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Determination of Feeding Frequency for *Clarias Gariepinus* Fingerlings on Fixed Ration Level

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ABSTRACT

In an effort to improve feed utilization efficiency, promote growth, and reduce production cost *Clarias gariepinus* fingerlings were subjected to five feeding frequencies: 2 times every day, 3 times every day, 3 times every other day, 8 times every day and 8 times every day (weekend off) for 56 days. Ten fingerlings of mean weight 1.3±0.2g were stocked into each of the fifteen 45L aquaria with 3 replicates per treatment. Fish were fed on commercial diet containing 56% crude protein at 5% body weight per day. The highest percentage weight gain and specific growth rate were observed in fish fed 8 times every day which were significantly higher ($p<0.05$) than all treatments except fish fed 8 times every day (weekend off). The best feed conversion ratio (FCR) was recorded for fish fed 8 times every day (weekend off) and 3 times every other day with values of 0.67±0.05 and 0.67±0.01 respectively. The best protein efficiency ratio (PER) was also observed in fish fed 8 times every day (weekend off) and 3 times every other day with similar values of 2.69±0.22 and 2.68±0.03 respectively. There were no significant differences ($p>0.05$) in the proximate composition of fish carcasses among the treatments. This study indicates that *Clarias gariepinus* fingerlings could be fed 8 times everyday weekend off.

Introduction

In any commercial fish culture, it is expected that fish grow rapidly within the shortest possible time, feed is utilized efficiently, feed wastage is kept to the bare minimum and harvested fish are of uniform size. These expectations require knowledge on the nutritional requirements of fish and more importantly on feeding management practices (Jobling *et al.* 1995; Goddard 1996).

The culture of African catfish, *Clarias gariepinus* is fast gaining global attention because of its good growth rate, resistance to diseases, high feed conversion rate, high market demand and good taste (Adewolu et al., 2010). However, one of the problems hindering its fast production is the high cost of feed and this plays a major role in the profitability of its commercial venture. It is therefore crucial for catfish culturists to optimize the use of fish feed through the strategy of feeding frequency.

The optimal feeding frequency for *C. gariepinus* fingerlings has not been clearly defined and this has led to uncertainty in the feeding routines used by many fish culturists. This may lead to overfeeding or underfeeding of fish, which in turn may cause poor feed utilization and reduced growth. Feeding frequency, therefore, has a major role to play on the success of catfish culture. It has been postulated that more frequent feeding of African catfish at a given ration level may result in more efficient utilization of feed. However, research has not been conducted to validate this hypothesis. Most of the research works have been focused on feeding fish to satiation at different feeding frequencies, measuring intake and linking this to feed utilization and growth performance. Most studies have not put into consideration on how feed at a given ration level is effectively utilized at different feeding frequencies. Although few workers have reported that fish when fed on fixed ration at different feeding frequencies may produce fish of more uniform sizes (Jobling 1983, Wang *et al*. 1998), and also increase the efficiency in which feed is utilized (Giberson and Litvak 2003). The effects of frequency of feeding on the growth performance of different fish species fed to satiation have been reported. Ruothonen *et al.* (1998) found that rainbow trout, *Oncorhynchus mykiss*, grow faster and reach a greater final weight when fed four times every day compared with twice. Thompson *et al.* (2000) reported that hybrid sunshine bass (*Morone Chrysops* X *M. Saxatilis*) should be fed twice every day when grown indoors. Cuneate drum, *Nibea miichthioides* fingerlings according to Wang *et al.*, (2007) could be fed once a day when reared in pen.

Generally, *C. gariepinus* fingerlings performed optimally well when fed on 5% body weight per day. However, how this fixed ration is effectively utilized through the strategy of feeding frequency has not been reported. It was therefore, the aim of this study to determine the effects of different feeding frequency on growth, feed utilization, survival and body composition of fingerlings of *C. gariepinus* at a fixed ration level.

