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Water quality parameters and length-weight relationship of *Bagrus bajad* (Fabricius, 1775) in Ajiwa Reservoir, Katsina State

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ABSTRACT

Continuous assessment of natural water bodies is essential to ascertain the pollution and health status. This study was conducted between February and September 2022 to evaluate the physicochemical parameters and the length-weight relationship of silver catfish in Ajiwa Reservoir, Katsina State with the aim of evaluating the pollution and health status of the water body. Temperature, pH, dissolved oxygen (DO), water hardness, turbidity, alkalinity, and total ammonia-nitrogen were evaluated using standard techniques. Length-weight relationship of silver catfish was also assessed. One-way ANOVA was used to compare each of the physicochemical parameters among three sampling stations in the reservoir. Linear regression was used to fit the length-weight relationship model and Fulton's condition factor for wellbeing of the fish. All the water quality parameters were similar among the three stations except total ammonia-nitrogen (TAN) 8.82±0.02 mgL^{-1}, which was significantly ($P<0.05$) higher in Kadaji compared to the two other stations. Monthly variation was also observed in all the examined water quality parameters. The length-weight relationship of *Bagrus bajad* during the study period showed negative allometric growth as the slope parameter (b) value ranged between 0.85 in Gamji to 1.16 in Kadaji. However, the fish were in good condition as the combined K value was 1.02 and each of the stations had K values between 0.92 and 1.10. The water body cannot be said to be under pollution stress considering all the physicochemical parameters were within the recommended level for tropical fish species and the K value revealed that the fish are in good condition.

Keywords: Physicochemical; *Bagrus bajad;* growth pattern; condition factor

INTRODUCTION

Nigeria is blessed with an enormous area of freshwater and brackish water ecosystems that extend from the coast into the arid zone (Essien-Ibok and Isemin, 2020). According to Lohdip and Gongden (2013) water bodies are any substantial collection of water on the surface of a planet, these include smaller pools of water like ponds, marshes among others. However, the word is most frequently used to refer to large pools such as oceans, seas, and lakes. Water is an important natural resource of great benefit to man, including social and economic benefits (Jenyo-Oni *et al*., 2010). A body of water does not necessarily have to be

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still or enclosed; rivers, streams, canals, and other geographical features where water flows from one point to another are also termed bodies of water; the majority of these features are naturally occurring, but some are man-made. For example, most reservoirs are created by man-made dams, but some natural lakes are also used as reservoirs. Similarly, most harbors are natural bays, but some have been created through construction (Lohdip and Gongden, 2013).

According to Kigbu *et al.* (2015), water quality refers to the chemical, physical, biological and radiological properties of water. Water must be kept in good quality in order to support and provide good habitat to aquatic species including fish and avoid leading of some species to extinction (Ahmad *et al*., 2016) It is a measure of the status of water in relation to the purpose of needs which could be that of human, fish species or other users of the water bodies. Water qualities include all physical, chemical and biological properties that influence the beneficial use of water (Jenyo-Oni *et al*., 2010). The economy of the aquatic biotype depends on water which is the fish habitat (Agbabiaka, 2014). The importance of water to the fish cannot be over emphasized because there is no fish without water. Thus, good quality water supports viable fisheries while polluted water may lead to extinction of the aquatic species (Agbabiaka, 2014). Some water quality parameters including pH, alkalinity, and hardness could have so much influence on the toxicity of most other variables in the water bodies. Increase in pH may lead to decrease in the total amount of ammonia-nitrogen required to cause toxicity but as pH, alkalinity, and hardness increase, the concentration of metals required to cause toxicity might also increase (Boyd *et al*., 2016).

Bagrus bajad (bajad), locally called *Ragon ruwa* (Hausa) is a member of Bagridae family which is commonly referred to as silver catfish. They are commercially important species found in Nigerian fresh waters (Malami and Magawata, 2010). According to Alhassan and Ansu-Darko (2011) *B. bajad* is a benthic omnivore (bottom feeder) as detritus (bottom deposits) has been found in its digestive tract along with other food items.

