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Effects of Feeding Frequency on Growth and Feed Efficiency of Rearing African Catfish (*Clarias gariepinus*, Burchell 1822) Fingerlings

[1]Lawan I., [1]Hassan, M., [2]Yusuf A.
[1]Department of Fisheries, University of Maiduguri, Borno State, Nigeria
[2]Department of Biology, Ahmadu Bello University, Zaria, Kaduna State, Nigeria

Abstract: *The effect of feeding frequency on feed consumption, growth and feed conversion efficiency of Clarias gariepinus was investigated in the laboratory over a period of 6 weeks. A 42% C.P. commercial feed (COPPENS) was fed at four different feeding frequencies (once, twice, thrice and four times) to triplicate group of 10 fingerlings of Clarias gariepinus. At the of the trial, the highest feed consumption was obtained in fish fed 3 times daily (2.96 ± 0.08 g) and the lowest feed consumption (2.26 ± 0.19) was observed in fish fed 2 times daily. However, no significant difference was observed in the amount of feed consumed at the thrice daily (2.96 ± 0.08 g) and four times daily (2.77 ± 0.05 g). Mean weight gain and specific growth rate were significantly (p<0.05) affected by the experimental treatments. Fish fed once daily had the lowest mean weight gain (2.41 ± 0.24 g) while fish fed thrice daily had the highest mean weight gain value (3.39 ± 0.06 g). The fish fed once daily had the highest feed conversion ratio and least feed conversion efficiencies (1.14 ± 0.18 and 92.26±14.99%) and the ones fed thrice and four times daily had the lowest feed conversion ratios and highest feed efficiencies (0.87 ± 0.03, 0.92 ± 0.04 and 114.60±4.61%, 109.80±5.15%) respectively. It was concluded that feeding Clarias gariepinus more than once a day increased growth performance and nutrient utilization especially when fed thrice daily.*

Key words*: feeding frequency, growth, Feed conversion ratio, feed conversion efficiency*

INTRODUCTION

Feeding frequency is the number of times fish in a pond are fed in a day. Feed expense is the highest share of total cost in any intensive aquaculture operations. Since the feed cost accounts approximately 40 - 60% of the operating costs in intensive culture systems (Agung, 2004). The economic viability of the culture operation depends on the feed and feeding frequency. It means that nutritionally well-balanced diets and their adequate feeding are the main requirements for successful culture operations. One problem facing fish culturists is the need to obtain a balance between rapid fish growth and optimum use of the supplied feed (Gokcek *et a*l., 2008). There is need to establish the effect of number of feeding times or frequency on feed management, nutrient utilization and growth rate of fish. The optimal feeding strategies improve growth, survival, and food conversion ratios (FCRs), and assist in minimizing food wastage and increase production efficiency (Tekinay *et al*., 2003, Dwyer and Brown, 2002).

Each species has its particular food preferences and feeding behaviours. Feeding and ingesting are the final result of a number of interacting factors between the fish and its environment (stock density, size range or variability, season, day length and time of the day). Time of feeding and feeding frequency have been reported to affect feed intake and growth performance in goldfish, *Carassius auratus* (Noeske and Spieler, 1985), Indian catfish, *Heteropneustes fossilis* (Sundararaj *et al*., 1982), channel catfish, *Ictalurus punctatus* (Noeske et al., 1985) and black sea trout *Salmo trutta labrax* Pallas, 1811 (Bascinar *et al*., 2007). Feeding frequency is one important consideration as it can affects growth, survival and fillet composition as well as water quality. Feeding also at the optimum frequency can result in tremendous savings in feed cost (Davies *et al*., 2006). The amount of the daily feed intake, frequency and timing of the feedings and presentation of the predetermined ration are the key factors of feed management strategies, influencing the growth and feed conversion (Jobling, 1995; Goddard, 1995). Optimal feeding frequency may vary depending on species, age, size, environmental factors, husbandry and feed quality (Goddard, 1995). The quality and quantity of feed given to an animal is directly related to outputs and returns this therefore, suggest that Aquaculture yields, productivity and consequently returns, are directly related to the quality and quantity of food given to the fish (Schimittou *et al.*, 1998). High quality fish seed and feed production are the basis for developing the aquaculture industry (Potongkam and Miller, 2006). It is based on the above assertion that the current work was carried to determine the effects of feeding frequency on performance of C. gareipinus under indoor experimental condition