Materials and Methods

Experimental Set up

The experiment was done indoor at the Lagos State University Hatchery, Ojo, Lagos, Nigeria. 15 black plastic aquaria tanks each of 45L in capacity with water depth of

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26cm were supplied with bore-hole water through an elevated water shower.

Experimental Fish

Fingerlings of *C. gariepinus* were obtained from a commercial hatchery (Faired farm Ishashi, Lagos – Nigeria) and were transported early in the morning between 06:35h and 7.00h to Lagos State University hatchery. Fish were acclimatized for 72h in the hatchery before the commencement of the experiment. During this period, fish were fed on commercial diet (Copens, Netherlands).

Experimental procedure

Five experimental feeding frequencies were applied in triplicates and were designated as Treatments 1, 2, 3, 4 and 5 based on the following:

Treatment 1 – Fish fed 2 times every day at 0800h and 1800h

Treatment 2 – Fish fed 3 times every day at 0800h, 1300h and 1800h

Treatment 3 – Fish fed 3 times every other day at 0800h, 1300h and 1800h

Treatment 4 – Fish fed 8 times every day at 3 hour intervals

Treatment 5 – Fish fed 8 times every day 3 hour intervals weekend off

These feeding treatments were chosen based on the different feeding frequencies employed by fish farmers. Treatment 1 served as the control based on the fact that most fish farmers in Nigeria fed their fish twice daily.

At the start of the experiment, the acclimated fish were deprived of feed for 24h, to empty their gut content. Fish of mean weight 1.3±0.2g were randomly distributed into experimental tanks with 3 replicates at 10 fish per tank. The fish were randomly assigned with a feeding treatment. Treatment 1 serves as the control experiment based on the fact that African catfish are normally fed twice daily by most fish culturists.

All groups received the same type of commercial diet (Copens International Helmond, Holland). The composition of the diet is given in Table 1. Fish were fed based on the different treatments. Feeding of fish was done by hand and feeding level of all treatments was fixed at 5% body weight. During feeding, feeds were spread evenly across the water surface of each tank. Fish were weighed every two week and feed weights were adjusted based on weight changes. The experimental duration was 56days.

Table 1. Nutrient composition of experimental diet.

Crude protein	56%
Crude fat	15%
Crude fiber	0.4%
Phosphorus	1.8%
Antioxidant	2.2%
Vitamin E	200mg/kg
Vitamin C (stable)	300mg/kg
Copper	5mg/kg
Preservative	280mg/kg

Source: Copens, Netherlands

Water management and analysis

There was 50% exchange of water in all the tanks daily and continuous aeration was provided to each tank through air stones connected to air compressor. Water temperature, pH and dissolved oxygen concentrations in water were monitored every day. Ammonia was monitored once a week. Temperature was measured using a mercury glass thermometer. pH was measured with a pH meter (Jenway model 9060) dissolved oxygen with an oxygen meter (Hanna model H1-9142) while ammonia was determined in the laboratory according to APHA (1992). The water temperature varied between 26-28^{0}C, pH ranged from 6.8 to 7.7, dissolved oxygen levels varied from 4.8– 5.5mgL^{-1} while ammonia concentration in water was between 0.03-0.05mgL^{-1} throughout the experimental period.

Chemical analysis

Samples of the experimental fish at the beginning and end of the experiment were subjected to proximate analyses. Moisture was obtained by drying the sample at 65^{0}C in an oven until constant weight was obtained. Crude protein was determined by using the microkjeldah digestion method (N X 6.25). Crude lipid was determined by soxhlet – extraction method. Ash content was determined by combustion in a muffle furnace to constant weight at 600^{0}C. Crude fiber was determined by using the acid/base digestion process. Nitrogen free extract was calculated by taking the sum values for crude protein, crude lipid, crude fiber, total ash and moisture and subtracting these from 100. All analyses followed the procedures of AOAC (1990).

