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SURVIVAL RATE, GROWTH AND CONDITION INDEX (FACTOR) OF TANK RAISED AFRICAN CATFISH (*Clarias gariepinus)* FINGERLINGS AT DIFFERENT LEVELS OF OXYGEN CONCENTRATION

[1]Ayim, E. M,[1]Akwari, A. A.[2]Okon, T. J, [3]Charles, V. M.

[1] Department of Animal and Environmental Biology, Faculty of Biological Sciences, Cross River University of Technology, Calabar

[2] Department of Fisheries and Aquatic Resources Management, Faculty of Agriculture, University of Calabar, Calabar.

[3]Department of Zoology and Environmental Biology, Faculty of Biological Sciences, University of Calabar, Calabar

Abstract

Dissolved oxygen (DO) refers to the level of free, non-compound oxygen present in water or other liquids. It is an important factor in assessing water quality because of its influence on the organisms living within a body of water.This study was carried out to determinethe survival rate, growth and condition factor of tank raised *Clarias gariepinus* fingerlings at different levels of oxygen concentration. One hundred and twenty fingerlings of *Clarias gariepinus*, were reared for 10 weeks under four different oxygen levels: TankA (1 air stone); TankB (2 air stones); TankC (3 air stones) and TankD (4 air stones). The result of the study revealed a better growth in fish reared in TankC and TankD, as reflected in feed conversion ratio (FCR) and feed conversion efficiency (FCE) of the fingerlings. The growth performance indices (g/day) of *C. gariepinus* reared under different oxygen concentration revealed a better growth in TankC (3 air stones), weight gain was higher with a value of 613.00± 4.00g/kg for bulk weight and a length gain of 14.30 ±0.76cm, followedby fish in TankD with a weight of 545.50 ± 5.50 g/kg and a mean length gain of 14.85±1.04cm. Analysis of Variance (ANOVA)revealed that there was a significant difference ($P<0.05$) in weight gain and length increment across the four treatments. The condition factor was not significantly different in the initial condition of the fish stocked ($P>0.05$) but there was a significant difference ($P<0.05$) in the final condition factor of the fish (k). pH and Temperature measured were within the ranges for fish culture. Conclusively,high concentration of dissolved oxygen (DO) in pond/tank water plays a key role in influencing the growth of fish in fish farming.

Key words: *Clarias gariepinus*, Survival rate, Growth, Plastic tanks, Dissolve Oxygen, Concentration.

1.1 Introduction

Fish is an important component of total human food and to a lesser degree of animal feed, it has been found nutritionally to be better than meat in terms of the quality of protein content with good amino acid profile. It has also been found rich in essential amino acids and minerals, and low in saturated fatty acids. Thus, the culture of fish has become an innovative technology aimed at producing large quantity of fish food for the ever-increasing human population in Nigeria (Qayyum *et al*., 2005, Ayim*et al.,* 2018), and its production contributes to the livelihoods and also fulfills the nutritional demand for millions of people.

The availability of suitable ecological conditions for the fish depend upon certain water quality parameters like dissolved oxygen, temperature, pH and ammonia. Failure to maintain an adequate water quality regime in ponds may cause parasitic infection or other diseases in fish (Qayyum *et al*., 2005).

African catfish *(Clarias gariepinus)* is a species of catfish of the family Clariidae. The fish is cultured in several countries throughout Africa as well as in Europe, Asia and South America (Ayim*et al*., 2018). Interest in the culture of *C. gariepinus* is increasing in Nigeria because of its high growth rate,good flesh quality, tolerance to poor water quality, acceptance of cheap feed and disease resistance (Opiyo*et al*., 2017, Fola-Matthews *et al.,* 2018).

2.0 Materials and method

2.1 Description of the study area

This research work was undertaken at the Science Laboratory of the Department of Zoology and Environmental Biology, University of Calabar, Calabar, Cross River State, Nigeria. Cross River State is located at latitude 4°34’59.99’’N and longitude 8°24’59.99’’E. Calabar is situated at an elevation of 98 meters above sea level. It is the biggest city in Cross River, with an area of 406 $km^{2.}$ Administratively, the city is divided into Calabar Municipality and Calabar South Local Government Areas. The state shares a common border with Cameroon to the East, Benue state to the north, Ebonyi and Abia State to the west and to the South by Akwa-Ibom and the Atlantic Ocean.

