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Effect of varying proportions of the daily feed rations on the performance of Juveniles of *Clarias gariepinus* (Burchell, 1882)

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ABSTRACT: African catfish *Clarias gariepinus* (Burchell, 1882) constitutes a bulk of farmed freshwater fish, particularly in Africa. Its optimal production relies on an optimal feeding regime as feed covers about 50% of operation cost. Studies on feeding regimes have mostly been on feeding frequency and the daily required rations. This study was therefore designed to evaluate the impact of varied proportions of normal daily rations on the performance of *C. gariepinus* juveniles. *Clarias gariepinus* Juveniles of 17.6 ± 3.7 g were stocked at a density of 15 juveniles per 50 L of water in 80 L plastic tanks and cultured indoors for 42 days. They were fed a standard specific feed at 5% total biomass three times daily (8:00, 13:00 and 18:00). Treatment 1 received 33.33% of its daily ration at each feeding period, while treatments 2 and 3 received (50%, 25% and 25%) and (25%, 25% and 50%) of the daily rations at 8:00, 13:00 and 18:00, respectively. Fish biomass and survival rate were determined weekly and individual fish weights and lengths were determined at the end of the experiment. Water was aerated continuously and half the volume was renewed daily; temperature and pH were monitored twice daily. The specific growth rate, weight and length gained were best in treatment 3 although not significantly different ($p>0.05$) among treatments. However, feed conversion ratio and condition factor in treatment 3 were significantly ($p<0.05$) better when compared to treatments 1 and 2 although temperature and pH in the different treatments were not significantly different ($p>0.05$). The estimated investment cost was 3891, 4136 and 3907 FCFA, with profit index of 0.95, 0.87 and 1.09 in treatments 1, 2 and 3, respectively. Therefore, administering about 50% of the daily ration in the evening as was the case in treatment 3 is more profitable in the culture of *C. gariepinus* juveniles.

Keywords: African catfish, cost of production, feed rationing, growth performance.

INTRODUCTION

Fish is a primary source of protein for many persons in the world and is crucial to a nutritious diet in many areas. Increasing consumption of fish is generally recommended for increased intake of omega-3 fatty acids which is important for the risk reduction of cardiovascular diseases (Raatz *et al*., 2013). In Cameroon, fish is the preferred source of animal protein due to its cheap cost when compared to other meat (Tekwombuo and Thorarensen, 2013). FAO statistics reveal *C*. *gariepinus* as the most important fish for aquaculture in Sub-Saharan Africa. This is due to the fact that this fish species is widely accepted as food fish; it is hardy and highly fecund, grows fast, and has fleshy and palatable meat (Offem *et al*., 2010). Moreover, in Cameroon, this species is considered a good candidate for aquaculture because of its economic value (Oben *et al*., 2015).

To improve the aquaculture production of African catfish, attention has been given to some aspects of its nutrition (Aderolu *et al*., 2018; Putra *et al*., 2017; Aderolu *et al*., 2010; Hossain *et al*., 2001a; Hossain *et al*., 2001b). According to Gokcek *et al.* (2008), obtaining a balance between rapid fish growth and optimum use of the supplied feed is one of the major challenges faced by fish farmers since feed cost accounts for up to 40 to 60% of the operating costs; with commercial feeds often too expensive for rural fish farmers (Charo-Karisa *et al*., 2013). Optimal feeding can ensure a successful aquaculture operation (Yuan *et al*., 2010), helps to prevent water quality degradation (Mihelakakis *et al*., 2002; Silva *et al*., 2007), improves the performance of the fish species and can result in tremendous savings (Davies *et al*., 2006). Meanwhile, over- or under-feeding could result in increased fish disease and mortality (Deng *et al*., 2003).

According to Aderolu *et al*. (2010), feeding *C*. *gariepinus* juveniles optimally; with the required daily ration results in optimal feed utilization and growth. Notwithstanding, the percentage of the daily ration required by the fish at different times of the day may vary. Hossain *et al*. (2001a) reported that fingerlings of *C*. *gariepinus* exposed to feed 24 hours daily used up to 70% of their daily ration at night. This study was therefore designed to investigate the optimal feeding regime for *C*. *garieninus* juveniles in terms of optimal proportions required at different periods of the day. The results obtained will be relevant for cost effective farming of *C*. *gariepinus*.

