UJMR, Volume 2 Number 2 December, 2017 *ISSN: 2616 - 0668*
https://doi.org/10.47430/ujmr.1722.001
Received: 25th June, 2017 **Accepted:** 18th Jul, 2017

Studies on the Physico-Chemical Parameters and Zooplankton Composition of Ajiwa Reservoir Katsina State, Nigeria

***Ibrahim, A.[1] and Abdulkarim, B.[2]**
[1]Department of Biological Sciences, Ahmadu Bello University Zaria, Kaduna State.
[2]Department of Biology, Umaru Musa Yar' adua University, Katsina, Katsina State.
*Correspondence author: ahmadkt21@gmail.com

Abstract
Studies on the physico-chemical parameters and Zooplankton composition of Ajiwa reservoir, Katsina State, Nigeria was conducted from May 2012 to April 2013. Three sampling stations were selected; the physico-chemical and biological parameters were determined using standard methods and procedures. The result showed that; Water temperature (23.8 ± 0.8 °C), pH (6.8 ± 0.1), Turbidity (99.3 ± 3.6 NTU), Conductivity (129.9 ± 4.1μS/cm), Total Dissolved Solids (17.8 ± 0.3 mg/L), Nitrate-nitrogen (6.01 ± 0.3 mg/L), Water hardness (88.8 ±1.4 mg/L$CaCO_3$), Dissolved Oxygen (6.6 ± 0.3 mg/L), Biochemical Oxygen Demand (3.2 ± 0.4 mg/L), Phosphate-phosphorus (6.4 ± 0.2 mg/L) and Water depth (5.4±0.3 m) varied with months and seasons. Analysis of variance indicated significant difference between seasons ($P<0.05$); but there was no significant difference in zooplankton distribution and abundance between the three stations ($P>0.05$). The result indicated Zooplankton percentage composition as follows: Rotifera (30.55%), Copepoda (29.33%), Protozoa (22.27%), and Cladocera (17.85%). Water quality of the reservoir was influenced by anthropogenic activities such as runoffs of inorganic fertilizers and pesticides; however the reservoir water is suitable for irrigational and domestic purposes in terms of most of the physico-chemical and biological parameters analyzed. However, there is need for an effective anthropogenic inputs control strategy for the reservoir.
Keywords: Composition, Physico-chemical parameters and Zooplankton

INTRODUCTION
Reservoirs constitute important ecosystem and food resources for a diverse array of aquatic life. Reservoir ecosystems are fragile and can undergo rapid environmental changes, often leading to significant declines in their aesthetic, recreational and aquatic ecosystem functions. Human activities can further accelerate the rate of changes; if the causes of the changes are known, human intervention (management practices) sometimes can control or even reverse detrimental changes (Mustapha, 2011).

Maintenance of healthy aquatic environment and production of sufficient food in reservoir are primarily linked with successful reservoir culture operations. To keep the aquatic habitat favourable for existence of living organisms, physical and chemical factors like temperature, turbidity, pH, odour, dissolved gases (Oxygen and CO_2), salts and nutrients must be monitored regularly, individually or synergistically. Activity of living organisms is influenced by the seasonal and diurnal changes of these parameters (Akinyeye *et al.,* 2011). Various studies had been conducted on changes brought about by biotic and abiotic factors of river as a result of damming. However, a response of rivers and it ecosystems to damming are complex and varied because they depend on local sediment supplies, geomorphic constraint, climate, dam structure and operation (Offem and Ikpi, 2011).

Nigeria is blessed with about 853,600 hectares of freshwater capable of producing over 1.5 million metric tonnes of fish annually (FAO, 2009). Therefore there is need to exploit means of benefiting from these precious resources It is no doubt; that reservoirs have contributed and will continue contribute to the economic growth of many nations especially Nigeria.