Calculations of growth and nutrient utilization parameters

Growth performance and feed utilization were measured in terms of weight gain (WTG), percentage weight gain (PWG), specific growth rate (SGR) feed conversion ratio (FCR), protein efficiency ratio (PER) and percentage survival. These parameters were calculated as follows:

WTG=Mean final bodyweight – mean initial bodyweight

$$PWG = \frac{\text{Mean weight gain}}{\text{Mean initial weight}} \times 100$$

$$SGR\ (\%BW/day) = \frac{(\log eWf - \log eWi) \times 100}{T}$$

Where T represents trial duration (day

Wf and Wi represent mean final and initial weights (g), respectively.

$$FCR = \frac{\text{Weight of dry feed fed (g)}}{\text{weight gain of fish (g)}}$$

$$PER = \frac{\text{Gain in weight of fish (g)}}{\text{Protein intake (PI) (g)}}$$

P1 =Feed intake (FI) X % protein in diet

F1 = 5% Body weight of fish per day.

Statistical analyses

All data were analyzed by one-way analysis of variance (ANOVA), followed by Duncan's Multiple Range Test to test for significant differences among treatments. Analysis was performed using the SPSS version 11 (Statistical Package for Social Sciences Version II). Significant level was chosen at p = 0.05. Values were expressed as means ± SD.

Results

Feed offered to fish was based on 5% body weight per day. The feed intake at different feeding frequency is shown in Table 2. The highest intake of feed was noted with fish fed 3 times every day followed by fish fed 8 times every day throughout the week and the lowest with fish fed 3 times every other day. The result of biweekly weight changes of fish fed at different feeding frequencies is presented in fig.1.

The figure shows that the weight of fish increased with increasing feeding frequency.

The results of growth and feed utilization are also presented in Table 2. The highest percentage weight gain of *C. gariepinus* was observed in fish fed 8 times every day and this result was not significantly ($p>0.05$) different from fish fed 8 times every day (weekend off feeding) but were significantly ($p<0.05$) different from other treatments. Fish fed 3 times every other day had the least percentage weight gain, followed by fish fed 2 times every day.

SGRs of fish fed 8 times throughout the week, and those fed weekend off 8 times per day were not significantly ($p>0.05$) different but were significantly ($p<0.05$) higher than fish fed 3 times every other day, 3 times every day and 2 times every day.

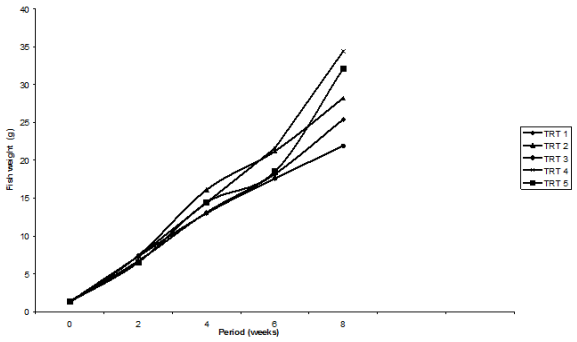

Fig 1. Weight changes of Clarias gariepinus fingerlings fed at different feeding frequencies.

TRT 1 – Fish fed 2 times everyday
TRT 2 –Fish fed 3 times everyday
TRT 3- Fish fed 3 times every other day
TRT 4- Fish fed 8 times everyday
TRT 5- Fish fed 8 times everyday weekend off

The FCRs of fish fed 2 times every day and 3 times every day were not significantly difference ($p>0.05$). Also, fish fed 8 times every day (weekend off) and 3 times every other day had the best FCR of 0.67 ± 0.05 and 0.67 ± 0.01 respectively. The poorest PER was observed in fish fed 3 times every day followed by fish fed 2 times every day with values of 1.49 ± 0.03 and 1.55 ± 0.09 respectively. The best PER was observed with fish fed 8 times every day (weekend off) with value of 2.69 ± 0.22. This value was not significantly different ($p>0.05$) with the value of 2.68 ± 0.03 of fish fed 3 times every other day.

At the end of feeding trial, no significant differences occurred in the content of moisture protein, lipid and ash of fish carcass among the treatments (Table 3).