MATERIALS AND METHODS

A total of 135 *C*. *gariepinus* juveniles of 17.6 ± 3.7g donated by the Institute of Agricultural Research for Development (IRAD) Station in Batoke-Limbe were used for the experiment. They were randomly assigned to 3 experimental treatments in triplicates at a stocking density of 15 juveniles per 50 L of water and fed a commercial diet for 42 days; three times (8:00, 13:00 and 18:00) daily at a rate of 5% body weight. In treatment 1 (T1), fish was fed 33.33% of the total daily ration at each feeding time as traditionally done in farms; fish in treatment 2 (T2) was fed 50, 25 and 25% of the total daily ration, respectively; while treatment 3 (T3) fish was fed 25, 25 and 50% of the total daily ration, respectively.

The survival rate in each tank was determined daily while total biomass in each tank was determined weekly and rations adjusted. The tanks were cleaned before the first ration of each day by siphoning faeces and leftover feed and renewing the water at 50% rate. Optimal dissolved oxygen levels were ensured by continuous aeration using an ACO-005 electrical magnetic aquarium air pump. Temperature and pH were monitored twice daily in the morning and evening using a digital aquarium thermometer and a pen pH meter, respectively.

Growth performance

At the end of the experiment, the total number of survivors in each tank was determined, individual fish length was measured to the nearest 0.01 mm using a Three-Button Digital Caliper (0-150 mm) and weight measured to the nearest 0.01 g. Growth and production indices were then computed as follows:

$$\text{Weight gain} = \text{Final weight of fish} - \text{Initial weight of fish}$$

$$\text{Mean weight gain} = \frac{\text{Total weight gain in a tank}}{\text{Number of fish in a tank}}$$

$$\text{FCR} = \frac{\text{Total weight of diet fed}}{\text{Total weight gain in the period considered}}$$

$$\text{Specific Growth Rate (SGR)} = \frac{\text{Ln(Wt)} - \text{Ln (Wi)}}{\text{t}} \text{x } 100$$

Where FCR = Feed Conversion Ratio, Wt = weight in grams at time t in days and Wi = initial weight in grams.

$$\text{Mortality} = \frac{\text{No. of dead fish in the period of evaluatin}}{\text{No. of fish at the begining of the experiment}} \times 100$$

Condition factor = W x100/L^3

Where W = weight in grams and L = the corresponding length in centimetres.

Fish length-weight relationship

The equation of the form shown as equation 2 was fitted to the data from each of the 3 treatments and used to describe the relationship between fish weight and length according to Pauly (1984).

$W = aL^b$……………….Eq. 2

Where: W = weight, L= length, ‘a’ and ‘b’ are constants with ‘a’ being the intercept while ‘b’ is the condition factor.

Table 1. Mean ± SD of the performance parameters.

Growth parameters	Treatment 1	Treatment 2	Treatment 3
Initial weight (g)	17.13 ± 3.70[a]	17.54 ± 3.10[a]	18.08 ± 3.77[a]
Final length (mm)	230.43 ± 30.20[a]	228.79 ± 27.82[a]	236.85 ± 24.24[a]
Final weight (g)	98.02 ± 38.19[a]	99.70 ± 38.13[a]	111.75 ± 40.53[a]
Condition Factor	0.760 ± 0.07[a]	0.80 ± 0.12[ab]	0.80 ± 0.08[b]
Average Weight gained(g)	59.43 ± 2.42[a]	58.41 ± 23.16[a]	69.66 ± 11.51[a]
Feed Conversion Ratio	1.76 ± 0.19[a]	1.91 ± 0.79[a]	1.53 ± 0.17[b]
Specific growth rate (SGR)	4.15 ± 0.18[a]	4.01 ± 0.59[a]	4.35 ± 0.27[a]
Survival (%)	91.11±10.18[a]	91.11±15.40[a]	91.11±3.85[a]

Values on the same row with the same superscript are not significantly different.

Economic analysis

The economic analysis was performed to estimate the investment cost in each treatment and profit index considering feed cost of 1200 FCFA/Kg and value of fish at 2000 FCFA/Kg. The cost of feed and fish were the only economic criteria under consideration in this case and were based on the current market cost of the commercial feed and the market value of a kilogram of fresh fish in Cameroon at the time of the experiment.

Estimated Investment cost analysis = Cost of feeding (N) + Cost of juveniles stocked (N)

Profit index = Value of fish (N)/Cost of feed (N)

Data analysis

All data collected was statistically analysed in Microsoft Excel and Statistical Package for Social Science (SPSS) version 20. One Way Analysis of variance (ANOVA) was used to compare treatment means and Duncan's multiple range test used to test for significance at 95% confidence interval.