MATERIALS AND METHODS
Study Area
Ajiwa reservoir was Located on Latitude 12°98'N, Longitude7°75'E in Batagarawa Local Government, Katsina State, Nigeria. It was built in 1975, has height of 14.7m with crest length of about 1491.8m and surface area of 607.0 ha. The main purpose of the reservoir is irrigation and water supply (Figure.1).

Sampling Stations
Sampling stations were selected as follows: Station I at Kanyar Bala (downstream), Station II at Loko (midstream) and Station III at Gada (upstream) based on stratified method of sampling. The distance between the stations was 200m apart.

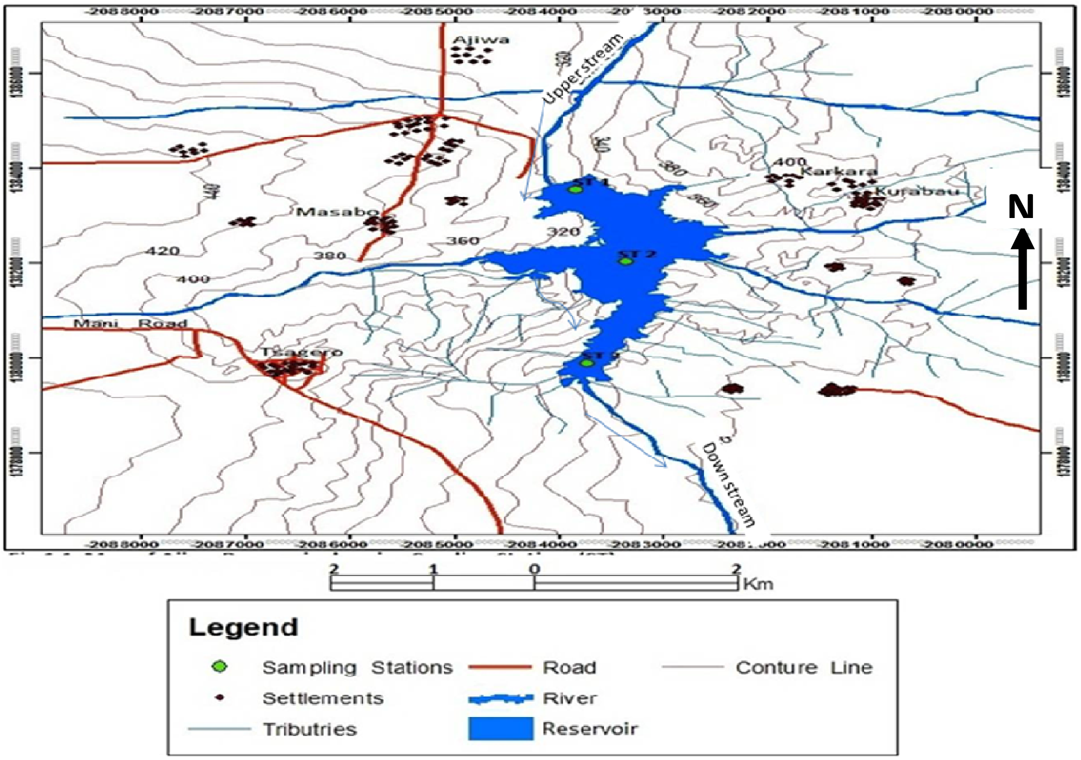

Figure 1: Map of Ajiwa Reservoir Showing sampling stations. (Source: Cartography unit, Dept. of Geography, UMYU).

Sampling was conducted monthly for the water and Zooplankton from May 2012 to April 2013. The water was sampled at the surface level by dipping one litre plastic sampling bottle sliding over the upper surface of water with its mouth against the water current.