Growth is an irreversible increase in the dry mass of biological matter and is a fundamental property of all living organisms (Dan-kishiya *et al*., 2018). Length and weight are major parameters that are used to describe growth of biological matter, and information about the two can be used to compute some major indices to measure biological well-being (Jenyo-Oni *et al*., 2014). In fisheries science, determination of the quality of growth is the usual starting point, the basis of which is the length-to-body weight ratio of fish species are examined (Demirel and Dalkara, 2012). Fish length to weight ratio has been widely established as an important tool in fisheries science, especially in the ecology of population dynamics and resource management (Salele *et al*., 2023). Dambatta *et al*. (2021) also noted that length-weight ratio is a vital instrument in biology, ecology, physiology assessment and conservation.

Fish condition factor serves as indicators of the physiological state of a fish in relation to its welfare (Jenyo-Oni *et al*., 2014) and are also used to distinguish between two populations living in a particular food density and climate (Dan-kishiya *et al*., 2018). Therefore, condition factor is among the important parameters for understanding the life cycle of fish species, hence, contributing to the proper management of these species and thus maintaining the balance of ecosystems (Imam *et al*., 2010). Hassan *et al.* (2014) noted that fish well-being can be affected by water quality parameters, and it could serve as a biological instrument for evaluating the health status of a water body. Therefore, this study was carried out to evaluate the physicochemical parameters and length-weight relationship of *B. bajad* in

Ajiwa reservoir, Katsina, with the aim of assessing the pollution and health status of the water body.

MATERIALS AND METHODS

Study Area

The study was conducted at Ajiwa Reservoir (Figure 1) which is located between latitudes 12°54'69" and 12°57'58" N and longitudes 7°42'53" and 7°47'50" 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 of Katsina state. 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 revenue for the nearest communities. Neighbouring villages apart from Ajiwa include Masabu, Kunturu, Watsa, Danku, Kadaji, Kundu waje among others, all in Batagarawa local government area of Katsina state, Nigeria.

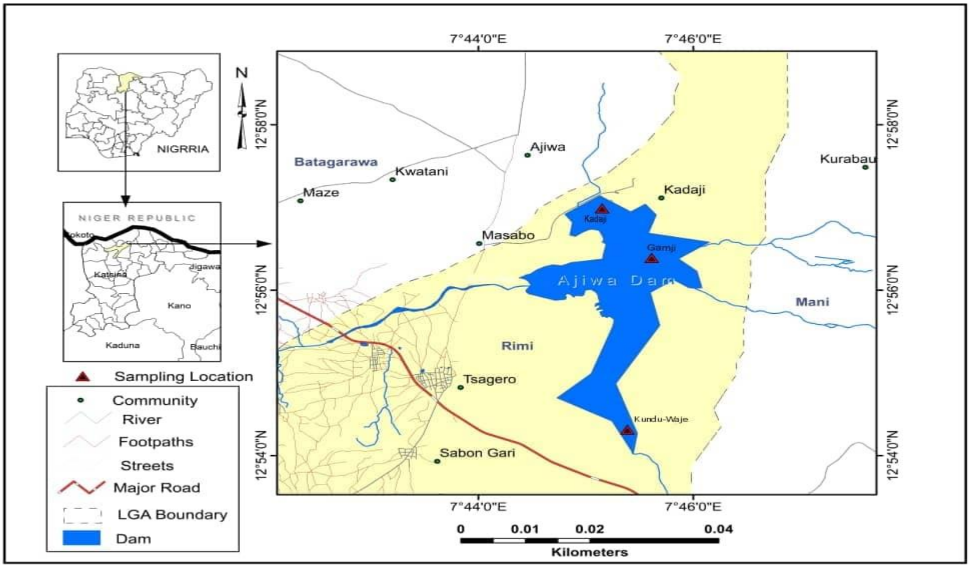

Figure1: Map of Ajiwa reservoir showing sampling stations

Sampling Procedure and Duration of the Research

Physicochemical parameters like water temperature (ºC), pH, dissolved oxygen (mgL^{-1}), hardness (mgL^{-1}), alkalinity (mgL^{-1}), total ammonia-nitrogen (mgL^{-1}) were measured using Fresh Innovative Multitec kits while water transparency (cm) was measured using a fabricated Secchi disc. The research was carried out within eight (8) months between February and September 2022, and the samples were collected once in a month which covered two seasons i.e four months of dry and four months of rainy season from the three of the fish landing sites on the water body namely, Kadaji, Gamji and Kundu waje.