RESULTS

Growth performance

Although the initial weight of the juveniles used in this study was not significantly different ($p>0.05$) among treatments, growth performance in T3 was best compared to the other treatments (Table 1). The specific growth rate (SGR) was highest in T3 (4.35 ± 0.27) and least in T2 (4.01 ± 0.59). T3 had a significantly ($p<0.05$) better condition factor and feed conversion ratio. Also, the mean weekly weights of the fish in T3 were best throughout the study period, and that in T2 which was higher than that in T1 for the first five weeks of the study reduced gradually and by the sixth week became lower than that in T1 (Figure 1). The study revealed a strong correlation between the weight of fish and time (Figure 2) and between fish weight and corresponding length (Figure 3). No significant difference ($p>0.05$) was observed in fish growth between T1 and T2 throughout the experimental period. Whereas, after day 28, the growth rate in T3 increased and remained superior, although there was really no significant difference when compared to the other treatments.

Economic analysis

Economic analysis was evaluated as investment cost and profit index (Table 2). Economic implication in T3 was most favourable as revealed by the best profit index obtained. Meanwhile, T2 had the highest investment cost which was best reflected by the least profit index obtained.

Effect of varying feed proportions on water quality parameter

The pH values ranged between 7.63 and 7.68 and values among the treatments did not vary significantly (Table 3). Also, the temperature recorded in the study did not differ significantly ($p>0.05$) among the treatments.

DISCUSSION

The SGR range of 4.01 to 4.35 (%/day) recorded in the study is significantly greater than the range of 2.71 to 3.19 (%/day) reported by Agokei *et al*. (2010) and 2.30 to 2.84 (%/day) reported by Odulate *et al*. (2014) for juveniles of the same species. This disparity could be attributed to variability in diets used and study duration. Also the difference in SGR could be attributed to the difference feeding frequency used. The three times feeding per day used in this study was more appropriate (Aderolu *et al*., 2010); when compared to the one and two times used by Agokei *et al*. (2010) and Odulate *et al*. (2014), respectively. This study recorded better weight gain in the treatment that

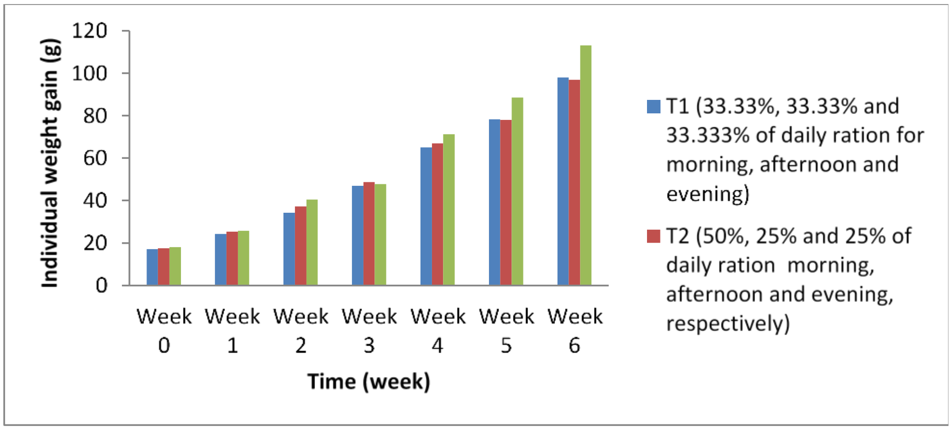

Figure 1. Weekly fish weight gain.

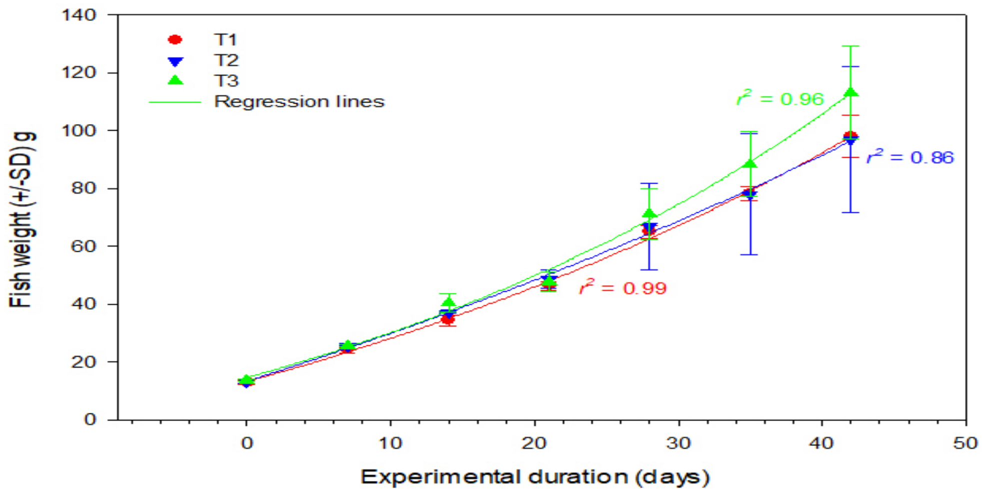

Figure 2. Fish weight–time relationship regression plot.