Physico-chemical parameters determinations

The turbidity was measured with turbidity tube and recorded in Nephelometric Turbidity Unit (NTU) from the graduated readings of the turbidity tube (Nathanson, 2003). Hanna 420 pH meter was used for pH. The electrode of the pH meter was dipped into the water sample for 2-3minutes and readings ware recoded (APHA, 1999). Temperature (˚C) of the water was measured by glass mercury thermometer (APHA, 1999). Hanna Dissolved Oxygen microprocessor HI 98186 was used to determine the dissolved oxygen; the readings were recorded in mgL^{-1}. For Biochemical Oxygen Demand; 100ml part of the sample was incubated for five days in cupboard at room temperature and Dissolved oxygen was tested. The difference between the initial value of Dissolved oxygen and the value after incubation was used as value of BOD in the water sample (APHA, 1999; Mahar, 2003). Water Hardness was determined by Erichrome black-T titration. Electrical Conductivity and Total Dissolved Solids (TDS) were measure with WTW 320 conductivity meter; Water samples were placed into clean beakers and conductance cell of the meter was immersed into the sample solution. The resistance was measured in µS/cm. Phosphate-phosphorus was determined using the Deniges method APHA, (1999). Nitrate-Nitrogen 100ml of water sample was poured into a crucible, evaporated to dryness, and cooled. 2ml of phenoldisulphonic acid was added and smeared around the crucible, after 10minutes, 10ml of distilled water was added followed by 5ml strong ammonia solution. Setting the spectrophotometer at the wavelength 430nm, absorbance of the sample treated was determined using distilled water as blank. The concentration of Nitrate-nitrogen was obtained from the Calibration curve in mgL^{-1} (APHA, 1999).

Zooplankton analysis

Zooplankton sample was collected with silk plankton net of 25cm diameter of 70meshes/cm and a collection bottle of 50ml capacity was attached at the base. The net was sunk just below surface of the water and then towed through a distance of 5m.

The content was collected into a vial and was then poured into plastic bottle of 70ml capacity and preserved in 4% formalin. Counting was done by shaking the preserved sample and pipetting 1ml into a Sedgwick Rafter Counting Cell and then mounted on a microscope. Identification was done according to Needham and Needham, (1975) and APHA (1999).

Statistical Analysis: Descriptive statistics and Percentage were used for Physico-Chemical Parameters and Zooplankton abundance. Results obtained was subjected to ANOVA to test the level significance at P<0.05. Least Significant Difference (LSD) was used to separate means. Pearson's correlation coefficient was used to test the relationship between physico-chemical parameters and Zooplankton abundance. Shannon and Simpson's diversity index were used to determine diversity.

RESULTS

Physico-Chemical Parameters

The analysis of variance (ANOVA) revealed significant difference between month and seasons (Table 1). The water temperature variation indicated mean ± SE value of (23.08 ± 0.8^{O}C); the pH values ranged between 6.5 -7.8 with mean ± SE value of 6.8 ± 0.1; Turbidity of the reservoir fluctuated with mean ± SE value of 99.3 ± 3.6NTU. The Dissolved Oxygen values in the reservoir ranged from 3.8mgL^{-1} to 7.9mgL^{-1}; with the mean ± SE of 6.6 ± 0.3mgL^{-1}. The BOD in Ajiwa reservoir revealed monthly variation with mean ± SE value of 3.2 ± 0.4mgL^{-1}. The electrical conductivity ranged from 102.4μS/cm to105.1μS/cm with mean ± SE of 129.9 ± 4.1μS/cm. The hardness in the reservoir showed a mean ± SE of 88.8 ±1.4mgL^{-1}($CaCO_3$); Nitrate-nitrogen indicated a mean ± SE values of 6.1 ± 0.3mgL^{-1}during the period of study. Total dissolved solids in the reservoir has a peaked value of 23.8mgL^{-1} which was recorded in the month of December while the least value of 10.1mgL^{-1} was recorded in the month of July with a mean ± SE was 17.8 ± 1.5mgL^{-1} and the mean ± SE value of Phosphate-phosphorus was 2.9 ± 0.2mgL^{-1}. The mean ± SE value of depth was 5.4±0.3m. Temperature, DO, BOD, electrical conductivity and nitrate showed a positive correlation while water hardness, total dissolve solids and turbidity indicates negative correlation (Table 3).