2.2 Collection of experimental materials andexperimental fish

Clarias gariepinus fingerlings (four weeks old) of average weight of 5g and average bulk weight of 50.00± 0.00g per treatmentwas purchased from the Department of Fisheries and Aquatic Resources Management Hatchery Complex, University of Calabar and used for this study. The fish samples purchased were transported to the location of the study in a 20 liter water storage can.Plastic aquaria/tanks were procured from Watt Market, the air stones were purchased from a scientific equipment store located in Lagos, aerator air pumps were obtained from the Department of Zoology and Environmental Biology Laboratory.

2.3 Experimental set up

Experimental plastic tanks were used to setup the experiments, air stones connected to aerator air pumps were used to apply different levels of oxygen to the tanks. Air stones release thousands of bubbles that aerate water and transport toxic gasses from water near the substrate to the surface for dissipation.

The experimental setup consisted of four (4) tank rows, done in triplicate, making it a total of twelve(12) tanks, connected to the aerator air pumps. Different levels of oxygen in the tanks were regulated by increasing the number of air stone in the tanks (TankA: 1 (one) air stone, TankB: 2 (two) air stones, TankC: 3 (three) air stones and TankD: 4 (four) air stones respectively). The experimental tanks were supplied with dechlorinated bore-hole water prior to the commencement of the experiment.The experimental fish was fed with Coppens commercial pellet feeds of 45% crude protein at 5% body weight for 70 days daily (twice). Unconsumed feed was controlled daily to ensure good water quality in the system.

2.4 Acclimation and Stocking of experimental fish

Fish fingerlings were randomly distributed to 12 tanks (10 fish per tank) and acclimated for 14 days prior to the introduction of the aerator stones.

2.5 Monitoring of the tank condition of the fish for water quality

Water quality parameters monitored included; Water temperature, pH and dissolved oxygen. Water pH (mg/L) and Temperature (^oC) were measured in. Water samples collected for dissolved oxygen analysis were carried in containers with ice blocks and taken to the physicochemical laboratory of the Institute of Oceanography, University of Calabar, Calabar.

2.6 Measurement of length and weight of experimental fish in the tanks

The growth rate (length and weight) and survival rate of the fish was measured every two weeks.Length and weight of individual fish fingerlings was measured using measuring board and sensitive weighing balance. The specific growth rate, weight gain, total body length (cm), and survival rate were determined as follows:

2.7 Evaluation of growth performance and food utilization indices

2.7.1 Growth performance indices

All growth indices were calculated according to De Silva and Anderson (1995) as follows:

Weight gain (g)

WG (g) = $W_2 - W_1$

Where WG = Weight gain

W_2 = Final weight

W_1 =Initial weight

Length increment (cm)

This is given as final length (L_2) – initial length (L_1)

Growth rate (GR)

$$GR = \frac{W_2 - W_1}{T \text{ (No. of days)}}$$

Where GR = Growth rate

W_2= final weight

W_1= initial weight

T= No. of days

Specific growth rate (SGR)

This is given as the percentage of weight gain per day

$$SGR = \frac{\text{Ln Final weight}(W_2 - \text{Ln Initial weight } (W_1)}{(\text{Number of days})\ 100 \text{ or } (T_2 - T_1)}$$

Where: W_2=Final weight at end of time T_2

W_1=Initial weight at beginning of time T_1

Ln=base of natural logarithm

Percentage weight gain

This is given as $100 \frac{(W_2-W_1)}{W_2}$

Where W_2=final weight

W_1=initial weight

2.7.2 Food utilization indices

This was also calculated according to De Silva and Anderson (1995) as follows:

Food consumed (g)

This is given as 5% X body weight X No. of days

Food conversion ratio

This is given as: $\frac{\text{Feed consumed (g)}}{\text{Weight gain (g)}}$

Food conversion efficiency

This is given as: [Weight gain (g)/Feed consumed (g)]100

2.7.3 Determination of fish mortality

This was calculated by counting the number of dead fishes in course of the experiment.

