African Scientist Vol. 23, No. 1 March 31, 2022
Printed in Nigeria

1595-6881/2021 $10.00 + 0.00

http://www.niseb.org/afs

AFS2022002/23102

Assessment of Water Quality Parameters of Zobe and Ajiwa Reservoirs, Katsina State, Nigeria

Sadauki, M.A., Bichi, A.H., Dauda, A.B.*, Geidam, M.B.

Department of Fisheries and Aquaculture, Federal University Dutsin-Ma, Nigeria

*Corresponding author; Email: tdabak@gmail.com Tel: +234 (0) 806 208 5120

(Received January 4, 2022; Accepted in revised form January 30, 2022)

ABSTRACT: A seven month study was carried out between August 2020 and February 2021, to assess the physicochemical parameters of Ajiwa and Zobe reservoirs in Katsina State, Nigeria, with a view to understanding the pollution status of the water bodies. Selected water quality parameters were assessed using standard methods, these include temperature, pH, dissolved oxygen (DO), hardness, turbidity, alkalinity and ammonia-nitrogen. The parameters were compared between the two water bodies using independent sample t-test, while Pearson correlation analysis was used to examine the interdependence among the water quality parameters. Temperature and transparency were higher in Zobe reservoir 24.14±0.77 °C and 8.36±0.12 cm respectively than in Ajiwa reservoir 23.13±0.74 °C and 7.37±0.11 respectively. DO, pH, Alkalinity, ammonia-nitrogen and hardness were all higher in Ajiwa reservoir, although none of the parameters was different significantly between the two water bodies ($P>0.05$). However, they were all within the recommended level for optimum performance of tropical fish species, except ammonia-nitrogen that was consistently higher than 1 mg/L. There were variations in the water quality parameters across the months. Temperature and ammonia-nitrogen were higher during the rainy season between August and October, then decline afterwards through the harmattan cold season. Transparency, DO, pH and hardness had their least during the rainy season, then rose gradually to peak in February. Some of the water quality parameters showed interdependence among each other with either negative or positive significant correlations. It is safe to say the water bodies are not polluted, however, the ammonia-nitrogen level deserves attention to prevent sub-optimal living of the fishes and other aquatic organisms in the water bodies.

Keywords: Ajiwa; Physicochemical parameters; Reservoir; Zobe; Katsina State

Introduction

Water is among the most important gifts of nature to mankind and it plays highly essential roles in survival and meeting daily needs of man. According to Jenyo-Oni *et al.* (2010), it is a vast natural resources of social and economic benefits. It has been over the years used for domestic water supply, industrial water needs, hydro-electric power supply, fishing activities, irrigation of farmlands among others (Keshere *et al.,* 2017). Nigeria is blessed with abundant water resources ranging from stream, rivers and reservoirs. Concerted efforts have also been made in the country to dam streams and rivers to have man-made lakes/reservoirs in order to meet up with human's demands of water and its resources. Katsina State is one of the states with highest man-made reservoirs in the country with about 40 reservoirs (Dauda *et al*., 2015). Zobe and Ajiwa reservoirs in Dutsin-Ma and Batagarawa Local Government Areas respectively are among the most important in the State. They have similar purposes of domestic water supply, fishing activities and irrigation of farmlands, and they are both surrounded by large areas of farmlands which is a great potential source of pollutants. Fish is a cheap source of animal protein and it is largely sourced both from wild capture fisheries and culture (aquaculture). While Nigeria fish production is still sourced largely from capture fisheries, with over 65% from artisanal fisheries (NBS, 2017; Dauda *et al*., 2021) both capture fisheries and aquaculture are affected by the status of water bodies including reservoirs. For instance, Zobe reservoir is a major source of capture fish in Katsina State and the water from the reservoir is still highly relied on for aquaculture activities at the fish farm of the Department of Fisheries and Aquaculture, Federal University Dutsin-Ma, sited just at the bank of the water reservoir. It is therefore important to ensure the quality of surface water bodies are maintained for sustainable fish production in Nigeria. Water quality parameter is one of the most significant factors in fisheries and aquaculture. Water is an altering system that comprises living and non-living components, organic, inorganic soluble and insoluble substance, with possibilities of variations in its quality that could happen on regular bases (Ndubi *et al.,* 2015). Aquatic organisms need a balanced environment with sufficient nutrients for survival and development. According to Neha *et al*. (2013), productivity of water is influenced by the physicochemical characteristics of the water body, hence the need for regular examination of water quality parameters. Jenyo-Oni *et al*. (2010) noted that water quality parameters include all the physical, chemical and biological factors that influence the beneficial use of water to man and other living organisms. The important physicochemical parameters are temperature, dissolved oxygen, pH, hardness, alkalinity and ammonia-nitrogen (Ahmad *et al*., 2016), and these are more regularly considered in studies on water quality evaluation. Several researches have reported water quality parameters of water bodies in Nigeria, few among them are Olanrewaju *et al*. (2017) on Eleyele reservoir, Southwest Nigeria, Lawal and Ahmed (2014) on Daberam reservoir, Katsina State, Nigeria, Hassan *et al.* (2014) on lower river Ogun river wetlands and Apollos *et al*. (2016) on Zobe reservoir, Katsina State. However, since anthropogenic activities around water bodies are always ongoing, assessment of quality status of water bodies should be a continuous effort. Ajiwa and Zobe reservoirs are exploited for their water resource, irrigation of farmlands and fisheries activities among others. The basins are currently under the pressure of dumping of untreated waste, sewage, runoff from the agricultural fields. The study therefore assesses the physicochemical parameters of Zobe and Ajiwa reservoirs in Katsina State, Nigeria with a view to understanding the pollution status of the two water bodies.