Table 1: Variations among Physico-chemical parameters in Ajiwa Reservoir, Katsina State, Nigeria.

Parameters	Months F-Values	Stations F-Values	Seasons F-Values
Temperature (°C)	52.094*	0.921^{ns}	3.007*
pH	20.010*	0.512^{ns}	12.019*
Turbidity (NTU)	53.128*	1.592^{ns}	12.019*
Dissolved Oxygen (mg/L)	408.941*	1.579^{ns}	11.196*
Biochemical Oxygen Demand (mg/L)	198.762*	2.881^{ns}	22.959*
Electrical Conductivity (μS/cm)	99.710*	0.771^{ns}	9.796*
Water Hardness (mg$CaCO_3$ L^{-1})	22.803*	5.049^{ns}	0.752*
Nitrate-Nitrogen (mg/L)	49.199*	0.239^{ns}	15.170*
Total Dissolved Solids (mg/L)	198.382*	1.087^{ns}	20.434*
Phosphate-phosphorus (mg/L)	42.659*	1.485^{ns}	4.095*
Water Depth (m)	52.659*	1.485^{ns}	44.095*

*= Significant
^{ns}= Non Significant

Table 2: Mean Monthly Physico-chemical Parameters in Ajiwa Reservoir, Katsina State, Nigeria.

Season	Months	Temp. (°C)	PH	Turbidity (NTU)	DO (mgL^{-1})	BOD (mgL^{-1})	EC (µS/cm)	TDS (mgL^{-1})	Depth (m)	PO_4- P (mgL^{-1})	NO_3-N (mgL^{-1})	Hardness (mg($CaCO_3L^{-1}$))
Wet Season	May	26.0^{ab}	6.9^{ab}	89.3^{bc}	7.2^{a}	3.6^{ab}	102.4^{c}	14.8^{bc}	5.3^{ab}	1.7^{bc}	6.3^{ab}	83.1^{ab}
	Jun.	25.3^{ab}	6.9^{ab}	89.3^{bc}	7.3^{a}	3.6^{ab}	112.4^{c}	14.0^{bc}	5.4^{ab}	2.5^{ab}	6.4^{ab}	84.1^{ab}
	Jul.	27.7^{a}	6.7^{ab}	89.3^{bc}	7.3^{a}	3.6^{ab}	120.7^{bc}	10.1^{cd}	5.4^{ab}	2.7^{ab}	6.4^{ab}	84.1^{ab}
	Aug.	26.0^{ab}	6.5^{ab}	88.0^{bc}	7.1^{a}	3.6^{ab}	122.0^{bc}	10.2^{cd}	6.4^{a}	3.1^{a}	7.1^{a}	87.9^{a}
	Sept.	24.0^{ab}	6.9^{ab}	88.6^{bc}	7.5^{a}	3.6^{ab}	122.7^{bc}	13.4^{bc}	7.5^{a}	3.6^{a}	7.2^{a}	88.6^{a}
	Oct.	22.6^{b}	6.8^{ab}	95.7^{bc}	7.8^{a}	3.8^{a}	129.7^{b}	17.0^{bc}	6.1^{a}	3.8^{a}	6.5^{a}	84.3^{a}
Dry Season	Nov.	23.7^{ab}	6.8^{ab}	98.3^{bc}	7.7^{a}	3.9^{a}	133.3^{ab}	19.3^{ab}	5.7^{ab}	2.4^{bc}	6.6^{a}	87.3^{a}
	Dec.	18.3^{bc}	6.9^{ab}	101.3^{ab}	6.9^{ab}	4.0^{a}	136.6^{ab}	23.8^{a}	5.3^{ab}	2.7^{bc}	5.3^{bc}	90.7^{a}
	Jan.	20.6^{b}	7.0^{a}	128.3^{a}	5.7^{ab}	2.3^{bc}	140.3^{ab}	23.5^{a}	5.3^{ab}	2.4^{bc}	4.2^{c}	90.9^{a}
	Feb.	22.3^{b}	7.2^{a}	115.0^{ab}	5.2^{ab}	2.1^{bc}	144.1^{ab}	23.2^{a}	4.1^{c}	3.2^{ab}	5.4^{bc}	94.1^{a}
	Mar.	23.6^{b}	7.4^{a}	108.7^{ab}	5.0^{ab}	2.1^{bc}	144.6^{ab}	23.7^{a}	4.0^{c}	3.4^{ab}	5.9^{ab}	99.4^{a}
	Apr.	25.7^{ab}	7.8^{a}	100.0^{ab}	4.9^{bc}	2.0^{bc}	150.1^{a}	20.1^{ab}	4.0^{c}	3.2^{ab}	6.0^{ab}	91.5^{a}
	Mean ± SE	23.8±0.8	6.8±0.1	99.3±3.6	6.6±0.3	3.2±0.4	129.9±4.1	17.8±1.5	5.4 ±0.3	2.9±0.2	6.1±0.3	88.8±01.4
	SD	2.7	0.3	12.9	1.7	0.9	14.3	5.5	1.0	0.9	0.9	1.9
	Min	18.3	6.5	88.6	4.9	2	102.4	10.1	4.0	1.7	4.2	83.1.1
	Max	27.7	7.8	128.3	7.8	3.8	150.1	23.8	7.5	3.8	7.2	99.4
	Standard	23-35	6.5-9	100-125	≥5	>3	3.5	150		10	10	20-200