MATERIALS AND METHODS

Experimental Site

The experiment was carried out at the Department of Fisheries hatchery complex, Faculty of Agriculture University of Maiduguri, Borno State Nigeria.

Experimental Fish

African catfish (*Clarias gariepinus*) fingerlings of uniform size (Plate1) were obtained from a reputable fish farm in Maiduguri, Borno State. Fish were acclimatized to laboratory conditions for fourteen days in concrete tanks fitted to a flow through system inside the hatchery complex.

Plate1: C. gariepinus Fingerlings used for the Experiment

Experimental Design and Procedure

Fingerlings were distributed randomly into four plastic tanks (measuring 52 x 33.5 x 21 cm) containing 25L of borehole water. Trial conditions included ten fish per tank and four feeding frequencies were assigned, with each feeding frequency being experimentally termed as treatments in triplicates. Fish were kept under natural photoperiod of approximately 12/12 h light/dark cycle (Aderolu *et al*., 2010) and fed a popular commercial catfish feed (Coppens, Holland) once (at 11.00 h), twice (09.00 and 16.00 h), thrice (09.00, 13.00 and 16.00 h and four times (09.00,11.00,13.00 and 16.00 h) daily respectively at 5% of biomass for 4 weeks. The treatments were designed as T1, T2, T3, T4 respectively. Fish tanks were cleaned daily by siphoning out residual feed and faecal matter, water in the tanks were replaced twice weekly and feeding rate were determined fortnightly according to the weight gain. Mean daily consumption of feed (g) by each fish fingerling per feeding frequency was estimated by subtracting the weight of the uneaten feed from the total weight of feed given to the fish in each tank and dividing it by the total number of fingerlings in the tank. These values were then summed up to determine the mean weekly feed consumption respective treatments and their replications.

Water quality parameters (temperature and pH) were monitored twice weekly with Digital thermometer equipped in degree centigrade (°C) and digital pH meter respectively. All fish were weighed individually at the beginning and end of the experiment, while subsequent weighing was on batch method. The fish lengths (Total length and Standard length) of each fingerling were measured to the nearest 0.1 mm using a standard meter rule.

Plate 2: Set of 12 experimental tanks stocked with *Clarias gariepinus* fingerlings

Measurement of Growth Parameters

Based on the length and weight increments, growth performances of the fish at different feeding frequencies were calculated and the following formulae were applied to the data obtained:

- **Specific growth rate (SGR);** the rate of growth of a fish is a fairly sensitive index of protein quality; under controlled conditions weight gain being proportional to the supply of essential amino acids. Daily SGR were calculated as:

$$SGR\% = \left(\frac{lnWf - lnWi}{T}\right) \times 100$$

- **Feed conversion ratio (FCR)**

The Feed Conversion Ratio (FCR) is the amount of food required to produce a unit of fish, or is the grams of feed consumed per gram of body weight gain. FCR was calculated thus:

Feed conversion ratio (FCR) = total feed intake (g)/total wet weight gain (g).