Materials and methods

Study area: The study was conducted in Zobe and Ajiwa reservoirs. The study area 1, Zobe reservoir (Figure 1) is an earth-fill structure completed in 1983 on the coordinates 12°23′18″ N (latitude) and 7°28′29″ E (longitude) in Dutsin-Ma LGA of Katsina State. The dam has a height of 48 m, length of 360 m with a base width of 2,750 m. The reservoir has a storage capacity of 179 Mca, as it is impounded from two major rivers Karaduwa and Gada (Dasuki *et al*., 2014). The study area 2, Ajiwa reservoir (Figure 2) is on the latitude 12°98′ N and longitude 7°75′ E, in Batagarawa LGA, Katsina State. The main purpose of the reservoir is irrigation farming and water supply to the populace of Katsina, Batagarawa, Mashi and Mani LGAs. The reservoir was impounded in 1973 and commissioned in 1975. The capacity of the water is nearly 22,730,000 m^3 (Parkman and Haskoning, 1996). It serves as a source of source of revenue for the nearest communities.

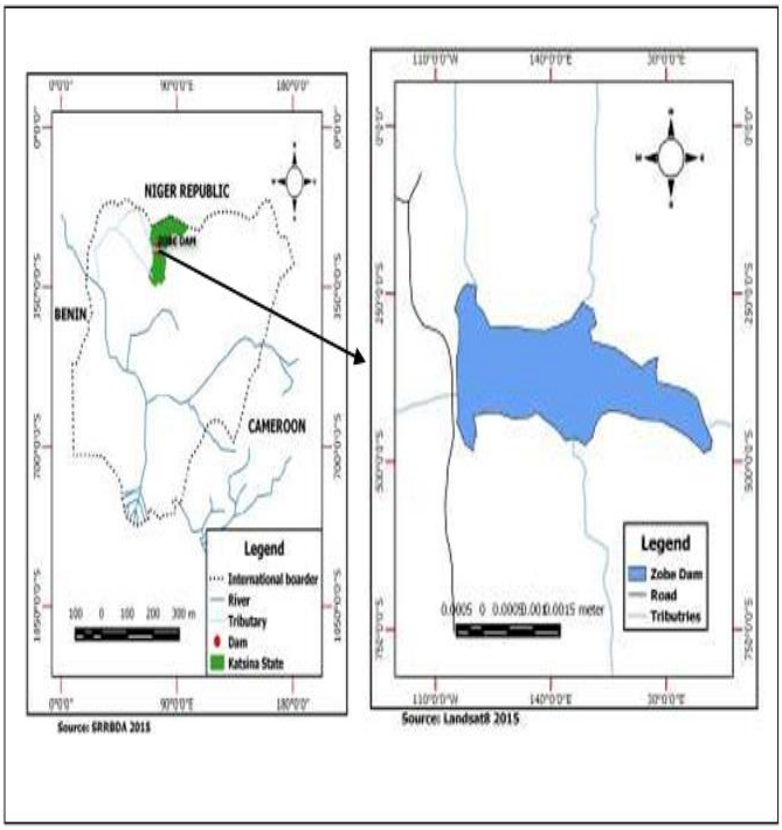

Figure 1: Map of Nigeria showing Zobe reservoir in Katsina State

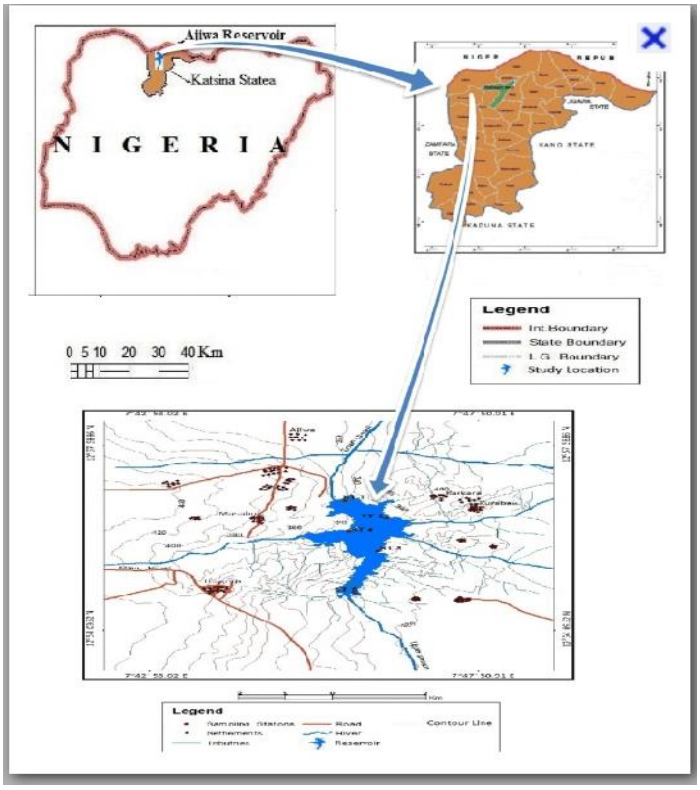

Figure 2: Map of Nigeria showing Ajiwa reservoir in Katsina State

Water sampling procedures and duration: Water samples were collected twice every month from each of the three selected stations (upstream, middle and downstream) in each of the reservoirs 700 and 800 hours, for a period of 7 months (August 2020 to February 2021). The water samples were analysed in the field for the selected water quality parameters including; temperature, pH, alkalinity, dissolved oxygen, ammonia-nitrogen, hardness and transparency, and they were determined following the methods described by Dauda and Akinwole (2014). All the procedure followed the standard methods (APHA, 2012)
Statistical analysis: The overall water quality parameters for the seven months were presented using descriptive statistics (mean±standard error). Independent sample t-test was used to compare each parameter between the two water bodies at 95% level of confidence interval (P<0.05). Line graph was used to present monthly variation, while Pearson's correlation matrix was used to examine the interdependence among the water quality parameters.

Results