Key: Temperature (Temp.), Nephelometric Turbidity Unit (NTU), Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Electrical conductivity (EC), Phosphate-Phosphorus (PO_4-P), Nitrogen-Nitrite (NO_3-N).
Columns with same superscript are not significantly different

Table 3: Correlation between Physico-chemical Parameters in Ajiwa Reservoir, Katsina State, Nigeria

	Temp	pH	Turbidity	DO	BOD	EC	Hardness	NO_3-N	TDS	PO_4-P	Depth
Temperature	1										
pH	-0.28^{ns}	1									
Turbidity	-0.58*	0.86*	1								
Dissolved Oxygen	0.50*	-0.89*	-0.70*	1							
Biochemical Oxygen Demand	0.63*	-0.89*	-0.67*	0.97*	1						
Electrical Conductivity	0.75*	-0.71*	-0.88*	0.62*	0.52*	1					
Water Hardness	-0.82*	0.29^{ns}	0.59*	-0.01^{ns}	0.07^{ns}	-0.59*	1				
Nitrate-nitrogen	0.64*	-0.67*	-0.92*	0.61*	0.53*	0.89*	-0.30*	1			
Total Dissolved Solids	-0.75*	0.73*	0.81*	-0.64*	-0.52*	-0.96*	0.69*	-0.77*	1		
Phosphate-phosphorus	0.41^{ns}	-0.56*	-0.63*	0.40^{ns}	0.29^{ns}	0.67*	-0.30^{ns}	0.69*	-0.65*	1	
Depth	0.58*	-0.37	0.83*	-0.65*	-051*	0.43 ^{ns}	0.45 ^{ns}	0.53*	0.57*	0.43 ^{ns}	1

ZOOPLANKTON

The total number of Zooplanktons identified in the three stations during the period of the study was 1473; they belong to four groups; Copepoda, Cladocera, Protozoa, and Rotifers. The percentage composition of Zooplankton (Table 4) indicated that Rotifers have the highest percentage with 30.55%, abundance composition. The highest number was recorded in the month of September while the lowest was recorded in the month of March and April. The Copepods have the second highest population, accounting for 29.33%. The highest number was recorded in the month of August while the lowest count was recorded in the month of April. The protozoa identified accounted for 22.27%. The highest number was recorded in the month of October and November while the lowest was in January. Cladocera accounted for the 17.85%. Zooplanktons indicated positive correlation with dissolved oxygen, biochemical oxygen demand, Phosphate-phosphorus and Nitrate-nitrogen while negative correlation with turbidity, TDS, hardness pH and water depth (Table 5). Simpson's and Shannon diversity index indicated that Zooplanktons are more abundant and diverse in the wet season than in the dry season (Table 6).