Fish Sampling

Fish were sampled monthly from artisanal fishermen catches who employ the use of different fishing gears ranging from traps, long line, and nets of different mesh sizes at the three selected fish landing sites, Kadaji, Gamji and Kundu waje. Fish samples were transported to the laboratory in an ice cube box for further analysis and identification using Olasebikan and Raji (2013) guide.

Data Analysis

Data on physicochemical parameters were presented with mean and standard error, after homogeneous variance of normality distribution test, the data were subjected to one-way analysis of variance (ANOVA) to compare the mean for each parameter among the various landing sites while the Duncan multiple range test was used to compare means. Line graph was used to present monthly variation in the water quality parameters, while simple linear regression was used to analyse the length-weight relationship of the fish from the reservoir and the slope of the graph was used as growth exponent (b).

Length-Weight Relationship and Condition factor (K)

The relationships between these two parameters were established by using equation reported by Froese (2006):

$W = aL^b$

Where:
W = Weight of fish (g)
L = length of fish in cm
a = constant
b = (slope) exponential expressing the relationship between length and weight

The relationship ($W = aL^b$) when converted into the logarithmic form gives a straight-line relationship graphically as:

LogW= Log a+ b Log L.

Where:
b= slope,
Log a= constant.

The coefficient of condition K was calculated using Fulton 's formula as follows:

$$K = \frac{w \times 100}{L\text{^}3}$$

Where:
W= weight of the fish in gram

L = length of the fish in cm
100 = is a factor to bring the value of K near unity.

RESULTS

Water Quality Parameters of Ajiwa reservoir

All the physicochemical parameters showed no significant difference ($p>0.05$) among the stations except total ammonia-nitrogen (TAN) which was significantly higher in Kadaji (8.82 ± 0.02 mgL^{-1}) compared to the two other stations (Table 1).

The highest monthly temperature was observed in Kundu waje during the month of April (34^{o}C) while the lowest was observed in February (20^{o}C) in Gamji (Figure 2) and the monthly variation in dissolved oxygen was highest (6.2 mgL^{-1}) in February, May and June in Kadaji and Gamji while the lowest (2.2 mgL^{-1}) was observed in March at Kadaji, August at Kundu waje and September at Gamji (Figure 3). Other parameters like transparency, pH, Alkalinity and hardness were higher in February, March, May and August respectively as presented in Figure 4-7 while the monthly variation in total ammonia (mgL^{-1}) was high (8.82mgL^{-1}) in all the months at Kadaji, at Gamji in March and April and at Kundu waje in July and September while the lowest (4.7 mgL^{-1}) was observed in February at Gamji (Figure 8).

Table 1: Physicochemical parameters of water in Ajiwa Reservoir

Parameters	Kadaji	Gamji	Kundu-waje
Temperature(^{o}C)	24.88 ± 1.33^{a}	26.38 ± 0.84^{a}	26.63 ± 1.38^{a}
pH	7.54 ± 0.22^{a}	7.12 ± 0.31^{a}	7.45 ± 0.28^{a}
Alkalinity (mgL^{-1})	23.75 ± 2.63^{a}	30.00 ± 2.67^{a}	32.50 ± 3.13^{a}
Dissolved oxygen(mgL^{-1})	4.94 ± 0.50^{a}	4.71 ± 0.49^{a}	3.66 ± 0.30^{a}
Total ammonia-nitrogen (mgL^{-1})	8.82 ± 0.02^{b}	7.30 ± 0.46^{a}	7.50 ± 0.33^{a}
Hardness (mgL^{-1})	46.00 ± 9.64^{a}	53.12 ± 18.47^{a}	27.63 ± 6.93^{a}
Turbidity (cm)	8.93 ± 0.56^{a}	8.93 ± 0.56^{a}	8.17 ± 0.60^{a}