- **Feed conversion efficiency (FCE %)** is the grams of weight gained per gram of feed consumed. It was calculated using the formula
  Feed conversion efficiency (FCE %) = (weight gain by fish (g)/ diet fed (g)) X 100
- **Protein efficiency ratio (PER)** is the grams of weight gained per gram of protein consumed.
  PER = wet weight gain (g)/total protein fed.
- **Relative growth rate (RGR %):**

$$RGR\% = \left(\frac{Wf - Wi}{Wi}\right) \times 100$$

- **Weight gain (WG)** is the final weight of the fish minus the initial weight of the fish:

$$WG = Wf - Wi$$

  Where *Wf* refers to the mean final weight,
  Wi is the mean initial weight of fish and
  T is the feeding trial period in days.
- Condition factor (K) = (W/TL^3) x 100
  Where:
  W – Body weight in grams,
  TL – Total length (cm).
- **Survival rate (%)**

$$S\% = \left(\frac{Ni}{No}\right) \times 100$$

Where;
M – Mortality
D – Total number of dead fish at the end of the experiment
No – Total number of fish stocked at the beginning of the experiment
Ni – Total number of fingerlings alive at the end of the experiment

- **Apparent net protein utilization (NPU)** is the percentage of ingested protein which is deposited as tissue protein.
  The Apparent NPU = [(Pb – Pa)/Pi] x 100
  Where;
- Pb – is the total body protein at the end of the feeding trial.
- Pa – is the total body protein at the beginning of the feeding trial.
- Pi – is the amount of protein consumed over the feeding trial.

DATA ANALYSIS

The data obtained were analyzed using one way analysis of variance (ANOVA) and Duncan's Multiple Range Test was used to compare the mean differences.

RESULTS

The results of the growth performance and survival of the experimental C. gariepinus under different feeding frequency are presented in Table1. Initial mean weight was uniform among fingerlings used for trial, ensuring homogeneity at onset of the experiment in terms of size. All other growth parameters were not significantly ($p>0.05$) different except for the final mean weight gain at the end of the experiment which ranged from 2.41g – 3.39g and similarly, specific growth rate ranged from 2.23 to 2.85g/day. Nutrient utilization parameters indicate insignificant effects of feeding frequency on performance of C. gariepinus tried under the three different frequencies. Feed intake did not differ significantly from one treatment to another.

Table2: growth performance and survival of c. Gariepinus on fed different feeding frequency

Growth Parameters	T1	T2	T3	T4
Initial Weight	2.78 ± 0.13^{a}	2.67 ± 0.10^{a}	2.77 ± 0.05^{a}	2.75 ± 0.07^{a}
Final Weight	5.19 ± 0.13^{b}	5.14 ± 0.34^{b}	6.16 ± 0.01^{a}	5.77 ± 0.22^{ab}
Weight Gain	2.41 ± 0.24^{b}	2.47 ± 0.29^{b}	3.39 ± 0.06^{a}	3.02 ± 0.15^{ab}
Specific Growth Rate	2.23 ± 0.23^{b}	2.32 ± 0.18^{b}	2.85 ± 0.07^{a}	2.65 ± 0.04^{ab}
Feed Conversion Ratio	1.14 ± 0.18^{a}	0.92 ± 0.03^{a}	0.87 ± 0.03^{a}	0.92 ± 0.04^{a}
Protein Efficiency Ratio	2.10 ± 0.43	2.09 ± 0.47^{a}	1.27 ± 0.01^{a}	1.24 ± 0.01^{a}
Condition Factor	0.56 ± 0.09^{a}	0.60 ± 0.04^{a}	0.64 ± 0.04^{a}	0.67 ± 0.09^{a}
Feed Conversion Efficiency (%)	92.26 ± 14.99^{a}	108.66 ± 4.38^{a}	114.60 ± 4.61^{a}	109.80 ± 5.15^{a}
Survival Rate	93.33 ± 3.33^{a}	93.33 ± 3.33^{a}	100.00 ± 0.00^{a}	93.33 ± 3.33^{a}

*Values in each row allocated common superscripts are not significantly different from each other ($P > 0.05$)