Table 4: Monthly Zooplankton Abundance (%) in Ajiwa Reservoir, Katsina State, Nigeria.

Months	Protozoa (Organisms/L)	Copepods (Organisms /L)	Cladocera (Organisms/L)	Rotifera (Organisms /L)
May	24	12	24	24
Jun.	28	18	28	40
Jul.	37	42	32	54
Aug.	41	81	36	76
Sept.	22	72	52	90
Oct.	54	60	36	49
Nov.	54	44	28	40
Dec.	40	46	18	38
Jan.	28	24	9	24
Feb.	0	16	0	9
Mar.	0	10	0	3
Apr.	0	7	0	3
Totals (%)	328 (22.27)	432 (29.33)	263 (17.85)	450 (30.55)

Table 5: Correlation between Abundance of Zooplankton and Physico-chemical parameters in Ajiwa Reservoir, Katsina State, Nigeria.

Taxon	Diversity Index	Wet	Dry
Copepods	Taxa_S	5	5
	Individuals	334	98
	Shannon_H	0.21	0.34
	Dominance_D	0.58	0.06
	Simpson's _1-D	0.42	0.94
Cladocera	Taxa_S	6	5
	Individuals	236	27
	Shannon_H	0.12	0.26
	Dominance_D	0.76	0.01
	Simpson's _1-D	0.24	0.98
Rotifers	Taxa_S	10	9
	Individuals	373	77
	Shannon_H	0.18	0.32
	Dominance _D	0.64	0.04
	Simpson's _1-D	0.36	0.96
Protozoa	Taxa_S	2	2
	Individuals	259	69
	Shannon_H	0.22	0.35
	Dominance_D	0.56	0.06
	Simpson's _1-D	0.44	0.94

Table 6: Zooplankton Diversity Index in Ajiwa Reservoir, Katsina State, Nigeria.

DISCUSSION

The water temperature of the reservoir fluctuated with months, which was between 18°C and 28°C in all the three sampling station. The low water temperature recorded in the reservoir was in the dry season, which could be because of seasonal changes in air temperatures associated with the cool dry North-east winds. This observation is supported by the findings of Indabawa (2009) which reports that variations in water temperature in the dry season can be attributed to intensified heat radiation and the effect of harmattan. The water pH in the reservoir was within 6.6 to 7.8, which made the water of the reservoir to be circum-neutral during the study. This was similar with the results of Ibrahim *et al.,* (2009) which reported that hydrogen ion concentration (pH) was nearly neutral throughout both season, and it was within the range for inland water pH 6.5 - 8.5 in Kontagora reservoir, Niger state, Nigeria; which makes it suitable for optimal biological activity. The Turbidity of the reservoir was high during the dry season; the higher values of turbidity in the dry season may be due to settling effect of surface run-offs and suspended materials that followed the cessation of rainfall. This is similar to Ayoade *et al.* (2006) that the onset of rain decreased the Secchi-disc visibility in two mine lakes around Jos. Turbidity of water is affected by the amount of the suspended solids in it, and it reduces the light penetrating depth, and hence, reduces the growth of the plants. Thus High turbidity restricts the light penetration and indirectly checks the phytoplankton growth (Mustapha, 2008).

