Influence of water quality on the zootechnical (biological) performance of*Clarias gariepinus*at different stages of development in some fish farms withinFako Division, South West Region of Cameroon

ABSTRACT

The problem of water quality in fish farms that could be associated with poor feeding and water quality managementImpacts the life of aquatic animals. Fish needs a healthy environment for Its optimal growth and development(case study of Catfish). The objective of this studied was to determine the influence of water quality on the biological performance of *Clarias gariepinus* in some fish farms within Fako Division-South West Region of Cameroon.*Material and methods:*The method used in this research topic is descriptive, with 4 different localities, namely IRAD Batoke(A), Bakingili (B), Cornelius Fish Center (C) and Oumarou fish farm (D) Mile 2 Limbe. Collection of physicochemical and biological data was conducted from the period of March 8th to May 15th2023 in Fako Division. *Results:*The results revealedhighest mean temperature value (28.22±0.94ºC) in IRAD Batoke broodstocks tanks while Cornelius fish Center had the highest mean pH, electrical conductivity and total dissolved solid with values of 8.16±1.25; 0.84±0.35ms/cm; and 0.38±1.8ppt in the broodstocks tanks and table fish tanks. The highest dissolved oxygen (<8mg/l); highest nitrite level (<0.025mg/l) and highest Ammonium (<0.05mg/l) were noted in three localities except the Bakingili locality. The physicochemical parameters of water had no negative impacts on the growth performance of this species. *Conclusion:*The results of physicochemical parameters such as water temperature, pH, and electrical conductivity, total dissolved solid, NH_4, NO_2, O_2obtained during the study experienced a relative variation and were very suitable for *Clarias gariepinus* life.

Key word: South West Region, Tanks, Physicochemical parameter of water, *Clarias gariepinus*, Zootechnical performance

1. INTRODUCTION

Fish need a decent environment for their living and livelihood. Fish species that have additional organs as a means of breathing such as catfishcan tolerate fairly extreme water conditions, but in order to develop optimally, water quality parameters need to be within their recommended ranges. Decreasing water quality will disrupt growth and enhance the proliferation of disease causing agents that grow and develop in low-quality waters.Ayuniar and Hidayat (2018)[1]stipulated that fish farming activities will be successful if we can manage the water quality of the cultivation media, seeds, and feed provided. Catfish can survive in unfavorable environmental conditions; according to Dauhan and Efendi (2014)[2]the water quality parameters of water to be used for the culture should be those that can support growth adequately. Physical parameters that need to be considered are temperature, pool water depth, turbidity level, TSS, or the presence of dissolved solids. Chemical parameters that also need to be controlled are DO, carbon dioxide, water pH value, the amount of Nitrate, Phosphate, and ammonia presence.

Physiologically, dissolved oxygen and temperature are essential for sustaining aquatic lives [3]. Additionally, nutrients enrichment mostly phosphorus and nitrogen stimulates unnecessary primary production, which can reduce oxygen.The changes in physical characteristics like temperature, conductivity, transparency and chemical elements of water (dissolved oxygen, and nitrite) provides valuable information on the quality of the water. According to Valetta (2013)[4]increase in temperature is known to speed up biochemical activities of metabolism; stimulated by heat energy. Turbidity is also a key water-quality characteristic because its effects on light transmission and water clarity define habitat characteristics.

Furthermore, water pH regulates aquatic chemistry, which can affect water use and habitats. The health of an aquatics ecosystem is highly depended on the physicochemical and biological characteristics of the water [5]; [6]. Changes in fish populations can be indicators of aquatics ecosystem health [7]. The existence and richness of fish species can be associated to the physical and chemical properties of water [8]. Reduced water quality is reported to affects fish communities by impacting habitat, food availability, and dissolved oxygen levels, which in turn influence their growth potential and reproductive abilities [9]. Thus, the present study was designed to determine the influence of water quality on the biological performance of *Clarias gariepinus* in some fish farms in the South West Region precisely Fako Division in Limbe 1, Limbe 2 (IRAD Batoke) and Bakingili Subdivision(Figure 1).