The results of the overall water quality parameters are shown in Table 1, temperature and transparency, 24.14±0.77 °C and 8.36±0.12 cm respectively were slightly higher in the Zobe reservoir. Other parameters including dissolved oxygen, pH, alkalinity, ammonia-nitrogen and hardness were all higher in the Ajiwa reservoir. However, the difference was not significant (P>0.05) for any of the parameters. Monthly variations in temperature (Figure 1) showed consistent similarities between the two water bodies. While the temperature rose slightly from August to peak at about 27 °C in October, it declined to 18 °C in January and rose back to above 20 °C in February. Transparency (Figure 2) was least in Zobe reservoir, 3.10 cm in August while it went up consistently to overall highest also in Zobe (16.73 cm) in the month of February. It was consistently higher in Zobe than in Ajiwa between November and January. Dissolved oxygen showed a haphazard variation (Figure 3), the least was noted in August (6.21 mg/L) in Zobe reservoir, and it increased slightly to peak in November at 7.50 mg/L in Ajiwa reservoir. The increase rate between August and November was higher in Ajiwa, then it declined in both water bodies till January and rose again in February. pH is shown in Figure 4 with a gradual increase in the two water bodies from 6.30 in August to the overall highest of 7.33 in Ajiwa in November. Unlike Ajiwa, the highest pH in Zobe was noted as 7.23 in February. Alkalinity (Figure 5) also showed monthly variations. Overall, the highest was reported in Ajiwa reservoir in October (35.16 mg/L), while the least (25.21 mg/L) was recorded from Zobe reservoir in December. The ammonia-nitrogen declined from 2.57 mg/L in August from Zobe reservoir to 1.05 mg/L in February. The decline was from September but also to February in Zobe reservoir. Monthly variation in hardness is shown in Figure 7. Aside from haphazard variations in the first three months, there was a consistent increase from the two water bodies between October and February with an overall highest of 98.23 mg/L recorded in Zobe reservoir in February.

Table 1: Mean water quality parameters from Ajiwa and Zobe Reservoir from August 2020 to February 2021

	Reservoirs	
Parameters	**Ajiwa**	**Zobe**
Temperature (°C)	23.13 ± 0.74[a]	24.14±0.77[a]
Transparency (cm)	7.37±0.11[a]	8.36±0.12[a]
Dissolved oxygen (mg/L)	6.92±0.10[a]	6.70±0.11[a]
pH (mg/L)	6.96±0.10[a]	6.90±0.10[a]
Alkalinity (mg/L)	31.01±0.98[a]	29.61±0.70[a]
Ammonia nitrogen (mg/L)	1.78±0.17[a]	1.65±0.14[a]
Hardness (mg/L)	84.15±2.49[a]	83.60±2.64[a]

Different letters as superscripts across rows showed significant differences (P<0.05)