Dissolved oxygen in the reservoir indicates two peaks, high in the dry season and low in the rainy season. The higher abundance of Zooplanktons during the rainy season may be the reason of high values of dissolve oxygen. This agrees with the report of Araoye (2008), which reported that the high oxygen concentration (8.2 mg/L) during the dry season was due to enhanced photosynthetic activities. Dissolved oxygen supply in water mainly comes from atmospheric diffusion and photosynthetic activity of plants (Akomeah, *et al.*, 2010). The reservoir revealed higher values of biochemical oxygen demand during the dry season, which may be due to reduction of phytoplankton and decomposition of other living organisms in the reservoir. Mahar (2003) made similar observation and suggested that it was due the depletion of oxygen in the water during decomposition in dry season. The highest Electrical Conductivity value was recorded in the dry season while the lowest was recorded in the wet season. The high dry season values may be due to the reduction in the water level and increases in nutrients due to run off of inorganic fertilizer from nearby farm lands. Atobatele and Ugwumba (2008) suggested that decrease in conductivity values during the rainy season might be due to dilution by rainwater. The higher values may due to chemical fertilizers from irrigated farmlands around the reservoir coupled with higher rate of evaporation that reduces the level of the water during the dry season. Water hardness was higher during the dry season than the rainy season; this could be because of low water levels and the high concentration of nutrients. Ibrahim *et al.* (2009) reported the water hardness is higher in the dry season and lower in the rainy season and suggested it 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.

Nitrate-nitrogen was found to exhibit variation range of 3.8mgL^{-1} to 7.3mgL^{-1}.The mean value recorded in rainy season was higher than that in dry season. The reason for this high concentration in rainy season may be due to excessive influx of nutrients from farmland fertilizers used to boost crop production particularly around the reservoir. The results agreed with that of Balogun *et al.* (2005) which observed mean monthly variation and significant difference between seasons of Nitrate-Nitrogen in Makwaye (Ahmadu Bello University Farm). The reservoir higher value of TDS during the dry season; could be due to decaying of vegetation and higher rate of evaporation caused by increase in air temperature and wind during the dry season. Similar observation was made by Atobatele and Ugwumba (2008) that increase in the values of total dissolved solids during the dry season which may be due to decaying of most of the vegetation, so there was a rise in amount of dissolved solids.

The higher values of Phosphate-phosphorus in the reservoir during the dry season may be due to reduced water volume, in addition to intensive agricultural activities around the reservoir involving the use of fertilizers and pesticides to produce dry season crops like vegetables and maize. Ibrahim *et al.* (2009) reported that the high dry season mean value of Phosphate-phosphorus (PO_4-P) could be due to concentration effects as a result of reduced water volume in the Kwantagora reservoir. The water depth of the reservoir fluctuates with season, especially during the dry season, which was cause by high evapo-transpiration during the dry season.

Zooplanktons composition in Ajiwa reservoir was dominated by rotifers, and then copepods, which were followed by Cladocerans and protozoans. The zooplankton composition and abundance varies with month and season, which may be due to fluctuation of physico-chemical parameters. Mahar (2003) reported that factors such as light intensity; food availability, dissolved oxygen, and predation affects the zooplankton population. The Rotifers had the highest species abundance in the reservoir that indicates the water was productive and of good quality. Mahar (2003) reported that rotifers appear to be sensitive indicators of changes in water quality. The Copepods exhibited monthly variation in abundance and positive correlation with nitrate-nitrogen, dissolved oxygen, biochemical oxygen demand and phosphate-phosphorus in Ajiwa reservoir. The protozoans also indicated variation in population abundance and composition within months but no there was significant difference between stations. In conclusion, all the physico- chemical parameters and the populations of rotifers, copepods, cladocerans, and protozoans revealed monthly and seasonal variations.

CONCLUSION

It could be concluded that the dominant zooplankton compositions of Ajiwa reservoir, Rimi Local Government in Katsina State were rotifers, copepods, cladocerans and microscopic protozoans. Significant seasonal and monthly variations in physico- chemical parameters in the dam were observed which affects the distribution of the zooplanktons compositions of the reservoir.

RECOMMENDATIONS

The following recommendations are made based on the research findings:

1. Irrigation activities should be encouraged among the communities near the reservoir so as to benefit from the water of the reservoir that is rich in nutrients.
2. Anthropogenic activities that will directly or indirectly lead to the pollution of the reservoir should be strictly supervised by the Government and other stake holders.