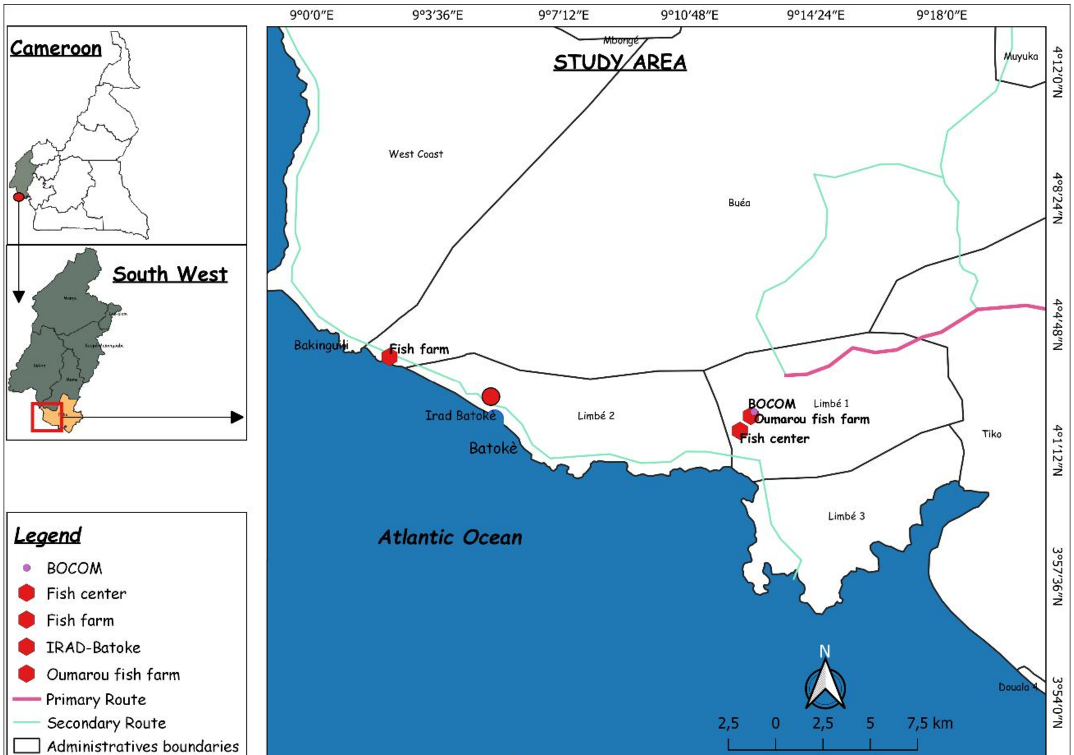


Figure 1**:** Location of study Area (Tabe, 2023)

2. MATERIAL AND METHODS

Physical parameters (Temperature,pH,Electrical conductivity, Total dissolved solid) were measured *insitu* using Hannah portable meter model HI98129. Transparency of the water was detected by eye observation while chemical parameters (NH_4; NO_2; O_2were measured *exsitu*using a Pro JBL AQUATEST Kit. The data collection was done from Tuesday to Friday; a day each per farm from 7-8am .

2.1. Experimental protocol

The Multiparameter was into each fish tank temperature, pH, electrical conductivity and total dissolved solid.The multiparameter was rinsed each time prior to using in another tank.

Thereafter, water was collectedfrom each fish farm and transported in an ice chest to IRAD-Batoke Laboratoryfor analysisusing a Pro JBL AQUATEST KIT.

To determine the biological parameters, the tanks were emptied very early in the morning before feeding and the fish were captured using a deep net and introduced into well-cleaned tanks. Using an electronic scale, the fish in each tank were weighed to determine the total weight (biomass) of fish then a count was made in order to have the total number of fish in the respective tanks. Using an ichthyometer, the total length and the standard length were measured for a sample of 10 -20 fish. This was done at the beginning and at the end of the experiment in order to have the initial and final weights. In the end this allowed us to calculate weight gain and Condition factor as follows:

- The initial average weight (Wi) and the final average weight (Wf); which corresponds to the total initial and final weight (biomass) divided by the total initial and total final fish number respectively.
- To calculate the total weight gain, it had being giving by the formula:

Total weight gain = Wf-Wi

At the end of the experiment, each fish was weighed and length measured. These individual data made it possible to calculate the K-factor using the formula:

$$K=W/L^3$$

W= fish weight (g)

L = total length of fish (cm)

2.2. Statistical analysis

The data collected was processed using Microsoft Office Excel 2013. One-way analyzes of variance (Anova) and, the Kruskal-Wallis test was performed to test for significance $p < 0.05$ using Statistical Package for Social Science (SPSS).

