nigeria. *African Journal of Applied Zoology and Environmental Biology*, 7: 3 – 77.
- Reed, W., Burchard, J., Hopson, A. J., Jennes, J. and Yaro, I. (2005). *Fishes of northern Nigeria*, Ministry of Agriculture Northern Nigeria. Gaskiya Corporation, Zaria, Nigeria. 156.
- Yem, I. Y. and Sanni, A. O. (2005). A study on the changing fishery of Lake Kainji in Nigeria. *Journal of Scientific and Industrial Studies*, 3(3): 51-54.