Discussion

Throughout the experimental period, all feed offered to fish were consumed, there was no incidence of diseases or mortalities. Data from this study show that different feeding frequencies affected growth rate and feed utilization of fingerlings of *C. gariepinus*. Fish fed more frequently at 8 times every day throughout the week or 8 times everyday weekend off grew faster than those fed twice daily, 3 times every day, or 3 times every other day. Judging from the performance of fish in terms of percentage weight gain, SGR, FCR and PER, fish fed 8 times everyday weekend off showed the best optimum result; suggesting that *C.gariepinus* fingerlings could be fed 8 times everyday weekend off.

The increased growth with increasing feeding frequency has been demonstrated by many workers. Piper (1982) observed that rainbow trout (0.3g) grew best when fed 8 times every day than once or twice every day. Pullin and Lowe-McConnell (1982) recommended feeding tilapia *Oreochromis niloticus* L. fingerlings of 20g at 12 X daily. Andrews and Page (1975) reported that channel catfish, *Ictalurus punctatus* grew more slowly when fed once daily than when fed 2 or 4 times every day. Schnaittacher *et al*. (2005) found that feeding halibut five times every day resulted in significantly greater final weight than feeding once every day.

In contrast to the results of this finding, Linner and Braennaes (2001) reported that low feeding frequency had a significantly positive effect on rainbow trout growth in comparison to high feeding frequency. Davies *et al*., (2006) found that catfish, *Heterobranchus longifilis* fingerlings could be fed twice daily for higher growth performance. Pantazis and Neofitou (2003) reported that sub-adult of *Clarias*

Table 2. Effects of frequency of feeding on growth and feed utilization of *Clarias gariepinus* fingerlings.

Feeding Frequencies					
Parameters	**Treatment 1 2 times Everyday**	**Treatment 2 3 times Everyday**	**Treatment 3 3 times Every other day**	**Treatment 4 8 times Everyday**	**Treatment 5 8 times everyday Weekend off**
Initial weight(g)	1.4 ± 0.1	1.3 ± 0.1	1.3 ± 0.2	1.3 ± 0.2	1.3 ± 0.1
Final weight (g)	25.4± 4.0b	28.2 ± 3.2b	21.9 ± 1.6a	34.4 ± 2.6c	32.1 ± 5.8c
Weight gain (g)	24.0 ± 3.9b	26.9± 3.1b	20.6 ± 1.6a	33.07 ± 2.6c	30.8±5.6c
%Weight gain	1706.81±157.06b	2065.14±79.84b	1553.12±177.02a	2496.49±280.27c	2366.64±391.90c
Specific growth rate	5.2 ± 0.2a	5.5 ± 0.1b	5.0 ± 0.2a	5.8 ± 0.2c	5.7 ± 0.3c
Feed intake (g)	27.58± 2.9c	32.26 ± 3.21d	13.72 ± 0.92a	31.24 ± 2.30d	20.35 ± 2.18b
Protein intake(g)	15.45 ±1.61c	18.07 ± 1.80d	7.68± 0.51a	17.50± 1.29d	11.40± 1.22b
FCR	1.16 ± 0.07c	1.20 ± 0.02c	0.67 ± 0.01a	0.95 ± 0.03b	0.67± 0.05a
PER	1.55 ± 0.09b	1.49 ± 0.03a	2.68 ± 0.05d	1.89 ± 0.06c	2.69± 0.22d

Values in the same row having different superscripts are significantly different ($P < 0.05$) and values in the same row with no superscript are not significantly different ($P > 0.05$).

Table 3. Body composition (%) of fingerlings of Clarias gariepinus fed at different frequency.