3. RESULTS AND DISCUSSION

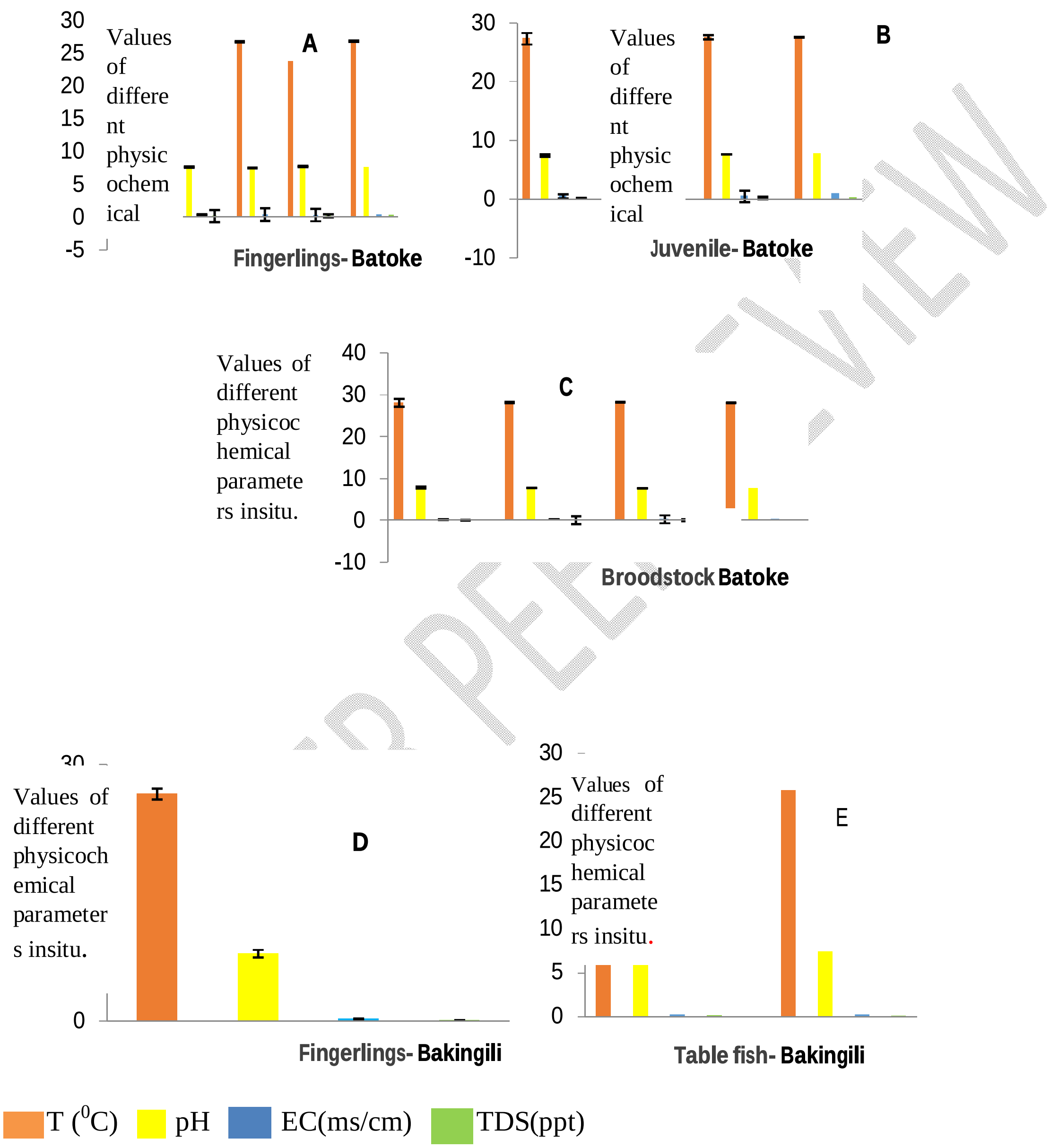
3.1. RESULTS

3.1.1. Physicochemical parameters measured insitu

The results for be seen in Figure 2 and Figure 3below.