2.7.4Determination of condition index of the fish

The condition factor, symbolized by K (Fulton's condition factor) which is the degree of wellness of a fish was determined as follows:

$K = \frac{W}{L^3} \times 100$……………………… (Fulton's equation)

Where: K = condition factor

W = weight of fish (g)

L = Length of fish

K was recorded for all the experimental fish samples.

2.8 Statistical analysis

Data obtained were analyzed using analysis of variance (ANOVA) to determine the level of significant difference in the growth indices, food utilization indices, condition factor (k) and Survival rate of the fish. Means were separated using Duncan's test. Thedata were analyzed using Statistical Package for the Social Science (SPSS) software (Version 22).The data were presented as mean and with a P-value that was considered significant at $P \leq 0.05$.

3.0 Results

3.1 Growth performance indices, food Utilization indices and condition factor of *C.gariepinus* reared under different Oxygen Concentration

Results for growth performance indices (kg/day), food utilization indices and condition factors of *C. gariepinus* reared under different oxygen concentrations (Table 1) showed that the prime growth came from fish in Tank C (3 air stones), weight gain was higher with a value of 613.00± 4.00 g/kg bulk weight and a length gain of 14.30 ±0.76cm, followed by fish in Tank D with a weight of gain of 545.50 ± 5.50 g/kg bulk weight and a mean length gain of 14.85±1.04cm, Tank B had a bulk weight gain of 535.35 ± 3.05 g/kg and a mean length of 13.98±0.48cm and the lowest weight gain was recorded in Tank A with a value of 439.35± 7.65 g/kg and a mean length of 13.97± 0.90cm. Analysis of Variance revealed that there was a significant difference ($P<0.05$) in weight gain and length increment across the four treatments.

For growth rate and specific growth rate (kg/day) of *C. gariepinus* reared under different oxygen concentration,fish in tank

C had a better growth rate with a value of 8.75± 0.55, and a specific growth rate of 3.69±0.01, followed by fish in Tank D with a growth rate of 7.79 ± 0.80 kg and a specific growth rate of 3.54±0.01, Tank B, had a growth rate of 7.64 ± 0.45kg and a specific growth rate of 3.51±0.01 and the lowest growth rate was recorded in Tank A with a value of 6.28 ± 0.11 kg and a specific growth rate of 3.26±0.20. Analysis of Variance showed that there was a significant difference ($P<0.05$) in their rates of growth and in the specific growth rate. Food conversion efficiency (FCE) of *C. gariepinus*reared under different oxygen concentration showed that in Tank A (1 air stone) food conversion efficiency was 89.43± 0.97% while the food conversion ratio was 1.12 ± 0.10 %, for Tank B (2 air stones), the food conversion efficiency was 80.99 ± 0.24 % with a food conversion ratio of1.23 ± 0.05 %, in Tank C (3 air stones), the food conversion efficiency was 67.37 ± 0.13 % and a food conversion ratio of 1.48 ± 0.05 %, and in Tank D (4 air stones), the food conversion efficiency was 71.70 ± 0.17 %, followed by a food conversion ratio of 1.39 ± 0.01%. Analysis of Variance showed that the food conversion efficiency and food conversion ratio were significantly different ($P<0.05$)

The condition factor (k) of *C. gariepinus* reared under different oxygen concentration (table 1) and (figure 1) showed that in tank A (1 air stone), condition factor ranged from 4.76±0.29 to 0.55±0.02. For fish in tank B (2 air stones), condition factor ranged from 5.06±0.24 to 0.75±0.06. For fish reared in tank C (3 air stones), condition factor ranged from 4.71±0.18 to 1.11±0.018.For fish in Tank D (4 air stones), condition factor ranged from 5.70±0.45 to 0.99±0.07. The condition factor as represented by the figure was higher initially and reduced with time as the fish grew in length and weight. There was no significant difference in the initial condition of the fish stocked ($P>0.05$) as reflected in the values but there was a significant difference ($P<0.05$) in the final condition factor of the fish (k).