REFERENCE

Akomeah, P.A., Ekhator, O. and Udoka, C. (2010). Dry Season Phytoplankton Composition Of Ibiekuma Dam, Ekpoma, Edo State. *Ethiopian Journal of Environmental Studies and Management* **3**(3):36-40

Araoye, P.A. (2008). Physical factors and their Influence on Fish Species Composition in Asa Lake, Ilorin, Nigeria. *International Journal of Tropical Biology* **57** (1-2): 167-175.

Ayoade A. A, Fagade, S.O. and Adebisi A. A. (2006). Dynamics of Limnological Features of Two Man-Made Lakes in Relation to Fish Production. *African Journal of Biotechnology* **5**(10): 1013-1021.
Retrieved from http;//www.academicjournals.org/AJB.on 23/12/2011.

Akinyeye, A.J., Komolafe, J.I. and OkorieT.G.(2011). Limnological Assessment of Effluents on Invertebrates from Alaro River in Oluyole industrial area of Ibadan, Oyo State, Nigeria. *Agriculture and Biology Journal of North America*. 2(7): 1053-1058. Retrieved from http://www.scihub.org/ABJNA

APHA (1999). *Standard Methods for Examination of Water and Waste Water*. American Public Health Association, New York, U. S.A.pg 108-112.

Atobatele, O.E. and Ugwumba, O.A (2008). Seasonal Variation in the Physico-chemistry of a Small Tropical Reservoir (Aiba Reservoir, Iwo, Osun, Nigeria). *African Journal of Biotechnology* **7** (12):62-171.
Retrieved from http://www.academicjournals.org/AJB on 23/12/2011

Balogun, J.K., Balarabe, M.L. and. Igberaese, P.M (2005) Some Aspects of the Limnology of Makwaye (Ahmadu Bello University Farm) Lake, Samaru, Zaria. *Academic Journal* **23**(12):850-860

F.A.O (2009). The State of World Fisheries and Aquaculture. Retrieved from FAO Website.
www.fao.orglsoflsofialindex_en.htm on 27 /12/2011.

Ibrahim, B.U., Auta, J. and Balogun, J.K. (2009). An Assessment of the Physico-chemical Parameters of Kontagora Reservoir, Niger state, Nigeria. *Bayero Journal of Pure and Applied Sciences,* **2**(1): 64 - 69

Indabawa, I. I. (2009). Studies on Limnological Parameters and Phytoplankton Dynamics of Nguru Lake, Yobe State, Nigeria. *Bioscience Research Communications,* **21**(4), 183-188.

Mahar, M.A. (2003). Ecology and Taxonomy of Plankton of Manchhar lake (Distt. Dadu), Sindh, Pakistan.Unpublished PhD. Thesis University of Sindh,Pakistan.
Retrieved from: http://usindh.edu.pk.mukhatiar.ahmad/Dessertation_mukhatiar. pg. 75-81.

Mustapha, M.K. (2008). Assessment of the Water Quality of Oyun Reservoir, Offa, Nigeria, using Selected Physico-chemical Parameters. *Turkish Journal of Fisheries and Aquatic Sciences,* **8**(4):309-319.

Mustapha, M.K. (2011). Perspectives in the Limnology of Shallow Tropical African Reservoirs in Relation to Their Fish and Fisheries. *Journal of Transdisciplinary Environmental Studies* **10**(1):16-23

Nathanson, J. A. (2003). *Basic Environmental Technology: Water Supply, Waste Management, and Pollution Control*. Upper Saddle River, New Jersey: Prentice Hall.pp55.

Needham, J.G. and Needham, P.R. (1975). *A Guide to the Study of Freshwater Biology* 4th edition, Holden - Day Inc., San Francisco.pg 75-82.

Offem, B. O. and Ikpi, G. U. (2011). Water Quality and Environmental Impact Assessment of a Tropical Waterfall System, *Environment and Natural Resources Research* **11**(1):23-25. Retrieved from www.ccsenet.org/enrr on 02/01/2012