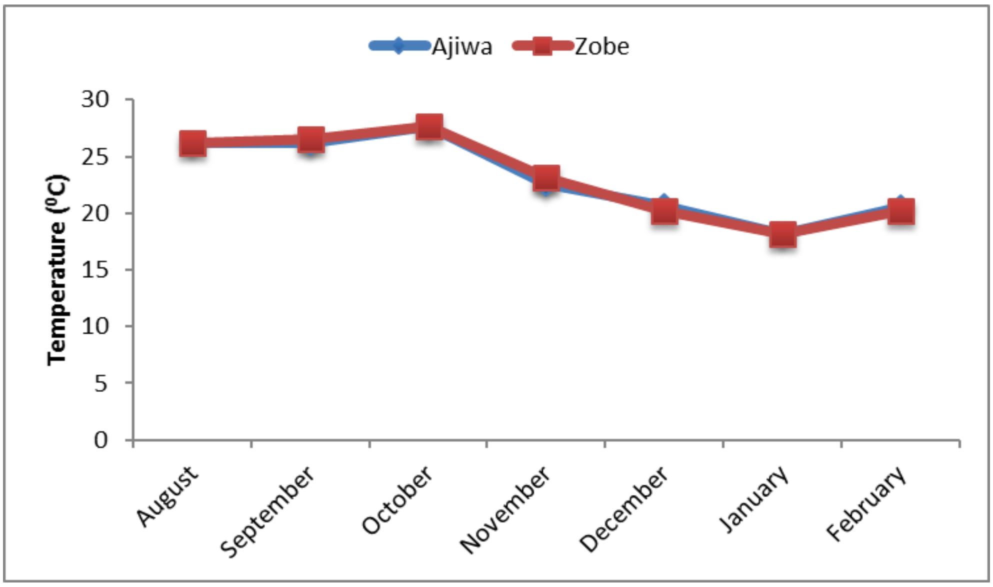

Figure 1: Monthly variations in temperature of Ajiwa and Zobe reservoirs from August 2020 to February 2021

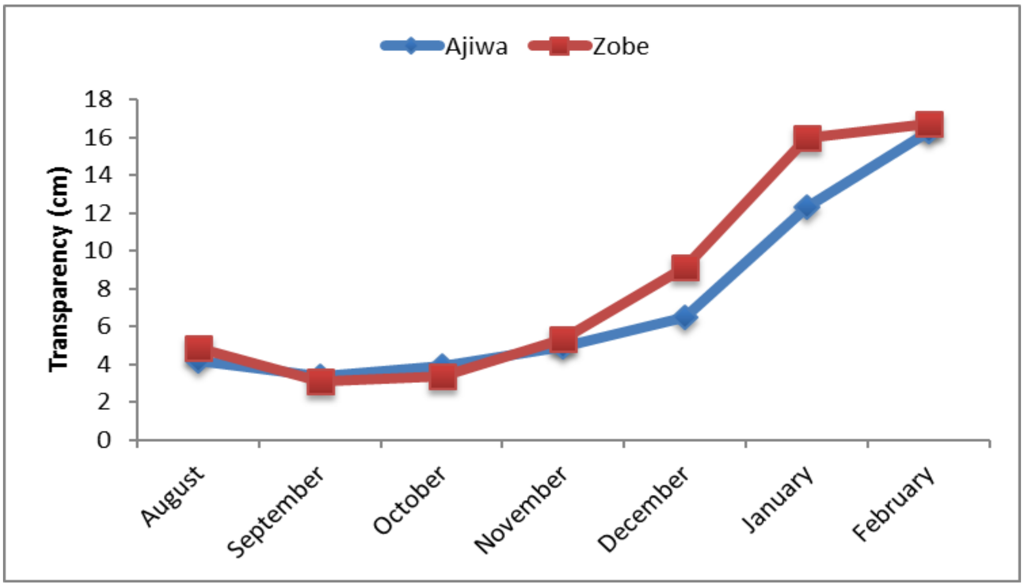

Figure 2: Monthly variations in Transparency of Ajiwa and Zobe reservoirs from August 2020 to February 2021

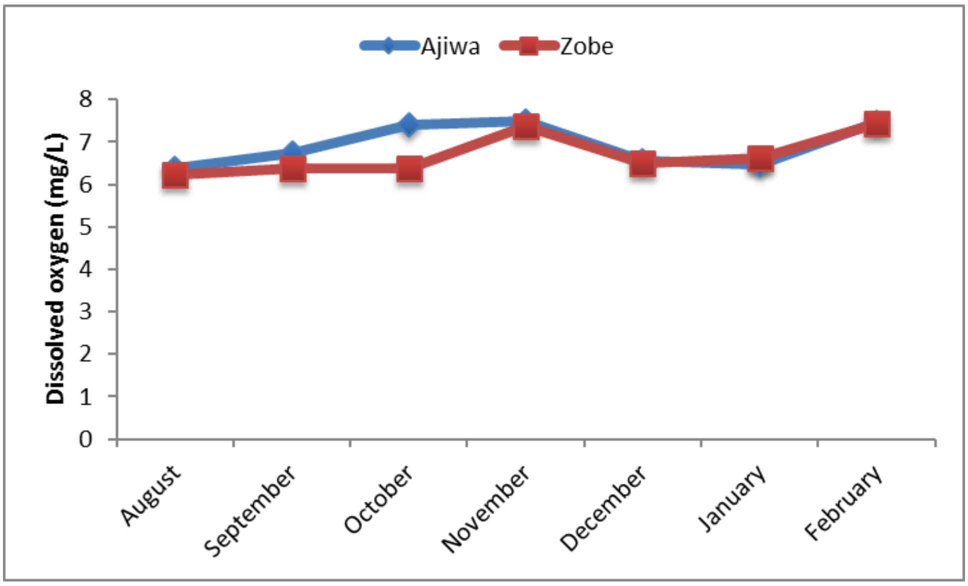

Figure 3: Monthly variations in Dissolved Oxygen of Ajiwa and Zobe reservoirs from August 2020 to February 2021