The values of the different physicochemical parameters insitu in the various tanks such as T(^{0}C), pH, EC(ms/cm) and TDS(ppt)) in the fish farms of IRAD Batoke (five tanks fingerlings, four tanks juvenile and four tanks broodstock) (Figure 2 A, B & C);

Bakingili(one tank fingerlings and two tanks table fish) (Figure 2 D & E); Cornelius fish center (two tanks juvenile, one tank table fish and one tank broodsock) (Figure 2 F,G & H) and Oumarou fish farm (one tank table fish and seven tanks broodstock) (Figure 2 I & J) were not significantly different (P>0.05) as seen below.



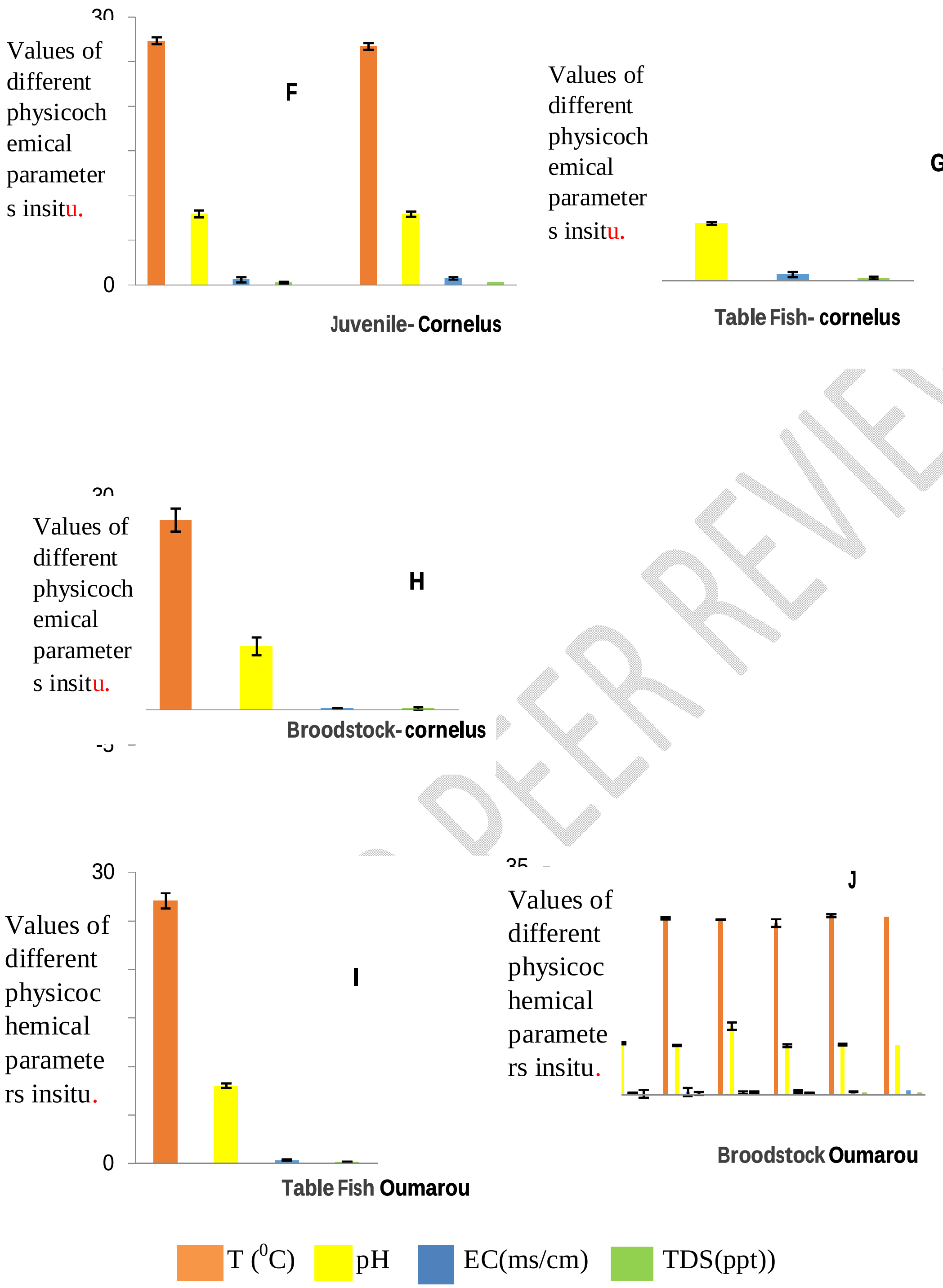


Figure 2: Physicochemical parameters of water in tanks among four fish farms studied

The comparative studies of physicochemical parameters *insitu* among the four different fish farms as seen in figure 3such as

Fingerlings tanks Batoke (5t) Compared to fingerlings tanks Bakingili (1t)

As illustrated on figure 3A below, the parameters variation for mean temperature was relatively high in Batoke fingerlings, but not significantly different (P= 0.611) from those of the fish farm in Bakingili while the Bakingili Station had a higher pH with P=0.280, which was equally not different from those of the fish farms in IRAD-Batoke .