Table 1: Mean growth performance, Food Utilization indices and condition factor of *C.gariepinus* reared under different Oxygen Concentration

Indices	Tank A	Tank B	Tank C	Tank D	P-value
Initial weight (g)	50.00±0.00	50.00±0.00	50.00±0.00	50.00±0.00	
Final weight (g)	489.35±7.65	585.35±3.05	663.00±4.00	595.50±5.50	
Weight gain (g)	439.35±7.65^{a}	535.35±3.05^{b}	613.00 ± 4.00^{c}	545.50 ± 5.50^{d}	0.000005
Initial Length (cm)	3.74± 0.5	3.65±0.05	3.52±0.02	3.49±0.07	
Final length (cm)	17.71± 0.04	17.63±0.43	17.82±0.77	18.34±0.98	
Length gain (cm)	13.97 ± 0.90^{a}	13.98 ± 0.48^{b}	14.30 ± 0.76^{c}	14.85 ± 1.04^{d}	0.785
Growth rate	6.28 ± 0.11^{a}	7.64 ± 0.45^{b}	8.75± 0.55^{c}	7.79 ± 0.80^{d}	0.000021
SGR	3.26 ± 0.20^{a}	3.51 ± 0.01^{b}	3.69± 0.01^{c}	3.54 ± 0.01^{d}	0.00063

PWG	0.90 ± 0.00[a]	0.92 ± 0.01[b]	0.92 ± 0.05[c]	0.92 ± 0.00[d]	0.028
Food consumed	392.84± 2.59[a]	433.58±1.19[b]	413.00±3.50[c]	391.13±3.04[d]	0.001
FCE	89.43 ± 0.97[a]	80.99 ± 0.24[b]	67.37± 0.13[c]	71.70± 0.17[d]	0.000042
FCR	1.12 ± 0.10[a]	1.23± 0.05[b]	1.48± 0.05[c]	1.39 ± 0.01[d]	0.000069
Initial CF	4.76 ± 0.29[a]	5.06 ± 0.24[a]	4.71 ± 0.18[a]	5.70 ± 0.45[a]	1.63
Final CF	0.55± 0.02[a]	0.75 ± 0.06[a]	1.11 ± 0.018[a]	0.99 ± 0.07[a]	0.023

* Values represents the mean of the triplicate experimental units and mean with the same superscript are not significantly different (P>0.05)