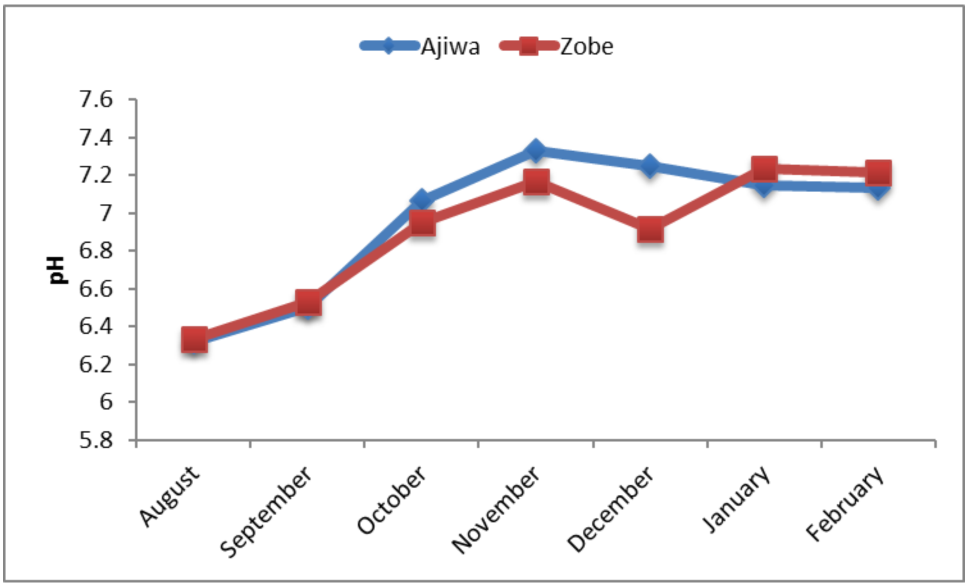

Figure 4: Monthly variations in pH of Ajiwa and Zobe reservoirs from August 2020 to February 2021

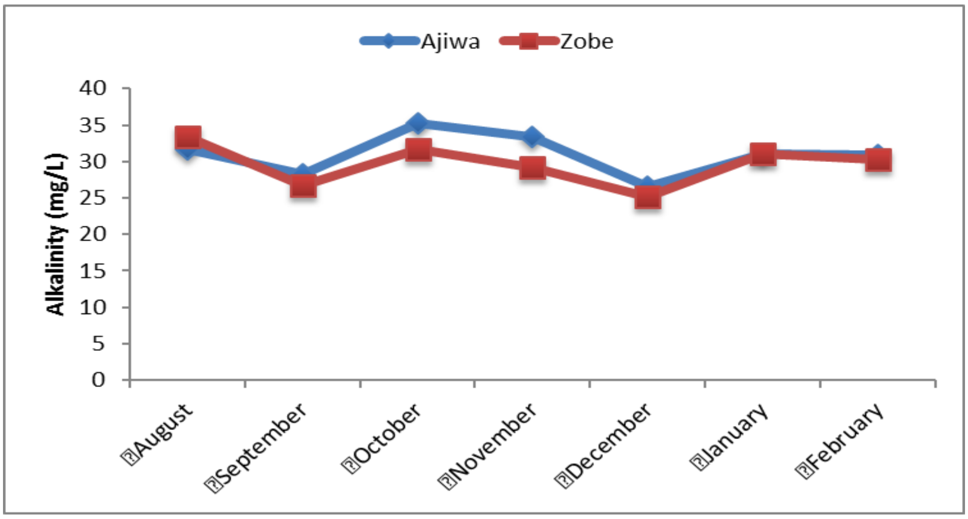

Figure 5: Monthly variations in alkalinity of Ajiwa and Zobe reservoirs from August 2020 to February 2021