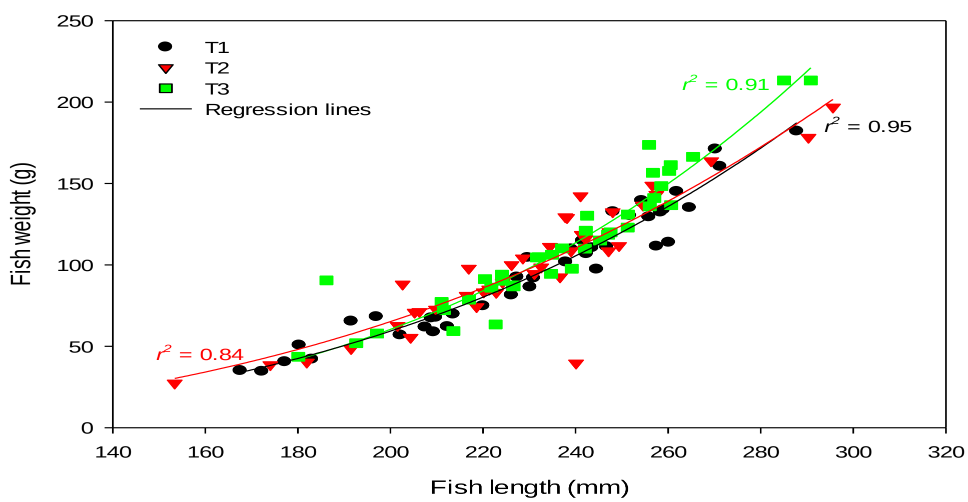

Figure 3. Fish weight–length relationship regression plot.

Table 2. Estimated investment cost and profit index.

Treatments	Fish biomass (Kg)	Investment cost (FCFA)	Profit index
Treatment 1	1.13	3 891	0.95
Treatment 2	1.15	4 136	0.87
Treatment 3	1.31	3 907	1.09

Table 3. The Mean ± SD of the various water quality parameters monitored.

Water quality parameters	Treatment 1	Treatment 2	Treatment 3
Water temperature (^{0}C)	27.63 ± 0.86[a]	27.58 ± 0.86[a]	27.55 ± 0.86[a]
Water pH	7.68 ± 0.21[a]	7.66 ± 0.19[a]	7.63 ± 0.21[a]

Values on the same row with the same superscript are not significantly different.

was administered more of the daily ration in the evening compared to the treatment where equal rations were fed to the fish. This finding is congruent with the findings of Hossain *et al*. (2001b); where it was observed that fingerlings used more of their daily ration at night when exposed to food 24 hours; indicating nocturnal habit for the species.

For the condition factor (K), the range of 0.76 to 0.80 reported in this study was within the range of 0.78 to 0.80 reported by (Ayo-Olalusi, 2014) for *C*. *gariepinus*, but was higher than the 0.52 of Getso *et al*. (2017) and 0.53 to 0.55 reported by Keyombe *et al*. (2015) indicating relatively better growth performance in this study. However, the fact that K values were less than 1 is indicative that growth was not optimal as K values less than 1 indicate that the fish did not do well (Froese, 2006). Notwithstanding, a strong length-weight correlation was observed in this study.

The feed conversion ratio of 1.53 to 1.91 recorded in this study was relatively poor when compared to the 0.66 recorded by Aderolu *et al*. (2010) for *C*. *gariepinus* juveniles fed equal proportions of feed daily. This difference could be associated with feed variation and culture conditions. However, in this study, the best feed conversion ratio was recorded in treatment 3; where fish was fed 50% of the daily ration in the evening, 25% in the morning and 25% in the afternoon indicating better feed utilization in the night as reported by Hossain *et al*. (2001b).

The percentage survival of 91% recorded in this study was within the range of 73 to 96 % recorded by Iriobe *et al*. (2018). Throughout the study, temperature and pH measurements were within the desirable range for fish *C*. *gariepinus* (Viveen *et al*., 1985; Ndubuisi *et al*., 2015).

Conclusion

This study revealed that when *C. gariepinus* juvenile is fed 50% of its daily ration in the evening, with 25% each in the morning and afternoon, best performance and least cost of production were obtained compared to when equal rations were fed at each feeding period as it is traditionally done. Therefore it is recommended that for more profitable production of *C*. *gariepinus*, at least 50% of the daily ration should be administered in the evening.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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