Advances in Environmental Biology, 4(2): 187-193, 2010
ISSN 1995-0756

This is a refereed journal and all articles are professionally screened and reviewed

ORIGINAL ARTICLE

Effect of Different Feeding Frequency on the Growth and Survival of African Catfish (*Clarias Gariepinus*) Fingerlings

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Marimuthu, K. Ang Chi Cheen and Muralikrishnan S, Kumar D.: Effect of Different Feeding Frequency on the Growth and Survival of African Catfish (*Clarias Gariepinus*) Fingerlings: *Adv. Environ. Biol., C(C): CC-CC, 2010*

ABSTRACT

An experiment was conducted to African catfish *Clarias gariepinus* fingerlings (1.623 ± 0.013 g) fed one of four feeding frequencies; once/day (1D), twice/day (2D), once every other day (1EOD) and twice every other day (2EOD) for 4 weeks. One hundred and twenty fishes were hand - counted and stocked into each of twelve 25 L round plastic troughs with three replicates/feeding regime under laboratory conditions. The fishes were fed *ad libitum* with commercial diet (38% protein, 5% lipid, 15% ash and 12% moisture). Significantly ($P< 0.05$) best percentage weight gain (371.57 ±26.77) and specific growth rate (5.535± 0.201) was observed in fish fed with twice/day groups compared to fish fed all other feeding frequencies. The lower feed conversion ratio (1.027 ± 0.261) was observed in fish fed with once every other day groups whereas no significant differences were noticed among the other feeding groups. Highest survival rate (96.67%±5.77) was recorded in fish fed once/day followed by (86.67±5.77%) twice/day fed groups. However, significantly no difference in survival rate was noticed among the feeding regimes. The body composition of African catfish fingerlings is also influenced by the different frequency of feeding. Based on the growth performance, cost the study suggests that twice/day feeding regimen is the best to obtain the highest growth rate in the African catfish fingerlings.

Key words: African catfish, *Clarias gariepinus*, nutrition, feeding frequency

Introduction

Recently the increasing popularity of aquaculture, feed constitute one of the highest operating expenditure in intensive practices. Several attempts have been made to reduce the feed cost by increasing the growth performance by employing suitable feeding strategy in order to maximize utilization of supplied nutrients to cultured fish, by mixed feeding schedule of alternating the high and low dietary protein level diet [12,21,17] and optimizing the feeding rate [39,14] and also by incorporating digestive enzymes in the diet [7]. Feed management in terms of optimization of feeding rate and frequency is become imperative in the culture of marine and freshwater fishes and it has become one of the crucial areas of research in the field of aquaculture. Overfeeding and waste food disrupts the water quality [37] while inadequate food supply has direct impact on production cost [36]. By controlling the optimum feeding frequency, farmers can successfully reduce the feed cost and maximize growth and also able to manage other factors such as individual size variation and water qualities which

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are deemed important in rearing of fish in culture conditions. Different species of fish have been shown to have different optimum feeding frequencies; young salmon fed continuously for 15 h/day [44], channel catfish twice a day [2], estuarine grouper once every 2 days [10], common carp three times a day [8], milkfish fingerlings twice/day [47], rainbow trout 3 times/day [42], hybrid sunfish 3 times/day [52], channel catfish once/day or twice/day [54,55], sunshine bass (*Morone chrysops x Morone saxatilis*) twice a day [53] and Red swordtail (*Xiphophorus helleri*) twice a day (James and Sampath 2003). Increased feeding frequency has been shown to improve the growth of several fish species.

The African catfish (*Clarias gariepinus*) is locally known as Ikan keli and belongs to the family Clariidae. It is a native fish species in African countries and it has been introduced and commercially cultured in several countries in Europe (Netherlands, Germany, Belgium) and Asian countries (Indonesia, Thailand, Malaysia) and South America (Brazil) [51,23]. It is one among the highly demanded freshwater food fish and cultivar species in Malaysia and elsewhere due to its resistance to diseases, ability to tolerate a wide range of environmental conditions and high stocking densities under culture conditions, relative fast growth rate, and good quality meat [19,22,25,27]. The African catfish inhabits in a wide range of water bodies like swamps, lakes and rivers. They are hardy and are able to thrive in harsh environmental conditions in muddy, turbid and oxygen depleted water bodies with the help of their accessory air-breathing organ (labyrinth organ) that allows them to breathe atmospheric oxygen. Generally, they are omnivores feeding nature. They feed on insects, plankton, snails, plant matter in the natural water bodies [6,50]. However, this species is highly cannibalistic when substantial differences in size occur [4]. In Malaysia, however its full aquaculture potential has not yet been realized in a large scale level. There are numerous reports available on the nutritional requirements and use of practical diets for African catfish [13,31,23,40,50,51,35] and limited information is available on feeding schedules for African catfish [26]. There is a need to know what feeding frequency is optimal, both financially and in terms of production. The objective of the study was to evaluate the effects of different feeding regimes on growth performance, food conversion, survival, and cannibalism of African catfish of *C. gariepinus* fingerlings which would lead to better larval rearing management during the critical period of larval phase.