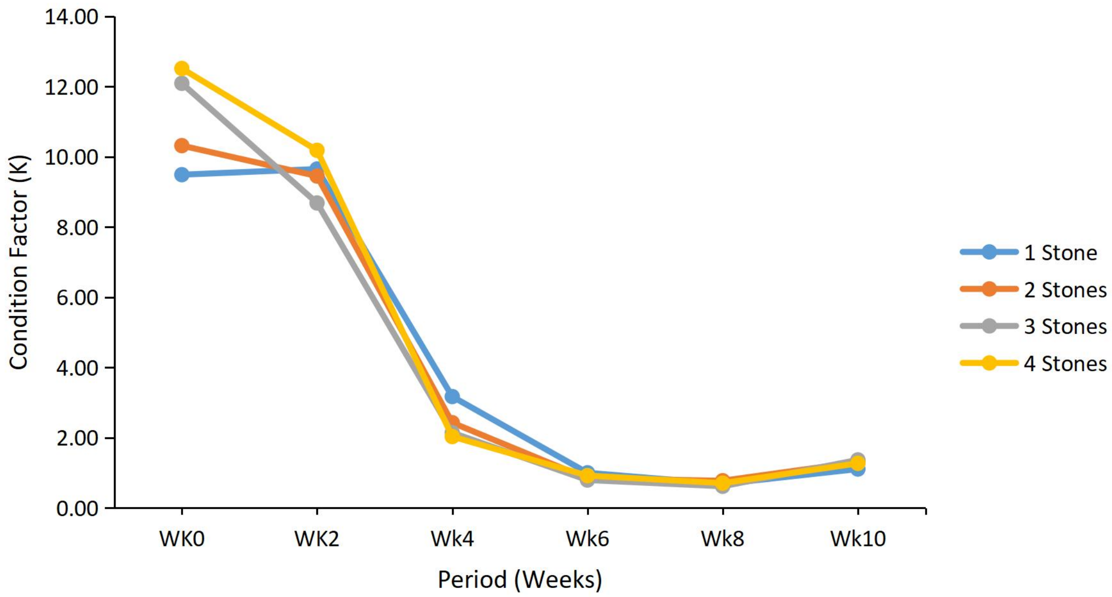

FIG.1: Weekly condition factor of the experimental fish

3.2 Mean survival rate (%) of *C. gariepinus* reared under different oxygen concentration

Table 2 shows a summary of results of the survival rates (%) of *C. gariepinus* reared under different oxygen concentrations. The rate of survival was highest in Tank A and Tank D with a value of (95.00± 5.00%) respectively, tank B and tank C had a survival rate of (90.00 ± 10.00 %) respectively. Analysis of Variance showed that survival rate (%) of fish reared under different oxygen concentrations were not significantly (P>0.05) different from each tank.

Table 2: Mean survival rate (%) of *C. gariepinus* expose to different Oxygen concentration

Period	Tank A	Tank B	Tank C	Tank D	P – Value
No. of fish Stocked	10.00 ± 0.00	10.0 0± 0.00	10.0 0± 0.00	10 .00± 0.00	-
No. Survived	9.50 ± 0.50[a]	9.00 ± 1.00[a]	9.00 ± 0.00[a]	9.50 ± 0.50[a]	0.877
Survival Rate (%)	95.00 ± 5.00[a]	90.00 ± 10.00[b]	90.00± 0.00[a]	95.00 ± 5.00[a]	0.877

* Values represents the mean of the duplicate experimental units and mean with the same superscript are not significantly different (P>0.05)

3.3 Physio-chemical parameters of the experimental units

Table 3 shows the Summary of the mean physio-chemical parameters measured in each of the experimental units for every three days before changing the water (the culture water drained and refilled with fresh water) include: pH, dissolved oxygen (mg/L), water temperature (°C). Results obtained for pHrevealed that in tank A, mean pH ranged from 6.04 ± 0.00 - 6.98 ± 0.02 mg/L. In T_B, mean pH ranged from 6.04 ± 0.00 - 7.04 ± 0.04 mg/L. In T_C, mean pH ranged from 6.04 ± 0.00 - 6.97 ± 0.02 mg/L. In T_D, mean pH ranged from 6.04 ± 0.00 - 6.90 ± 0.05 mg/L. Dissolved oxygen showed that in tank A, mean dissolved oxygen ranged from 6.09 ± 0.00 - 6.69 ± 0.24 mg/L. In tank B, mean dissolved oxygen ranged from 7.04± 0.00 - 8.36 ± 0.24 mg/L. In tank C, mean dissolved oxygen ranged from 9.13 ± 0.60 mg/L - 9.06 ± 0.92 mg/L. In tank D, mean dissolved oxygen ranged from 9.14± 0.05 mg/L - 9.73 ± 0.27 mg/L. Water temperature°Cin all the experimental tanks were within the normal ranges for the culture of fresh water fishes, the highest temperature value was recorded in tank C and D with a mean value of 29.2 ± 0.02 °C respectively and the lowest value of 28.00 ± 0.00 °C was observed in tanks A and B.

Table 3: Mean physicochemical parameters in the treatment tanks

Water Parameters	Tank A	Tank B	Tank C	Tank D
pH (mg/L)	(6.04 ± 0.00-6.98 ± 0.02)	(6.04 ± 0.00-7.04 ± 0.04)	(6.04± 0.00-6.97 ± 0.02)	(6.04± 0.00-6.90 ± 0.05)
Dissolve oxygen (mg/L)	(6.09 ± 0.00-6.69±0.24)	(7.04 ± 0.00-8.36±0.24)	(9.13 ± 0.60-9.06±0.92	(9.14 ± 0.05-9.73±0.27)
Temperature (°C)	(28.0 ± 0.00-28.9±0.06)	(28.00±0.00-28.5±0.04)	(28.00±0.00-29.2±0.02)	(28.00±0.00-29.2±0.02)

