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Growth Response of *Clarias gariepinus* (North African Catfish) Under Varying Feeding Rates

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Abstract

In fish farming, feeding rate is an important factor affecting the growth of fish, and thus determining the optimal feeding rate is important to the success of any aquaculture operation. This study which lasted for 99 days investigated the effect of varying feeding rates on the growth response of African catfish, *Clarias gariepinus* fingerlings. One hundred and eighty fingerlings were randomly distributed into nine experimental tanks giving 20 fingerlings per tank with an initial weight of 5.92±0.006 g. Three feeding rates were employed as treatments – 3%, 5%, and 7% of fresh body weight, with three replicates per treatment. The fishes were fed three times daily with commercial feed (Aller-aqua) of 42% crude protein. Growth and water quality parameters were measured fortnightly and feed ration adjusted according to the biomass in each tank. Results show that Final Mean Weight, Mean Weight Gain, Specific Growth Rate, Performance Index and Protein Efficiency Ratio were significantly higher ($p<0.05$) in fish fed 7%. However, Feed Conversion Ratio were better at 3% body weight ($p<0.05$). Based on the growth performance and feed efficiency data obtained, the study suggests the optimum feeding rate of 5% bw/day for African catfish, *C. gariepinus* fingerlings.

Keywords: *Clarias gariepinus*; African catfish; Growth response; Feed utilization; Survival; Feeding rate.

1. Introduction

Aquaculture production has been supplementing the output of capture fisheries for the last 6 decades, thus, helping to sustain humanity's demand for aquatic products. This is due to constant improvement in the techniques employed in raising aquatic animals and plants, one of which is fish nutrition viz optimum nutrient requirement, feeding rate, feeding frequency, proper feeding method, etc. Reports shows that aquaculture marginally supplied 7% of fish for human consumption in 1974, increasing to 26% in 1994, 39% in 2004, and 44.1% in 2014 [1], but in 2018 the total contribution of aquaculture to total global fish production rose to 46% and is expected to cross the 50% margin in the next 10 years [2].

Feeding rate depends on the weight of the fish as well as being influenced by variables such as water temperature, dissolved oxygen, photoperiod, season and other physico-chemical parameters. Growth of fish can be influenced by availability of space, adequate feed and other environmental cues [3]. Feeding fish by percentage body weight is a feeding strategy undertaken to promote growth while economizing feed. To meet the continuous increase in demand for fish and to achieve the goal of an aquaculturist producing marketable size fish within the shortest possible time, factors including feeding rate, choice of species as well other environmental variables play a crucial role in the rearing process.

Clarias gariepinus is an important species for aquaculture in Sub-Saharan Africa as well in areas of Europe and Asia where it has been introduced. It is cultured for its omnivorous feeding habit, high growth rate and its resistance to handling and stress [4]. *C. gariepinus* is one of the most cultured fish species in Nigeria because of the good adaptability to captivity condition, rapid growth rate, flesh tastiness, hardiness, and disease resistance ability [5].

Feed represents more than 50 percent of aquaculture inputs particularly in intensive farming systems as fish culturist cannot do without fish feed. Several studies [6-9] have recently been carried out to determine the best feeding ration for *Clarias gariepinus*, with varying and sometimes contradictory results. Some techniques such as feeding by percentage body weight have left farmers in the question of which percentage proffers the best yield. Therefore, proper research is required to determine which percentage body weight produces the best growth response in fish. The objective of the study was to evaluate the effect of different feeding rates on the growth performance, survival and nutrient utilization of *Clarias gariepinus* (North African catfish) in tarpaulin tanks.

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2. Materials and Methods

2.1. Experimental Site and Fish

This research was conducted at Fulfilment Fish Farm located in Obio Offot, Uyo metropolis, Akwa Ibom State, Nigeria. The area lies between Latitude 5.014050°N and Longitude 7.877050°E. The experiment was conducted for 99 days using 9 tarpaulin tanks of 1 m^3. Two hundred fingerlings of *Clarias gariepinus* were procured from a hatchery in Uyo. On arrival at the farm, *C. gariepinus* fingerlings were acclimated for one week. During this period, the fingerlings were fed using Aller-aqua feed of 0.8-1.2 mm, containing 45% crude protein.

2.2. Experimental Procedures and Design

The setup was a completely randomized design (CRD). One hundred and eighty fingerlings were randomly distributed into nine experimental tanks having 20 fingerlings per tank with an initial weight of 5.92±0.006 g. These were assigned to three treatments and replicated thrice. Treatment 1 had fingerlings which were fed diet of 3% body weight, fish in treatment 2 were fed diet with 5% body weight while treatment 3 were fed diet of 7% body weight. Aller-aqua feed (42% CP) ranging from 1.2 – 4.5 mm as the fish increased in weight was used for the feeding trial. Nine tarpaulin tanks of size 1 × 1 × 1 m^3 filled with 450L of water were used for the experiment. At the start of the feeding trail, the acclimated fish were deprived of feed for 24 hrs and initial body weight taken, this was to prepare them for the feeding trial. They were fed based on their treatments at the hours of 7:00, 13:00 and 18:00 hrs for 99 days.