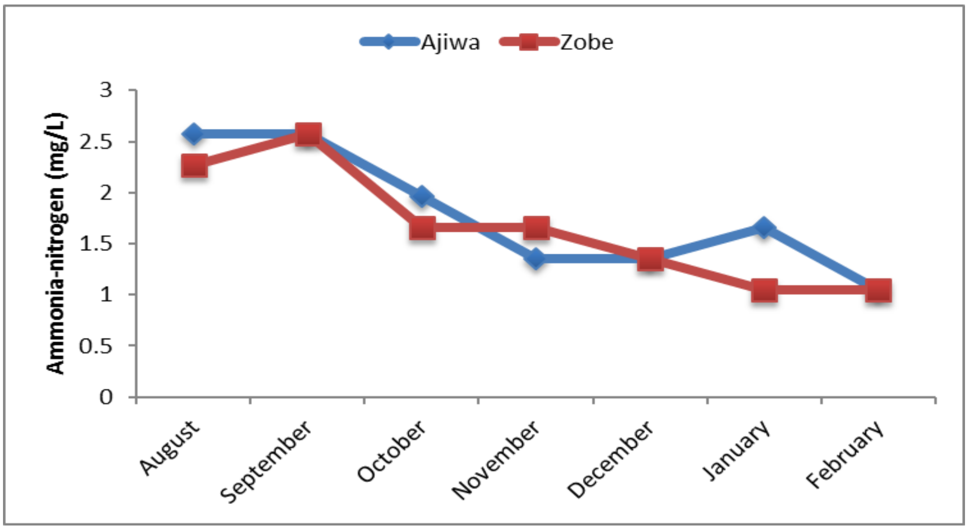

Figure 6: Monthly variations in ammonia-nitrogen of Ajiwa and Zobe reservoirs from August 2020 to February 2021

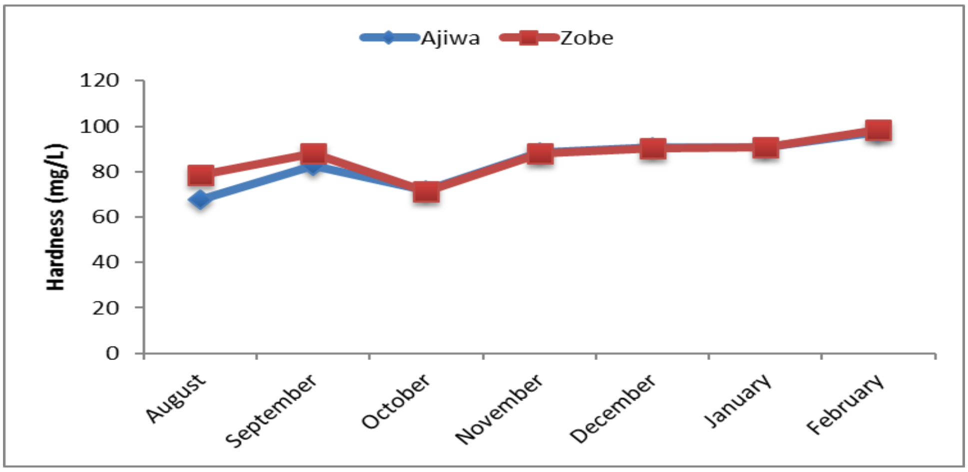

Figure 7: Monthly variations in hardness of Ajiwa and Zobe reservoirs from August 2020 to February 2021

The results of the interdependence among the selected physicochemical parameters are shown in Table 2. Temperature had very strong, although negative correlation with transparency and hardness, it also had strong but negative correlation with pH and a strong and positive correlation with ammonia-nitrogen. Transparency had significant but weak positive correlation with pH, a strong positive correlation with hardness but negative with ammonia-nitrogen. DO had weak but significant correlation with pH, ammonia-nitrogen and hardness with that of ammonia-nitrogen as negative. pH also showed a negative correlation with ammonia-nitrogen while it had a strong and positive correlation hardness. Alkalinity showed no significant correlation with any other parameter. Ammonia-nitrogen also had a strong but negative correlation with hardness.

Table 2: Interdependence among water quality parameters from Zobe and Ajiwa reservoirs

	Temp	**Transparency**	**DO**	**pH**	**Alkalinity**	**NH_3-N**	**Hardness**
Temperature	1						
Transparency	-0.825**	1					
DO	-0.169	0.288	1				
pH	-0.500**	0.390*	0.433**	1			
Alk	0.210	0-.032	0.177	.066	1		
NH_3-N	0.615**	-0.619**	-0.361*	-0.405**	0.045	1	
Hardness	-0.776**	0.691**	0.373*	0.514**	-0.004	-0.576**	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
DO-dissolved oxygen, NH_3-N Ammonia-nitrogen