* Values represents the mean of the duplicate experimental units

4.0 Discussion

Dissolved oxygen (DO) level plays a key role in water quality in aquaculture and adequate concentrations of oxygen in water are vital to intensive fish farming (Ritola *et al*., 2002). The measurement of oxygen consumption is an indirect way to estimate metabolism in fish (Pichavant*et al*., 2001). DO, besides feed and temperature, is the most important factor governing growth, and a constant DO content below a critical level is considered to decrease feed consumption, growth and feed conversion efficiency (Jobling, 1994). Results for growth performance indices (growth rate, specific growth rate) recorded in these studies revealed a better growth in tank C, weight gain was higher with a value of 613.00± 4.00 g/kg and a length gain of 14.30 ±0.76 cm, and the lowest weight gain was recorded in tank A(439.35± 7.65 g/kg) and a mean length of 13.97± 0.90cm.Analysis of Variance revealed that there was a significant difference ($P<0.05$) in weight gain, length increment, growth rate, and specific growth rate across the four treatments, which is an evidence that moderate hyperoxia may improve the growth of fish and the results tallies with the findings of Dabrowski *et al*., (2004) and Hosfeld *et al*., (2008).Better growth was observed in fish reared with higher levels of oxygen concentrations, which is in line with the findings of Thorarensen *et al*., (2010), who equally observed mean body weight of fish reared at hyperoxia treatment to be significantly higher than in the group maintained at hypoxia and normoxia treatment. No significant difference ($P>0.05$) was observed in the initial condition of the fish stocked in all the treatments but there was a significant difference ($P<0.05$) in the final condition factor of the fish (k) as recorded in this study. More so,findings of the present study concur with those of several other studies, which indicate that oxygen saturation close to 100% or even higher is required to support the maximum growth (Crampton *et al*., 2003). Feed intake and satiation in fish are regulated by physiological, social or environmental factors, or by the interaction among them (Tran-Duy *et al*., 2008). Rafatnezhad and Falahatkar (2011) mentioned that the most important factors responsible for the differences in growth are primarily oxygen concentration. So, decrease in oxygen content decreases the growth rate of fish as reflected in fish reared in tanks A and B in this study. The outcomes from present study obviously showed reduced feed intake and growth at hypoxic condition, fish may not eat well when oxygen supply does not satisfy oxygen demand. Decreased feed utilization might be an indicator of the higher levels of stress (Kai *et al*., 2014) and it could be an indirect mechanism by which protracted hypoxia lessens growth and may be a way to reduce energy and thus oxygen demand. The present study revealed that dissolved oxygen had a significant effect on growth and a low level of oxygen accompanied by reduction in feed intake result in lower growth.The FCR and FCE between the treatment tanks was significant at 5% level of significance. The survival rate was highest in tank A and D but there was no significant difference in the survival rate of the fish in the four treatment tanks because of the proper management of the water quality in all the tanks.Although, other factors like stocking densities, feed type, predators and genetic makeup do affect survival rate of fish (Ajah, 2017). The high survival in the plastic tanks may be due to the smoother surface and highly reduced abrasions compared with the concrete tank and the high level of dissolved oxygen combine with good feeding that was maintained throughout the experiment. The cause of mortalities was jumping out of the tanks, particularly common at night.

5.0 Conclusion

In line with the findings of this study, this research has also proven that Oxygen plays a very important role in the growth and development of fish as reflected in the growth performance of fish in tank C and tank D. The high growth performance recorded in fish fingerlings in tank C is attributed to better food conversion efficiency and the suppression of stress in the tank resulting in a better physiological response. This enabled more energy to be converted to body weight. The salient findings of this study was discovered in tank C (fish reared with 3 air stones as oxygen boosters), this further validatedthe opinions of many other researchers on the influence of dissolved oxygen on growth of fish. Therefore for intensive production of fish, it is essential to maintain a good and healthy environment and monitoring of the oxygen level constantly with the aim of boosting it if observed to be low will produce higher fish yield and better survival rates of the fishes.

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