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

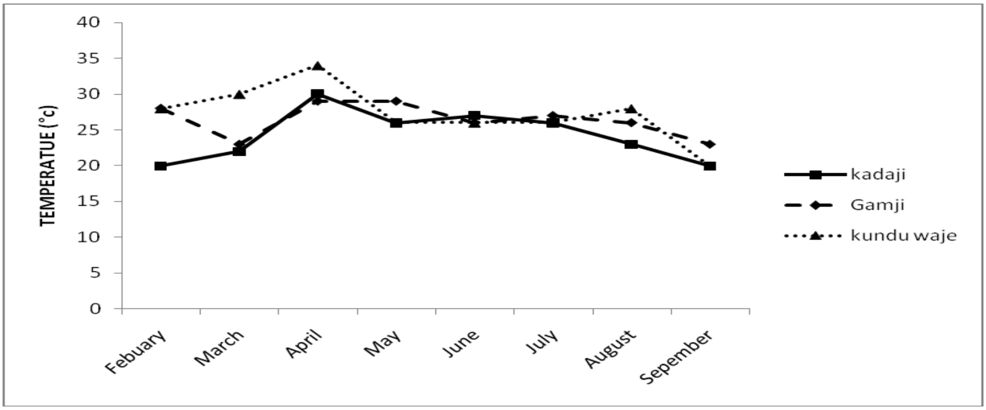

Figure 2: Monthly variation of temperature in Ajiwa reservoir

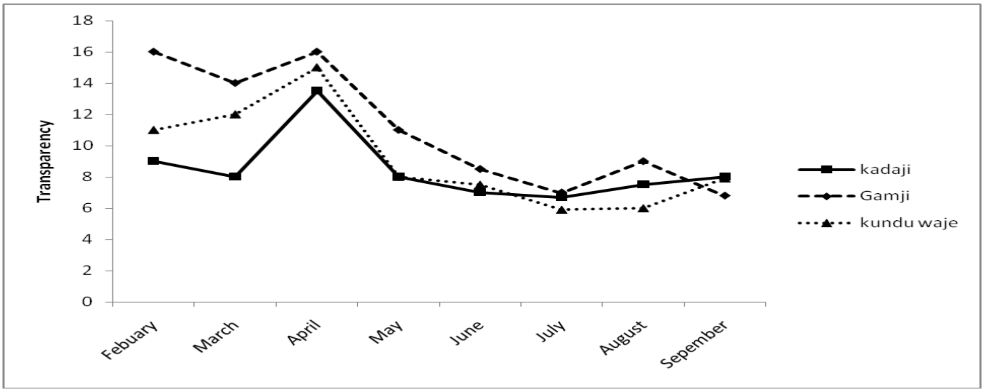

Figure 3: Monthly variation of transparency in Ajiwa reservoir

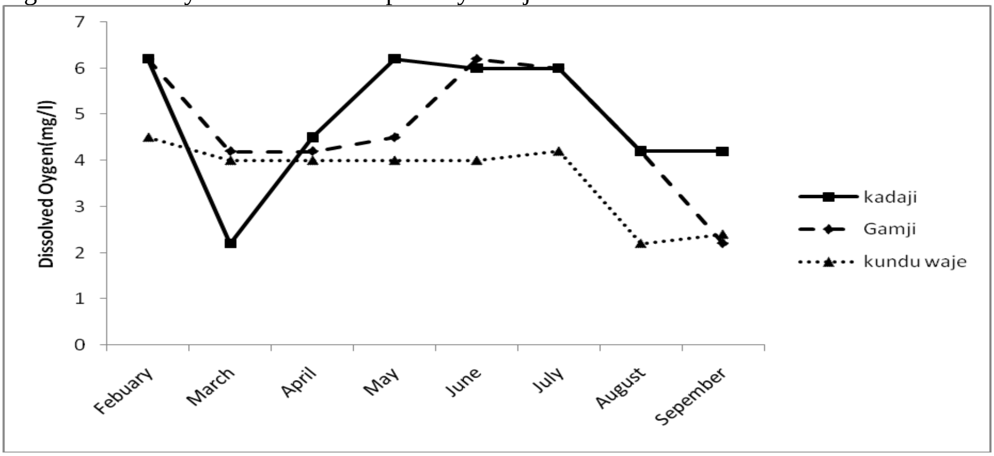

Figure 4: Monthly variation of Dissolved oxygen in Ajiwa reservoir

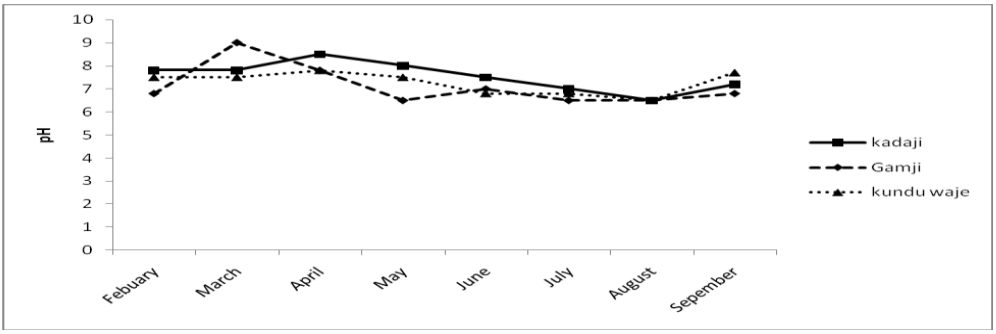

Figure 5: Monthly variation of pH in Ajiwa reservoir

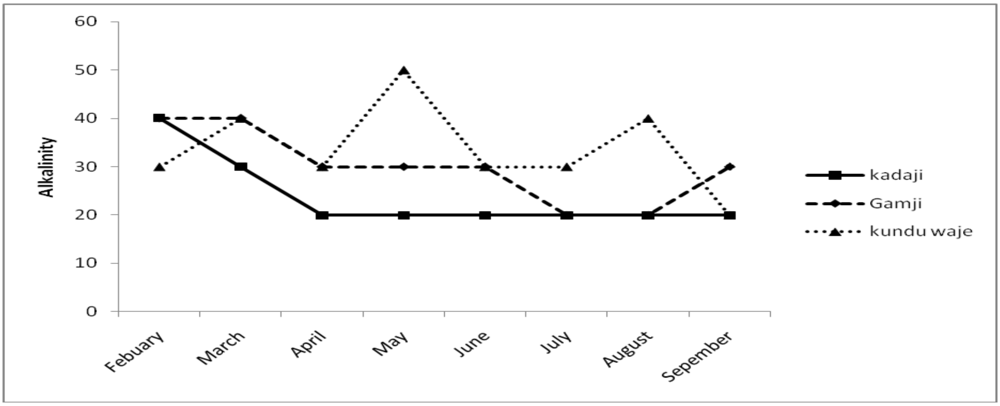

Figure 6: Monthly variation of Alkalinity in Ajiwa reservoir

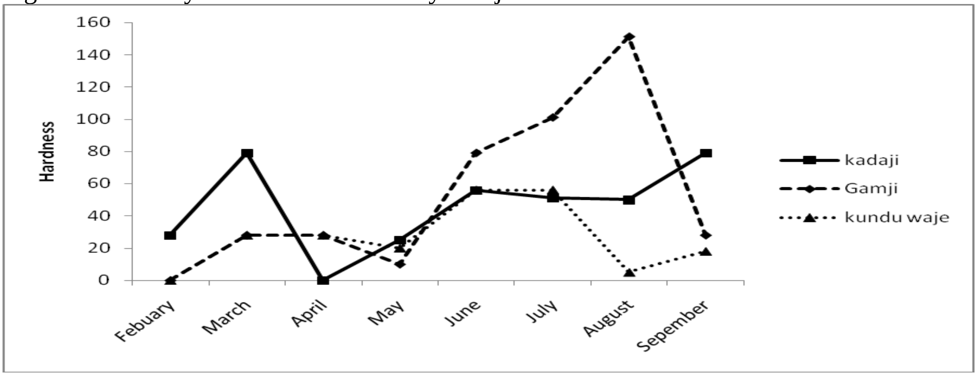

Figure 7: Monthly variation of hardness in Ajiwa reservoir

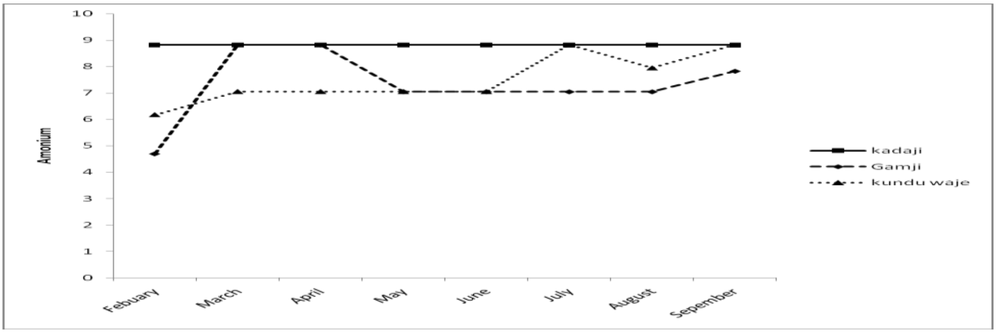

Figure 8: Monthly variation of total ammonia-nitrogen in Ajiwa reservoir

Length-weight relationship and condition factor of *Bagrus bajad* from Ajiwa reservoir

The result of the length - weight relationship of the sampled fish species is presented in Table 2, the coefficient of determination (R^2) varied from 0.61 in Kundu-waje to 0.72 in