Discussion

Water is a primary need that supports existence of life, the needs go beyond water alone but also for the resources within among which are aquatic organisms that serve as food for human being. According to Suleiman and Audu (2014) damming of water to create reservoirs is one of the ways of making more water available for the needs of man as the water is stored and made available all the time. Nonetheless, water is only able to be of maximum advantage if it is of optimum quality. Fish and other aquatic resources deserve a proper balance of physical, chemical and biological properties of water for their optimum productivity (Olanrewaju *et al.*, 2017). Among the highly important physicochemical water quality parameters are temperature, pH, DO, and nitrogenous metabolites (Jenyo-Oni *et al*., 2010; Ahmad *et al*., 2016). In this study all the examined water quality parameters had similar means between the two water bodies and were within the recommended range for optimum performance of tropical fish species (Hassan *et al*., 2014; Andem *et al*., 2012; Mustapha 2009) except ammonia-nitrogen. They can also support cultured fish adequately should the water they be used for fish production (Dauda and Akinwole 2014). Water quality parameters are affected by environmental factors both natural and anthropogenic, hence, the spatial and temporal variations observed by different researchers. In this study temperature was similar between the two water bodies throughout the period of examination (August to February), it rose slightly from August to peak in October, then declined through to January before rising again in February. The observation can be largely attributed to change in atmospheric temperature. According to Dauda *et al*., (2015), there are about four temperature regimes in the State. A hot dry season from March to May, followed by a warm wet season from June to September, then a less marked season of gradual temperature drop after rain, from October to November before the cool dry harmattan season from December to February when the least temperature is experienced. A similar trend was reported by Appollos *et al*. (2106) in Zobe reservoir, although they reported slightly higher temperature than the current study. Transparency is a function of the suspended particles in the water body and could provide similar information with turbidity. It rose gradually from September to February. The least transparency in the two water bodies during rainy season could be associated with run-off from the banks to the water bodies, and this get settled and the water bodies become clearer through into dry season. Olanrewaju *et al*. (2017) also reported higher transparency in wet season in Eleyele reservoir in Ibadan, Nigeria. The observed higher transparency in Zobe reservoir than Ajiwa between November and January may be due to volume of activities as against the volume of the water body and probably the nature of the sediment in the two water bodies. Dissolved oxygen was consistently higher than the recommended minimum of 5 mg/L as optimum DO for surface waters (Yakubu and Ugwumba, 2009). The result was similar with what was previously reported for reservoirs in the State (Lawal and Ahmed 2014; Suleiman and Audu 2014; Apollos *et al*., 2016). A lower DO was reported from Eleyele reservoir, Ibadan, that was classified to be under pollution stress (Olanrewaju *et al*., 2017). A slightly alkaline pH (6.5 -8.5) is recommended for optimum performance of aquatic organisms (Dauda and Akinwole, 2014), and the results in this experiment were within the range. The least pH observed in the two water bodies were in the month of August and September, which fell during rainy season. This might be associated with decomposition of acidic chemical run-off from agricultural farmlands around the water bodies. Alkalinity and hardness usually follow similar trends across seasons in water bodies but there was a slight variation between the two in this experiment. Alkalinity and hardness are highly influenced by the geology of the area and the dissolution of carbon dioxide at the water surface. The results obtained in the study are comparable with that of Dirican (2015) in Camligoze Lake in Turkey and Bera *et al*. (2014) in Kangsabati reservoir in India. Ammonia-nitrogen is the most important nitrogenous metabolite resulting from breaking down of organic particle and colud be toxic to aquatic organisms beyond the recommended level. The observed trend in this experiment showed a decline from September to November, before a further slight decline to February. Although and unusual rise was noted from December to January in Ajiwa reservoir. The higher ammonia-nitrogen in rainy season, especially the later part could be associated with breaking down of organic partcles in the run-off, which might likely have influenced the observed lower pH within the same period. The period also had higher temperature that might have facilitated the microbial activities to decompose the organic particles, hence, the lower pH and higher ammonia-nitrogen. Olanrewaju *et al*. (2017) also reported a higher ammonia-nitrogen in wet season than dry season. Generally, the ammonia-nitrogen reported in this study was higher than 0.3 – 1.17 mg/L reported by Bala and Bolorunduro (2011) in Sabke reservoir but within the same range with that of Lawal and Ahmed (2014) from Daberam reservoir all in the same State. However, it is less than the range reported by Olanrewaju *et al.* (2017) from Eleyele reservoir in Ibadan, Nigeria and classified to be under pollution stress. Some of the water quality parameters showed significant correlation which implies a level of interdependence. Temperature showed significant negative correlation with transparency and hardness but a positive correlation with ammonia-nitrogen. This implies that as the temperature goes higher, the transparency, pH and hardness go lower but an increase in ammonia-nitrogen. An increase in temperature might increase the activities of micro-organisms, then they feed more on suspended organic particles during which they produce more carbon-dioxide and lower the pH and hardness. The decomposed nitrogenous particles and die-off micro-organisms then resulted in increase ammonia-nitrogen. Dauda and Akinwole (2014) also reported increase in nitrogenous metabolites with increase in temperature, while Olanrewaju *et al*., (2017) reported a decrease in pH with increase in temperature. The higher the transparency the more tendencies of higher pH and hardness but a decrease in ammonia-nitrogen. DO also showed a trend towards increase with increase in pH and hardness but decrease in ammonia-nitrogen. All these can be explained with the microbial decomposition processes. A high DO will ease further decomposition and oxidation of ammonia-nitrogen to less toxic nitrate-nitrogen. Also at higher dissolved oxygen, increase hardness might be due to lower amount of carbon-dioxide in the water body which also prevent pH from decreasing. A decrease in ammonia-nitrogen with increase in transparency was also reported by Olanrewaju *et al*. (2017) while a decrease in ammonia-nitrogen due to increase in DO was reported by Dauda and Akinwole (2014).

Conclusion

The results from the experiment showed that aside ammonia-nitrogen all the examined water quality parameters were within the recommended range for optimum and productive living of aquatic organisms. The water can also be used for fish culture in ponds and tanks along the banks of the reservoirs. However, the slighly higher ammonia-nitrogen in the water bodies may be due to farming and other anthropogenic activities. It is important to regulate the discharge of wastes and chemicals used in farmland around to safe the water bodies from pollution which might negatively affect their productivity.