Comparison of juveniles tanks Batoke(4t) / Cornelius Fish Center(2t)

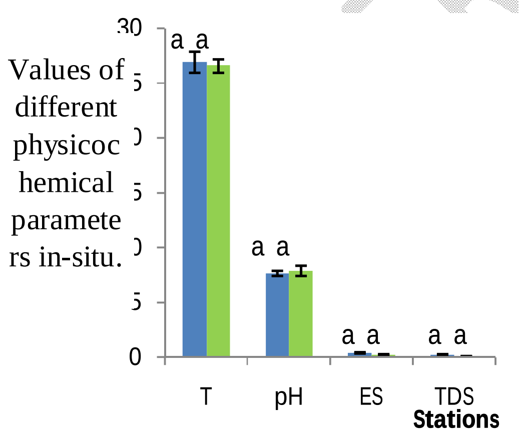
From the figure 3B below, the mean temperature, were higher in Batoke juveniles tanks, but not significantly different (P=0.201) from those in Cornelius fish center, while the Cornelius Fish Center had a higher pH, EC, and TDS with P=0.172, P=0.395, P=0.000 respectively.

Table Fish Tanks Bakingili(1t)/ Cornelius Fish Center(1t) /Dr Oumarou(1t)

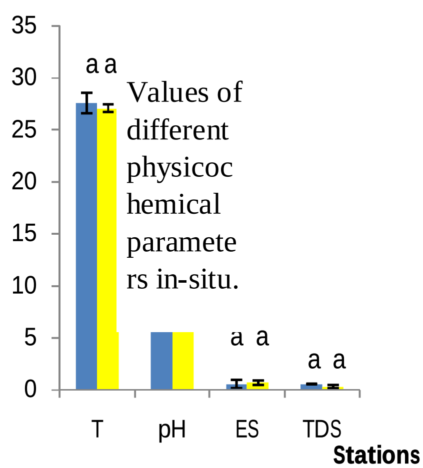
From figure 3C below, according to the parameters variations of table fish, the mean Temperature and EC were significantly higher with P=0.002 and P=0.000, respectively in Cornelius fish farm while the station of Oumarou had significantly (P=0.034).

Comparison Broodstocks Tanks Batoke, Cornelius and Dr Oumarou Fish Farms

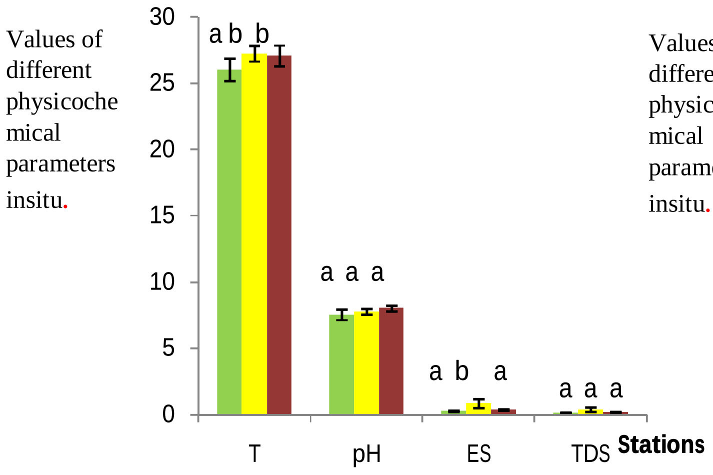
From figure 3Dbelow, according to the parameters variations, the mean Temperature was significantly (p=0.000) higher in Batoke fish farm and but EC was higher, but not significantly different (P=0.472). While the station of Oumarou had a higher pH, which was however not significantly different with p=0.588.