DISCUSSION

Based on the results emanated from this feeding trial, the growth performance of C. gariepinus has been slightly related to number of feeding times. Although, all other parameters were not significantly ($p<0.05$) different, mean weight gain and specific growth rate showed variation to the feeding frequencies tried (Table1). Feeding and feeding frequencies are key factors that determine the growth and survival chances of fish. In this investigation, it was observed that the highest quantity of feed was consumed by fishes fed three times daily, while the least amount was consumed by fishes fed twice daily. This parameter was not significantly different (P< 0.05) between the various feeding frequencies. In a related experiment Costa-Bomfin (2014) reported that, none of the parameters associated with growth performance (survival, weight gain, specific growth rate, feed intake, and condition factor or size variation) showed any significant differences among treatments. The authors further stated that although feeding frequency had no effect on the growth performance of cobia larger than 110 g, in commercial farming operations where large numbers of fish are kept within a single rearing structure, fish may have aggressive interactions during feeding. Under these conditions, it is difficult to ensure that all fish are fed to satiation and thus it is usual to provide two or more meals per day. The basic principle in feeding is that fish should be fed exactly to satiation (FEAP-Aquamedia, 2010). If they are fully fed, the fish are not stressed and they provide high quality food for human consumption. Studies on some fish species have shown that the highest weight gain was obtained (P<0.05) by feeding the fish frequently (three times daily), providing more feed (Bascinar *et al.*, 2007). The studies showed that a higher growth rate depended on both higher and more frequent feed supply.

Investigations have considered the effect of feeding rate on the growth and feed efficiency of juvenile milk fish (*Chanos chanos*) and found that, regardless of the feeding rate, increasing the feeding frequency from four (4) to eight (8) times per day significantly increased growth and feed efficiency of the fish by 20% (Bascinar *et al.*, 2007). These authors suggested that more frequent feeding over a long period would be an efficient strategy for feeding *Chanos chanos* in ponds. In the present study, feeding the African catfish fingerlings up to 3 times daily showed a significant weight increment (P<0.05) over feeding it twice or less daily.

The feed conversion ratio (FCR) was highest in the fish fed once daily (1.14 ± 0.18) followed by the fish fed four (4) times and twice daily (0.92 ± 0.04 and 0.92 ± 0.03, respectively). The fish fed thrice daily had the least FCR value (0.87 ± 0.03). The values obtained for Feed Conversion Efficiency (FCE) were a reflection of the FCR values since the FCE is the reciprocal of the FCR expressed as a percentage. The highest FCE was observed in the feeding frequency three times daily (114.60±4.61%) and the least was in feeding frequency once daily, (92.26±14.99%). There was an observed decrease in the feed conversion efficiency as the feeding frequency increased above the thrice daily level. These values are technically lower than established figures (1.5-2.0) for C. gariepinus. These variation may be due errors related with calculating feed intake and output. Since FCE's values recorded in the present study are greater than 50% considered as "good growth". Farms reporting low FCR's normally have good management practices in place, with no over feeding and very low, if any, mortalities. Fish are not completely efficient feed converters (i.e. with FCR's of 1.0 and FCE's of 100%). When fed a given weight of feed, fish cannot exhibit the same amount of growth in weight because they must use some of the energy in feed for metabolic heat, digestion, respiration, nerve impulses, salt balance, swimming and other life activities (Craig and Helfrich, 2002).

The ability of fish to utilize nutrients especially protein will positively influence its growth rate (De Silva and Anderson, 1995). This is justified by the highest PER and low FCR in the treatments fed thrice daily. This suggested that fish must have efficiently converted feed consumed to growth. Efficient production and growth of fish depend on feeding the best possible diets at levels not exceeding the dietary needs (Charles *et al*., 1984). In fish culture practices, studies on the amount and frequency of feeding are aimed at identifying the optimum levels of both. Increased feed digestibility and increased water quality are the benefits of using the correct feeding frequency. Two or three feeding a day have been found to be sufficient for maximum growth of a number of different fish species (Robinson *et al*., 2007). This generally agrees with the result of this study as depicted by the parameters already mentioned.