Feeding Frequencies					
Parameter	Treatment 1 2 times Everyday	Treatment 2 3 times Everyday	Treatment 3 3 times Every other day	Treatment 4 8 times Everyday	Treatment 5 8 times Weekend off
Moisture	68.85±0.03	69.00±0.02	69.20±0.01	68.85±0.25	69.00±0.02
Protein	17.4±0.7	17.2±0.5	16.8±0.4	17.2±0.6	17.0±0.5
Fat	7.5±0.3	7.2±0.4	6.9±0.3	7.4±0.5	7.0±0.0
Ash	3.5±0.02	3.4±0.03	3.6±0.04	3.5±0.02	3.5±0.02

gariepinus exhibited better growth and food conversion when fed twice a day. Some workers found that feeding frequency did not influence fish growth as reported by Bailey *et., al* (2003) in Atlantic Salmon, *Salmo Salar*, Griberson and Litrask (2003) in Juvenile Atlantic Sturgeon, *Acipenser oxyrinchus*; Guroy *et al.*, (2006) in European sea bass, *Dicentrarchus labrax*.

From the results of the present study, it is evident that different feeding frequencies affected FCR. Fish fed 8 times every day (weekend off feeding) had the best FCR than fish fed either 3 times every day or 8 times every day throughout the week. This observation is in support of the works of Okumus and Baclinar (2001) in rainbow trout, *Oncorhynchus mykiss*; Rawland et al (2005) in silver perch; *Bidyanus bidyanus;* Lee, *et al.* (2000) in flounder, *Paralichthys Olivaceus*. These workers found that FCR was better with higher feeding frequency. On the contrary, Tsevis *et al.* (1992) reported that increasing feeding frequency resulted in an inferior feed efficiency in sea bass while Schnailtacher *et al.* (2005) observed that juvenile halibut that were fed less frequently processed their food as efficiently as fish that were fed more frequently. Some researchers also in contrary to the present report, found that different feeding frequencies have no effects on FCR: Wang *et a.l* (1998) in hybrid sunfish; Dwyer *et al.* (2002) in yellow tail flounder; Schnailtacher *et al* (2005); in juvenile halibut; Gandra *et al.* (2007) in *Pirarucu Arapaima gigas.* The different responses of fish to different feeding frequencies might be due to differences in fish species, fish size/age, different feeding methods, the structure of digestive system, differences in experiment set up among others.

In several fish species studied by various workers, increased fish growth with increasing feeding frequency has generally been attributed to increased food consumption when fish were fed to satiation (Ruothonen et al.1998; Thompson et al. 2000; Wang et al. 2007). In the present investigation, however, where fish were fed on a fixed ration, the increased growth rate at high feeding frequency might be due to better feed utilization efficiency rather than increase feed intake. This strategy of increased growth by the effective utilization of feed through frequent feeding has been reported by Kayano *et al.* (1993). These workers found that red-spotted grouper, *Epinephelus akaara* reared with the same feeding ration but different feeding frequencies showed high weight gain and high feed conversion efficiency at high feeding frequency, thus supporting the results of the present investigation.

The increased feed efficiency at high feeding frequency with *C.gariepinus* fingerlings might be as a result of the small size of the stomach coupled with frequent enzyme secretion at different sections of the intestine. This may have resulted to faster digestion rates of the small size meal and a quick return of appetite for the next meal and subsequently leads to efficient utilization of feed and better FCR. Supporting this, are the reports of Ruohemen and Grove (1996); Craig and Helfrich (2002) and Krogdahl and Bakke-Mckellep (2005). The low FCR that was obtained in fish fed 8 times everyday weekend off would be of commercial interest as this would certainly lower the cost of fish production. The two days of feed deprivation may have resulted to better food conversion and increased weight gain when fish were refed. This is in agreement with the claim of Ali et al. (2003) who reported compensatory growth when fish are deprived of feed for a period of time before refeeding. The high PER coupled with low growth observed in fish fed 3 times every other day is an indication that protein was not utilized for growth but for other metabolic processes. This is supported by Eroldogan et al. (2008). The benefits of feeding fingerlings of *C. gariepinus* 8 times every day (weekend off) are that feed is efficiently utilized, increased growth, higher economic returns to catfish culturists, less feed wastage and environmental sustainability.

In conclusion, this study suggests that African catfish fingerlings could be fed at a frequency of 8 times every day (weekend off). The two days off feeding will save about one week of feeding and labour cost per month, translating to about 25% saving. In addition, these off feeding days may improve the overall quality of the culture water, thus supporting environmental sustainability.

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