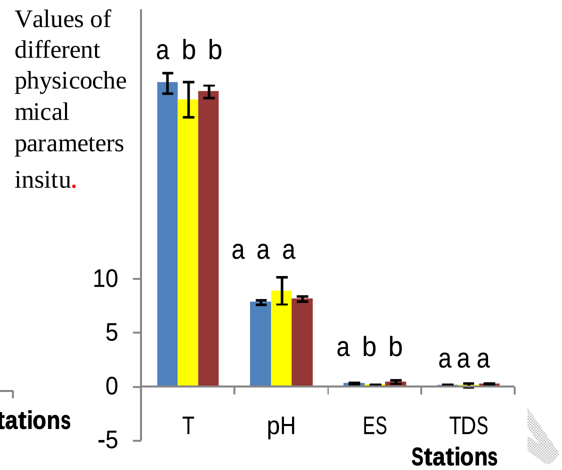
A) Water parameters of fingerlings tanks of Batoke compared to Bakingili



B) Water parameters of juvenile’s tanks Batoke compared to Cornelius



C) Water parameters in Table fish tanks of Bakingili(1t) / Cornelius(1t) / Oumarou(1t)



D) Water parameters of Broodstocks tanks Batoke; Cornelius & Oumarou

Batoke Bakingili Cornelius Oumarou

$p < 0.05$, compared with same parameter (T (^{0}C), pH, EC (ms/cm), TDS (ppt)

The values that affects the same letters had no significant different

Figure 3: comparative analysis of water parameters of tanks in four different localities of Fako Division, South West Region of Cameroon

3.1.2. Physicochemical parameters ex-situ

The results of water quality parameters for physicochemical measured situ such as dissolved oxygen, Nitrite and Ammonium for catfish broodstock tanks for the various farms is presented in Table1.

Table 1: physicochemical parameters ex-situ for catfish (*Clarias gariepinus*) tanks

Parameters	IRAD Batoke	Cornelius	Oumarou fish farm
NH_4	<0.05mg/l	<0.05mg/l	<0.05mg/l
NO_2	<0.025mg/l	<0.01mg/l	<0.01mg/l
O_2	<8mg/l	<8mg/l	<8mg/

3.1.3. Evolution of biological parameters of Africa catfish (*Clarias gariepinus)*

Some biological parameters of Africa catfish were collected during the research period in the four (04) different fish farms and their results obtained; as shown on Table 2. Theresult showedthat zootechnical performance of *Clarias gariepinus* for all the tanks of different stations was favourable. The growth of fingerlings for Batoke fish farm was remarkable greater than that of bakingili fingerlings.

Table 2:**Biological parameters of Africa cat fish**

Clarias gariepinus	**Stations**	**Biological Parameters**					
		Mean number of fish per tank	Initial mean Weight(g)	Final mean Weight(g)	Total weight Gain(g)	Total length(cm)	Standard length(cm)
Fingerlings	Batoke	6864	4.65	44	39.54	11.23±2.33	9.21±2.14
	Bakingili	2000	3.46	38.50	35.04	9.31±1.01	8.31±1.25
Juveniles	Batoke	1200	94.67	243.11	148.44	24.27±9.41	21.04±8.44
	Cornelius	5000	98.25	260.50	162.25	23.54±8.08	19.62±6.60
Table fish	Bakingili	60	205	1307	1102	34.86±5.82	31.67±6.23
	Cornelius	10000	212	535	323	36.12±9,54	33.07±7.55
	Oumarou	30	245	376	131	37.34±9.78	33.64±7.78
Broodstocks	Batoke	35	1519.5	2048.50	529	75.24±25.53	67.12±25.94
	Cornelius	100	2400	3700	1300	68.26±9.42	59.23±23.59
	Oumarou	145	1134.14	2177.14	1043	78.44±12.79	66.92±13.91