Gamji. The intercept (a), also varied from 0.79 in Kadaji to 1.25 in Gamji while the growth exponent (b), varied from 0.85 in Gamji to 1.16 in Kadaji. All the fish species had negative allometric growth (b<3). The highest condition factor (K) was 1.10 in fish from Kundu-waje, while least was 0.92 from Kadaji and the combined K for the water body was 1.02, while b was 1.00.

Table 2: Length-weight relationship and condition factor of *Bagrus bajad* at three stations in Ajiwa reservoir

Stations	a	b	R^2	K	Growth type	Length-Weight equation
Kadaji	0.79	1.16	0.67	0.92	Negative Allometric	Log W = Log 0.7867 + 1.1556L
Gamji	1.25	0.85	0.72	1.05	Negative Allometric	Log W= Log 1.2537 + 0.8493L
Kundu-waje	0.87	1.09	0.61	1.10	Negative Allometric	Log W= Log 0.8742 + 1.0906L
Combined	1.02	1.00	0.67	1.02	Negative Allometric	Log W = Log 1.0214 + 0.9992L

DISCUSSION

Water quality parameters are affected by environmental factors both natural and anthropogenic, hence, the spatial and temporal variations observed by different researchers (Sadauki *et al*., 2022). The changes in temperature might be as a result of seasonal variation, the low water temperature recorded in some months may be due to the characteristics of cool weather while the relatively high-water temperature in other months might be due to the low water level and higher atmospheric temperature (Ikongbeh *et al*., 2013; Sadauki *et al*., 2022). The temperature of the reservoir is low around February and March and rises around April to July but decline again. The observation can be largely attributed to changes in atmospheric temperature. According to Dauda *et al*. (2015), there are about four temperature regimes in Katsina 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. The water temperature is similar to the finding of Sadauki *et al*. (2022) in Ajiwa and Zobe reservoir; Ibrahim and Abdulkarim (2017) in Ajiwa reservoir; Ibrahim *et al*. (2009) in Kontagora reservoir and Obaroh *et al.* (2016) in river Argungu. The transparency was within the acceptable range for tropical fish species, the highest value recorded in the month of March may be as a results of low organic loads in the water, while the low transparency in the month of July maybe as a results of runoff and high organic loads of the early rainy season, the results is similar to the findings of Sadauki *et al*. (2022) in Ajiwa and Zobe reservoir; Ibrahim and Abdulkarim (2017) in Ajiwa reservoir; Ibrahim *et al*.(2009) in Kontagora reservoir and Bala and Bolorundo (2011) in Sabke reservoir. Turbidity is a measure of suspended organic materials that interferes with the passage of light (Agbabiaka, 2014).