Materials and methods

The feeding trial was performed at AIMST University, Malaysia. Brood fishes were obtained from a private fish farm, Sungai Petani, Malaysia. Ripe females and males with an average weight of (750 ± 75 g) were selected based on the method of Viveen *et al*. [51] for induced breeding. Larvae were fed exclusively on unhatched, decysted *Artemia* for a period of 5 days from 48 h after hatching, and then weaned gradually by supplementing the *Artemia* with a commercial diet. Afterwards the larvae were fed with commercial diet (Post larva I- crumbles, Gold Classic 901; 38% protein, 5% lipid, 15% ash and 12% moisture) only. Two weeks prior to the start of the feeding trials, 120 fish were selected and acclimated to 12 experimental plastic tanks (25 L capacity) at 10 fish per/tank. During the acclimation period the fishes were fed with the same commercial diet twice daily at *ad libitum*. At the start of feeding trial the acclimated fish were deprived of feed for 24 hrs, pooled, and 12 groups each of 10 fish with the initial mean weight of 1.623 ± 0.013g were randomly stocked into 12 experimental tanks. The fishes were fed one of four feeding schedules: (1) once/day (1D) at 08:00; (2) twice/day (2D) at 08:00 and 17:00 (3) once every other day (1EOD) at 08:00; (4) and twice every other day (2 EOD) at 08:00 and 17:00 respectively. The experiment lasted for 28 days, and the fishes were fed *ad libitum*. Each tank was covered with nylon mesh.

At the beginning of the experiment and at 7-day intervals all the fish from each tank were collected, counted, individually measured (nearest mm) and weighed (nearest mg) for four weeks. Continued aeration was provided by aquarium aerator and air stones. Approximately 80% of the water of each tank was exchanged with freshwater two times daily, in the morning (08.00 hrs) and in the evening (16.30 hrs). Each aquarium uneaten feed and waste excreta were also removed twice a day by siphon pipe with minimal disturbance to the fishes. After each sampling period, the amount of feed given was calculated. Dead fish in each tank were recorded daily. Dead or eaten fish were not replaced during the experiment. Cannibalism was calculated by recording the difference in fish numbers between each count [39]. The water quality parameters like pH, water temperature and dissolved oxygen (DO) level were measured weekly once. At the end of four weeks feeding trials, fish were deprived of feed for 24 hr, captured and weighed individually in all the treatments. Five fishes were sampled from each replicate for the determination of whole body composition. The sampled fish were frozen at −20 °C until analysis. The moisture, crude protein, lipid, and ash contents of experimental fishes were determined by standard methods [3].

Mean wet weight gain, specific growth rate (SGR) [(ln final weight)-(ln initial weight)/Number of days] X100; weight gain (%) = {[(final weight-

initial weight)/ initial weight]*100} and feed conversion ratio (FCR) [dry feed fed (g)/wet weight gain (g)] were estimated. All experimental data like final mean weight, survival and SGR, weight gain, FCR were subjected to one way analysis of variance (ANOVA) to determine the significant difference among the feeding frequency. Differences between mean values were assessed by Duncan's multiple range tests using SPSS (version 11.0) for windows software program for statistical analysis (version 11). Effects with a probability of (P< 0.05) were considered significant.

Results and Discussion

Physicochemical water quality parameters such as temperature, pH and dissolved oxygen were given in Table 1. The ranges of values of the physicochemical parameters during the experimental period were as follows: pH 6.26-6.45; dissolved oxygen 3.59- 4.75 mg/L and temperature 27.00 - 27.40 ºC. Mean temperature, pH and dissolved oxygen levels, were found to be not affected by feeding frequency during the four weeks feeding trial. The recorded mean values of all these parameters were within the acceptable limits for fish growth and health (Boyd 1979; Mazik et al. 1991).

Growth performance of African catfish fingerlings fed with different feeding regimes was presented in Table 2. Initially *C. gariepinus* fingerlings, had similar weight, and exhibited no significant difference among the treatment (P< 0.05). After 28 days of feeding trial, the final mean weight of African catfish fingerlings fed twice/day were significantly (*P* < 0.05) higher (7.653± 0.366) compared to fish fed once/day (3.607± 0.152), once every other day (3.370± 0.291), and twice every other day (4.066 ±0.156). Significantly highest growth (6.029 ±0.380) was observed in fish fed with twice/day followed by (2.446±0.148) in twice every other day. The daily specific growth rate of fish fed twice/day (5.535± 0.201) was significantly higher compared to fish fed twice every other day (3.285± 0.125). No significant difference (P> 0.05) with regard to SGR of fish fed with once/day (2.823± 0.154) and once every other day (2.618± 0.318). Significantly highest weight gain (371.57±26.77) was observed in fish fed with twice per day (p< 0.05) when compared to all other feeding regimes. The best food conversion ratio (1.027± 0.261) was observed in once every other day fed groups whereas no significant differences were noticed in all the other feeding regimes. Significantly the highest percentage survival (96.67± 5.77) was recorded in once per day fed groups followed by twice every other day (90.00± 0.00), twice per day (86.67± 5.77) fed groups respectively (P<0.05). Poor survival was noticed in once every other day fed groups.