3.2. DISCUSSION

Based on the results of water temperature measurements during the study, the results were relatively constant and following the quality should follow the water temperature was very suitable for *Clariasgariepinus* growth and development. Water temperature in IRAD Batoke station was 26.92±0.94ºC, in Bakingiliwas 26.58±0.61ºC for the fingerlingstanks. According to the suitable temperature range for *Clariasgariepinus* farming this varies from 23-30 ºC[10].So based on research that has been carried out, the temperature range during the research period on *Clariasgariepinus* farming still meets the feasibility conditions and is good enough for *Clariasgariepinus* farming. Too high temperature will damage the process of growth by preventing enzyme activity in cells. Temperatures less than the ideal range can cause a decrease in processing efficiency, increasing the toxicity of an aquatic organism pollutant[7]. Temperature values at the four different studied fish farms are still classified as supporting the growth rate of *Clariasgariepinus* and do not have adverse effect on the other parameters.

The results of water pH during the period of measurement with the highest mean pH recorded in Cornelius Fish Center Farm had the mean pH value of 8.16±1.25 in the Juveniles tanks**.** Hence, the pH range measured in this study is still classified as the optimum pH to support *Clarias gariepinus* life. According to a suitable pH for *Clarias gariepinus* farming ranges from 6.5 to 8.5 pHwhich is high or above 8.5, can cause increased toxicity in the water, but if the pH is low or below 6.5, it can inhibit the growth rate of *Clarias gariepinus*. Ndubusiet *al*.(2015)[11]stated that microorganisms generally have growth conditions with a pH of 4-9.5. Ammonium compounds that can be ionized are found in waters that have a low pH.Ammonium isnot toxic, but at high pH conditions, there is more ammonia that is not ionized and is toxic. So, based on research that has been carried out, the pH range during research on *Clariasgariepinus* maintenance in the four stations metthe recommendation and is good enough for catfish farming.
the highest mean electrical conductivity recorded during the period of experiment was 0.84±035ms/cm in Cornelius fish farm in table fishtanks. Also, the highest mean for total dissolved Solid of 0.38±18ppt recorded in Cornelius table fish farm.

Dissolved oxygen measurements were within the recommended range reported by [12]for *Claris gariepinus* in all farms except in the fish farm in Bakingili.

The values for nitrite obtained in IRAD Batoke, Cornelius fish center and Oumarou fish farm were <0.025mg/l; <0.01mg/l and <0.01mg/l, respectively. According to Chapman and Kimstach (1996)[13]mean concentration of 1.8 mgL^{-1} of nitrite was found to be the upper recommended limit for *Clarias gariepinus* survival and growth. Nitrite concentration in reservoirs range from less than 1.0 mgL^{-1} to 5.0 mgL^{-1}.

Ammonium measurements obtained in the broodstock tanks at IRAD were<0.05mg/l; <0.05mg/l and <0.05mg/l, respectively with all being within the recommended range as reported by Viveen *et al.* (1985)[12].

The biological data collected revealed favourable biological performance as culture conditions in the various farms were within the optimal levels for *C. gariepinus*. This was due to the fact that physicochemical parameters of water werecarefully monitored and controlled. However, there was an exceptional case for the zootechnical performance of fingerlings tanks inIRADBatoke/ Bakingili; for which the growth performance was more favourable in Batoke fingerlings compared to Bakingili. This could be due to the methods of feeding, since IRAD BatokeStation feeds appropriately with high quality feeds which are extruded compared to Bakingili and the other fish farms (Cornelius and Oumarou) where feeds of variable quality (locally pelleted feeds often used with extruded feeds from time to time).

4. CONCLUSION

This study revealed a strong correlation between fish tanks, water quality parameters and the zootechnical performance of the fish in all the studied localities. Thus the need to maintain healthy water quality through appropriate feeding and water quality management approaches. The study also revealed that, although the African catfish can tolerate poor water conditions, optimal water quality is crucial for its optimal growth and development. These findings are relevant to the fish production sector for the sustainable production of the African catfish.

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