2.3. Data Collection

Water quality parameters such as dissolved oxygen, temperature and pH were observed weekly (07:00am, Saturdays). Dissolved oxygen and temperature were measured using DO meter (HI 9461) in mg/l and °C units respectively while pH was measured using a pen type pH meter (pH-009 111). Data on the growth indices were recorded every two weeks during the experimental period. The weight of each replicate of treatment was determined with an electronic scale (Mettle Toledo, Model PB 60). The experimental tanks were inspected daily to remove dead fish if any. Data collection was determined as follows:

Mean Weight Gain (g) (MWG)

$$MWG = MFW - MIW$$

Where MFW = mean final weight of fish and MIW = mean initial weight of fish

Percentage Weight Gain (%) (PWG)

$$PWG = \frac{MWG \times 100}{MIW}$$

Where MWG = Mean weight gain of the fish, MIW = Mean initial weight of fish

Specific growth rate (%/day) (SGR) [10]

$$SGR = \frac{100 \times [In\ (mean\ final\ weight) - In\ (mean\ initial\ weight)]}{Rearing\ duration\ in\ days}$$

Where Ln = Natural logarithm reading (Log_e)

Survival rate (%) (SR)

$$SR = \frac{100 \times Total\ number\ of\ fingerling\ that\ survived}{Total\ number\ of\ fingerlings\ stocked}$$

Mortality rate (%) (MR)

$$MR = \frac{Nt_1 - Nt_2 \times 100}{Nt_1}$$

Where Nt_1 = Number of fingerlings stocked, Nt_2 = Number of fingerlings remaining

Performance/production index (PI) [11]

$$PI = \frac{SR \times MFW - MIW}{Rearing\ period\ in\ days}$$

Where SR = Survival rate, MFW = Mean final weight, MIW = Mean initial weight

Feed conversion ratio (FCR) [12]

$$FCR = \frac{Dry\ weight\ of\ feed\ given\ (g)}{Wet\ weight\ gain\ of\ fish\ (g)}$$

Protein efficiency ratio (PER) [13]

$$PER = \frac{Wet\ weight\ gain\ by\ fish\ (g)}{protein\ intake\ (g)}$$

Where;

$$Protein\ intake = \frac{\%\ protein\ in\ feed \times total\ weight\ (g) of\ diet\ consumed}{100}$$

2.4. Statistical Analysis

Growth parameters and water quality parameters were subjected to one-way analysis of variance (ANOVA) at 0.05 probability level to test for significant difference. Results with $p \leq 0.05$ were considered significantly different. The statistical analysis was done using IBM SPSS (version 25 by IBM Corporation, New York, USA). Microsoft Excel 2016 (Microsoft Corporation, Washington, USA) was used for graphical presentation.

3. Results

Table 1 shows the results of water quality parameters obtained during the study. There were no significant differences ($p>0.05$) in temperature, dissolved oxygen and pH as these parameters were found to be unaffected by feeding rates during the 14 weeks feeding trial.

Table 2 shows growth, survival and feed utilization parameters of *Clarias gariepinus* fingerlings fed by percentage body of 3%, 5%, 7% for 99 days. The results indicated no significant differences ($p>0.05$) in initial mean weight (IMW), survival rate (SR), mortality rate (MR) and performance index (PI) for the different feeding rates. Whereas, significant differences ($p<0.05$) were shown in the in final mean weight (FMW), mean weight gain (MWG), specific growth weight (SGW), percentage weight gain (PWG), feed conversion ratio (FCR) and protein efficiency ratio (PER) in *C. gariepinus* feeding rates groups.

Table-1. Physio-chemical parameters in the cultured tanks

Parameters	3%	5%	7%
Temperature (°C)	27.40 ± 0.01 [a]	27.23 ± 0.02 [a]	27.29 ± 0.02 [a]
Dissolved oxygen (mg/l)	7.03 ± 0.48 [a]	6.54 ± 0.29 [a]	6.52 ± 0.44 [a]
pH	6.47 ± 0.05 [a]	6.38 ± 0.06 [a]	6.35 ± 0.04 [a]

Means within same row with same superscript are not significantly different ($p>0.05$)

Table-2. Growth performance of *C. gariepinus* fed various feeding rates

Parameters	3%	5%	7%
MIW	5.907± 0.003 [b]	5.933±0.007 [a]	5.917±0.009 [ab]
MFW	203.123±8.093 [c]	255.683±4.047 [b]	314.547±19.131 [a]
MWG	197.217±8.091 [c]	249.750±4.052 [b]	308.630±19.137 [a]
SGR	3.608±0.040 [c]	3.840±.017 [b]	4.051±0.061 [a]
PWG	3338.801±135.93 [c]	4209.408±17.323 [b]	5216.997±329.488 [a]
PI	183.899±5.232 [b]	229.839±18.412 [ab]	289.107±24.347 [a]
SR	91.667±4.410 [a]	90.000±5.774 [a]	91.667±4.410 [a]
MR	8.333±4.410 [a]	10.000±5.774 [a]	8.333±4.410 [a]
FCR	1.158±0.003 [c]	2.178±0.061 [b]	3.237±0.117 [a]
PER	0.486±0.003 [c]	0.915±0.026 [b]	1.360±0.052 [a]