Dissolved oxygen is by far the most important parameter for the well-being of fishes, where low dissolved oxygen levels are responsible for most fish mortality. The amount of dissolved oxygen in Ajiwa Reservoir during the study period indicates the water to be in good condition and will support optimal fish production (Dauda and Akinwole, 2014). Low dissolved oxygen was observed in August and September in the reservoir, a possible reason for this may be due to the dilution effect of the physical properties of the study area, which is related to larger-scale photosynthetic events.

Generally, the total ammonia-nitrogen reported in this study appears high, however it should be noted that it is total ammonia nitrogen and not just ammonia (unionized) as reported by Bala and Bolorunduro (2011) in Sabke reservoir and Olanrewaju *et al*. (2017) from Eleyele reservoir in Ibadan. According to Dauda *et al*., (2014) tropical fish species can tolerate TAN of up to 8.8 mg/L. Ammonia-nitrogen is the most significant nitrogenous metabolite that results from the breakdown of organic particle and could be toxic to aquatic organisms beyond the recommended level. The observed trend in this experiment showed a decline in the month of February, despite the majority of the total ammonia-nitrogen in the reservoir being at the same range. The higher ammonia-nitrogen in the rainy season, especially the later part, could be associated with breaking down of organic particle in the run-off, which might likely have influenced the observed lower pH within the same period. Generally, All the physico-chemical parameters are within the acceptable range suitable for tropical fish species (Hassan *et al*., 2014).

The length- weight relationship of the studied fish species showed a negative allometric growth pattern with the slope (b) values less than 3.0 in all the stations. This suggests that the rate of growth in length is higher than growth rate in weight. According to Adeyemi *et al*. (2009), the negative allometric growth pattern of fish suggested that the increase in body weight was less than the cube of body length. Dan Kishiya *et al*. (2018); Ikongbeh *et al*. (2013); and Ibrahim *et al*. (2012) all reported negative allometric growth patterns in *Bagrus bajad* and this is due to the morphology of the fish as a slim and dorsal-ventrally compressed fish species, and not really an implication of poor health.

The condition factor is a useful index for monitoring of feeding intensity, age and growth rates in fish (Ndimele *et al*., 2010). The condition factors (K) of the species (average of 1.02) in the present study indicated that the fish species were in good physiological condition in the Reservoir (Jenyo-Oni *et al*., 2014). This could be attributed to availability of food and suitability of the water quality to support their well-being. A similar finding has been reported by other researchers from different water bodies (Ibrahim *et al*., 2012; Alhassan and Anso-darko, 2011; Malami and Magawata, 2010; Neimat, 2003).

CONCLUSION

The study revealed that the water quality parameters are similar among the selected stations, except for total ammonia-nitrogen that is higher in Kadaji. All the water quality parameters are within the range for tropical fish species. So, Ajiwa reservoir cannot be said to be under pollution stress, and it is suitable for fish production and other domestic uses. The study also showed that the *Bagrus bajad* in Ajiwa reservoir exhibits negative allometric growth even though the species are in good physiological condition as dictated by the condition factor.

It is recommended that there should be continuous monitoring of the water quality and biological condition of the important fish species in the water body for early detection of problems. Also, people living around the water body should be educated on activities that could have negative impacts to the water, so that they can avoid or limit such practices to the barest minimum.

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