CONCLUSION

In conclusion, the success of African catfish fingerlings culture depends on effective feeding frequency, a feeding frequency of three times compare to once, twice or four times is sufficient for effective growth and nutrient utilization under the experimental condition carried out in this study. Studies involving environmental conditions as they relate to feeding and frequency be carried out since these parameters have been implicated to have influence growth and feed intake in previous studies.

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REFERENCES

Aderolu, A.Z. , Seriki, B.M. , Apatira, A.L and Ajaegbo., C.U. (2010). Effects of feeding frequency on growth, feed efficiency and economic viability of rearing African catfish (Clarias gariepinus, Burchell 1822) fingerlings and juveniles. *African Journal of Food Science* 4 (5) : 286 – 290.

Agung S (2004). Comparism of Lupin meal based diets cost efficiency for juvenile *Penaeus monodon* tested under pond conditions. *J. Coastal Dev*., 8(1): 47–51.

Basçınar N, Okumu, Ba_çınar NS, Sa_lam EH (2001). The influence of daily feeding frequency and feed consumption of rainbow trout fingerlings (Oncorhynchus mykiss) reared at 18.5 - 22.5°C. *The Israeli J. Aquacult. –Bamidgeh*., 53 (2): 80-83.

Charles PM, Sebastian SM, Raj MCV, Marian MP (1984). Effect of feeding frequency on growth and food conversion, Cyprinus carpio Fry. *Aquacult.*, 40: 293-300.

Craig, S. and L.A. Helfrich, (2002). Understanding Fish Nutrition, Feeds and Feeding. In: Virginia Cooperative Extension, Virginia Polytechnic Institute and State University. [p.420-256

De Silva, S.S., Anderson, T.A. (1995). Fish Nutrition in Aquaculture. Aquaculture Series, Chapman & Hall, London. 1995.

Costa-Bomfim, CN , Pessoa, WVN., Oliveira JL., Farias, Domingues, EC, Hamilton, S. and Cavalli RO. (2014). The effect of feeding frequency on growth performance of juvenile cobia, *Rachycentron canadum* (Linnaeus, 1766). *Journal of Applied Ichthyology*, 30 (1): 135-139.

Davies O.A, Inko-Tariah MB, Amachree D (2006). Growth response and survival of Heterobranchus longifilis fingerlings fed at different feeding frequencies. *Afr. J. Biotechnol.*, 5: 778-787.

Dwyer, K.S., Brown, J.A., Parrish, C., Lall, S. (2002). Feeding frequency affects food consumption, feeding pattern and growth of juvenile yellowtail flounder (Limanda ferruginea). *Aquaculture*, 213: 279-292.

FEAP-Aquamedia, (2010). What is feed conversion Ratio? *Federation of European Aquaculture Producers – Aquamedia. http:// www.piscestt.com/ home/ FAQ/ Answers/an8_en.asp*

Goddard S (1995). Feed Management in Intensive Aquaculture. Chapman and Hall, New York. p. 94.

Gokcek CK, Mazlum Y, Akyurt I (2008). Effects of feeding frequency on the growth and survival of Himri barbell and Barbus luteus fry under laboratory conditions. *Pak. J. Nutr.*, 7(1): 66-69.

Jobling M (1995). Fish Bioenergetics, Chapman and Hall, London. P. 309.

Noeske TA, Spieler RE, Parker NC, Suttle MA (1985). Feeding time differentially affects fattening and growth of channel catfish. *J. Nutr*. 115: 1228-1232.

Potongkam K., Jim Miller, (2006). Catfish Hatchery and Production Manual. *FAO Technical Advisor Aquaculture and Inland Fisheries Project*

Robinson, E.H. and M.H. Li, (2007). Effect of Fish Size and Feeding Frequency on Channel Catfish Production. In: *The FishSite.com*. pp: 1-6.

Tekinay, A.A., Davies, S.J., G.ner, Y. (2003). Growth, feed utilization and carcass composition in rainbow trout fed diets with a similar digestible energy content and different carbohydrate levels. *Isr. J. Aquacult. Bamidgeh*, 55: 123-131.