Means within same row with same superscript are not significantly different ($p>0.05$)

4. Discussion

In the present study the increasing feeding rates did not introduce poor water quality as dissolved oxygen, water temperature along with pH were within tolerable ranges for catfish culture [14-16]. On the other hand, feeding rate presented a significant effect on all the growth performance and feed efficiency indices. It is obvious that feeding rate is one of the main limiting factors for growth of fishes as increasing feeding rate led to increasing growth response. Similar results were observed for cobia (*Rachycentron canadum*) juvenile, which presented a greater specific growth rate when fed with 7% body weight/day than with 3% body weight/day [17]. Other fish species like channel catfish (*Ictalurus punctatus*) [18], African catfish (*C. gariepinus*) [8], and hybrid catfish [3] (*Heteroclarias*) also presented greater growth response when fed with higher feeding rates.

In several fish species including *C. gariepinus*, a decrease in cannibalism has been reported with increasing food availability [19]. In the present study, the initial assumption was that increased feed application rate could reduce the cannibalism and increase the survival rate of carnivorous cannibalistic catfish. On the contrary, results show that increase in the feed application rate did not significantly ($p>0.05$) reduce cannibalism nor increase survival rate. The substantial size differences in fish existed in all the feeding treatments except 3%. According to Van der Waal [20], a considerable growth variation has been exhibited in African catfish both in aquaculture and in nature. The heterogeneity in size often leads to social dominance, which results in aggressive behaviour and cannibalistic responses [21].

Growth indices, survival rate and mortality rate are great tools for measuring the effect of feed and its value composition on fish species [22]. From this study, results obtained agrees with De Silva and Anderson [23] and David and Afia [12] who opined that the quality of a feed is a function of how well that feed meets the nutrient requirement of an animal. The efficient growth performance and nutrient utilization of fish fed varying feeding rates in this study are an indication that the feed contained balanced nutrients. From the current study, *Clarias gariepinus* responded positively to all feeding rates as witnessed in their growth performance parameters including final mean weight, mean weight gain, percentage weight gain, specific growth rate and performance index. Significant differences ($p<0.05$) were shown in the analysis results in final mean weight (FMW), mean weight gain (MWG), specific growth rate (SGR), and percentage weight gain (PWG) in *C. gariepinus* feeding rates (Table 2). This result agreed with Marimuthu, *et al.* [6], whose research stated that weight gain increases proportionally with feeding rate, thus explaining why 7% showed highest values and 3% least values. Growth results from the present study shows disparity when compared with reports of Andem [7], Ashley-dejo, *et al.* [8], Afia, *et al.* [3], and Afia, *et al.* [9]. This disparity in result is attributed to differences in feeding level, stocking density, age of fish at first stocking and culture medium employed for the experiment.

Values for survival and mortality rate show that there was no significant difference ($p>0.05$) between *C. gariepinus* fed with varying feeding rates. Survivability has never been a concern when rearing *C. gariepinus*, this

can be traced to its tolerance to water quality fluctuations and resistance to diseases [24]. Hence, survival rate was not threatened in the present study because water quality parameters were optimum for *C. gariepinus* survival in the tank.

In general, feed conversion ratio (FCR) increased with feed application rates above optimal feeding rates in different fish species. Due to the integral nature of fish feed in aquaculture, feed consumed and feed conversion ratio are vital for evaluating feed utilization. The proper understanding of FCR helps the farmer to feed the fish to satiation, and when fish are fed exactly the quantity of feed required, they are not stressed and they provide high quality meat for human consumption [25]. For the present study, *C. gariepinus* fed 7% diet consumed more feed than fish 5% and 3% diets. Ekanem, *et al.* [26], opined that growth and feed conversion ratio of a fish is a remarkable tool to compute the acceptability of artificial feed. From the results obtained in the present study, there were significant differences ($p<0.05$) observed in FCR and protein efficiency ratio (PER) between the different feed application rates. Both 7% and 5% diets indicated extremely poor values from the 12th week of culture. Therefore, it can be recommended that feeding rates of 7% and 5% diets should not be administered beyond the 12th week of culture, rather it can be reduced to 3% feeding rate. 3% diets gave the best FCR but had low PER.

5. Conclusion

For an appreciable growth to occur in living organisms such as fish species, the supply of good quality feeds in sufficient quantity and at the right feeding rate is very essential. The present study has shown that there were no significant differences ($p>0.05$) in IMW, SR, MR and PI. Significant differences ($p<0.05$) were observed in FMW, MWG, SGR, and PWG in *C. gariepinus*. The results suggest that, although a feeding rate of 7% gave the highest growth performance, it is not cost effective and has a very high FCR. Likewise, feeding at 3% body weight has low growth performance which may not be profitable to farmers.

Therefore, *C. gariepinus* should be fed at the rate of 5% body weight per day. The feeding trial shows that this feeding rate is optimal since it is evident both growth and feed utilization were most efficient at this level of feeding. Effective feeding rates play a crucial role in the successful production of North African catfish, *Clarias gariepinus*.

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