References

Ahmad I, Afshan K, Ramzan K, Hayat S, Raza Rizvi SS, Qayyum M: Effect of water quality parameters on isopod parasite alitropus typus (Aegidae) of ectotherms in Chashma Lake, Pakistan. Pak J Zool, 48(3): 769-779. 2016.

Andem AB, Udofia U, Okorafor KA, Okete JA, Ugwumba AAA: A study on some physical and chemical characteristics of Ona River, Apata, Ibadan, South-West, Oyo State, Nigeria. Eur J Zool Res, 1(2): 37-46. 2012.

American Public Health Association (APHA): Standard Methods for the Examination of Water and Waste Water. 22nd Edition, American Public Health Association, American Water Works Association, Water Environment Federation, Washington DC. 2012.

Apollos TG, Raji A, Modibbo U: Seasonal variation of water quality parameters of Zobe reservoir Dutsinma Katsina State, Nigeria. Hydrol Curr Res, 7: 261. 2016.

Bala U, Bolorunduro PI: Limnological survey and nutrient load of Sabke Reservoir, Katsina State, Nigeria. Afr Sci 12 (3):163- 168. 2011.

Bera A, Bhattacharya M, Patra BC, Sar UK: Ichthyofaunal diversity and water quality in the Kangsabati reservoir, West Bengal, India. Adv Zool, 1: 1-8. 2014.

Dasuki A, Dauda AB, Oshoke JO, Tiri GD, Bichi AH: A Survey of Artisanal Fisheries of Makera Zone of Zobe Reservoir, Katsina State. In: Proceedings, 29th Annual Conference of Fisheries Society of Nigeria (FISON), held from 24th – 29th November, 2014 at Royal Choice Inn Ltd, Gondo Aluor Road, Old GRA, Lobi Quarters, Makurdi, Benue State Nigeria. pp 2-5. 2014.

Dauda AB, Dogo MT, Abdulkareem HO: Socio-economic status of fisherfolks and fishing activities in Dutsin-Ma reservoir, Katsina State, Nigeria. In Book of Abstract 36th Annual conference of the Fisheries Society of Nigeria, Garden City 2021, held between 24th and 29th October 2021 at Ebitimi Banigo Auditorium, University of Port Harcourt, Choba Rivers State. FISONR2021/FSE/016. 2021.

Dauda AB, Dasuki A, Bichi AH: Analysis of constraint to aquaculture development in Sudano-Sahelian region of Nigeria. Trop Subtrop Agroecosystem 18:189-193. 2015.

Dauda AB, Akinwole AO: Interrelationships among water quality parameters in recirculating aquaculture system. Nig J Rural Ext Develop 8(4): 20-25. 2014.

Dirican S: Assessment of water quality using physicochemical parameters of Çamlıgöze Dam Lake in Sivas, Turkey. Ecologia 5: 1-7. 2015.

Ndubi D, Oyaro N, Githae E, Afullo A: Determination of physicochemical properties of sources of water in Narok North sub-county, Kenya. Int Res J Environ Sci, 4(1): 47-51. 2015.

Neha G, Krishna KY, Kumar V, Deepak S: Assessment of Physicochemical Properties of Yamuna River in Agra City. Int J ChemTech Res 5(1):528-531. 2013.

Hassan, A.A., Jenyo-Oni, A., and Dauda, A.B. (2014) Assessment of water quality, Ichthyofauna and Macroflora diversity of lower Ogun river wetlands. World J Fish Mar Sci 6: 101-108. 2014.

Jenyo-Oni A, Akinwole AO, Dauda AB: Benthic Macro-invertebrates and physicochemical quality of reservoirs in University of Ibadan, fish farm. Ibadan J Agric Res, 6: 19-26. 2010.

Keshere OJ, Mustpha IM, Sani MU, Goni IS: Water an important gift for mankind. Alhassan Publishers, Yola, Nigeria. 2007.

Lawal I, Ahmed A: Physicochemical parameters in relation to fish abundance in Daberam reservoir, Katsina State, Nigeria. Entomol Appl Sci Lett 1(3): 43-43. 2014.

Mustapha MK: Limnology and fish assemblages of Oyun reservoir, Offa, Nigeria. Ph.D. Thesis submitted to the Department of Zoology, Faculty of Science, University of Ilorin, Ilorin, Nigeria. 2009.

National Bureau of Statistics (NBS): Nigeria's fish production: 2010 – 2015. National Bureau of Statistics, Abuja, Nigeria. 22p. 2017.

Olanrewaju AN, Ajani EK, Kareem OK: Physico-chemical status of Eleyele reservoir, Ibadan, Nigeria. J Aquac Res Dev 8: 512. 2017. doi: 10.4172/2155-9546.1000512.

Parkman B, Haskoning M: Reconstruction of Ajiwa Reservoir Katsina, Katsina State. Nigeria. pp. 1-23. 1996.

Suleiman FB, Audu AA: Analysis of water from some dams in Katsina State, Nigeria. IOSR J Appl Chem 7(1): 1-9. 2014.