The survival rate and cannibalism was not reduced by increasing or decreasing feeding frequency to fishes. Size variation in fish length was observed in all the treatments. In all the feeding regimes, most small fingerlings were cannibalized and all treatments had a few large individuals at the end of feeding trial. Proximate composition (moisture, protein, lipid and ash content) of fish fed with different feeding regimes are presented in Table. 3. The highest ash content was observed in experimental fishes than the initial control fishes. The higher lipid content was observed in fish fed with twice/day groups (P<0.05) when compared to other feeding regimes. Whole body lipid content was the lowest in the group fed with once a day (7.27 %) when compared to the other feeding regimes. The highest protein content (50.82%) was observed in the group fed with twice a day and (50.19 %) in twice every other day than the other treatments. Bio economical parameters analyses of the feed for the fish fed with different feeding regimes are summarized in Table 4. The cost of diet used in the present study was RM2.00/kg of diet. Based upon this value, it cost RM.2.68 to produce one kilogram of African catfish fed with twice a day.

Discussion

In the present study has showed that, growth performance of African catfish fingerlings can be significantly influenced by feeding regimes that strongly affect the feed ingestion and assimilation. The highest growth performance (final mean weight, weight gain percentage, and specific growth rate and food consumption) were recorded in fingerlings fed with twice/day groups followed by twice every other day fed groups. Fish that are fed less frequently can adapt to such conditions by consuming larger amounts of feed during each meal. If such a schedule is applied for a longer period, this can lead to increased gut capacity and to hyperhagia [28,41], Fish that are fed more frequently consume a larger amount of feed; however, when the intervals between meals are short, the food passes through the digestive tract more quickly, resulting in less effective digestion [33]. Hence, determining the optimum feeding frequency is imperative. Optimum feeding frequency for maximum growth of fish generally depends upon fish size, age and culture conditions including water temperature, food quality and amount of food provided [52,32]. Teshima *et al.* [47] observed that in milkfish, *Chanos chanos*, best growth performance was recorded in fingerlings fed twice/day than fish fed once/day, while Chiu *et al.* [9] reported that in milkfish, better growth was achieved in fish fed with eight times/day than when fed four times per day. Chua and Teng [10] reported that feeding estuarine grouper, *Epinephelus tauvina*,

Table 1: Water quality parameters of African catfish fingerlings (*C. gariepinus*) fed with different feeding frequency for a period of four weeks.

Treatments	pH	Temp. (°C)	D.O (mg/L)
Once a day (1D)	6.26± 0.32[a]	27.40± 0.32[a]	3.88± 0.45[a]
Twice a day (2D)	6.30± 0.30[a]	27.22± 0.30[a]	3.59± 0.65[a]
Once every other day (1EOD)	6.42± 0.15[a]	27.08± 0.23[a]	4.75± 1.06[a]
Twice every other day (2EOD)	6.45± 0.25[a]	27.00± 0.34[a]	4.27± 0.99[a]

Within the column the means with different superscript are significantly different at $P < 0.05$.

Table 2: Growth and survival of African catfish *Clarias gariepinus* fingerlings fed with different feeding frequency for a period of four weeks.

Treatment	Initial mean weight (g)	Final mean weight(g)	Mean weight gain (g)	SGR(%/day)	Weight gain (%)	FCR	Survival rate (%)
Once a day (1D)	1.634[a]±0.008	3.607[bc]± 0.152	1.970 [bc] ±0.153	2.823c± 0.154	120.55[bc] ±9.59	1.569[b]± 0.102	96.67[a]± 5.77
Twice a day (2D)	1.623[a]± 0.016	7.653[a]± 0.366	6.029 [a] ±0.380	5.535[a]± 0.201	371.57[a] ±26.77	1.497[b]± 0.105	86.67[ab]± 5.77
Once every other day 1EOD	1.615[a]±0.002	3.370[c]± 0.291	1.755 [c] ±0.292	2.618[c]± 0.318	108.67[c]±18.15	1.027[a]± 0.261	76.67[b]± 15.28
Once every other day (2EOD)	1.620[a]±0.019	4.066[b]± 0.156	2.446 [b] ±0.148	3.285[b]± 0.125	151..02[b]±8.67	1.624[b]± 0.083	90.00[ab]± 0.00

Values are means of three replications. Data are expressed as mean ± SD. Means with same superscript in the column are not significantly different at ($p< 0.05$).

Table 3: Carcass composition (dry weight basis) of fish fed with four feeding regimes.

Feeding regimes	Moisture (%)	Crude Protein %	Crude Lipid (%)	Ash (%)
Initial	76.5	44.62	7.18	14.05
Once/ day (1D)	74.6	44.44	7.27	21.37
Twice/day (2D)	75.9	50.82	10.22	21.03
Once on alternate day (1EOD)	75.2	48.30	8.28	21.47
Twice on alternate day (2EOD)	76.5	50.19	8.53	21.24

Table 4: Bio economic analysis of the feed for fish fed with different feeding regimes

Bio economy parameters	1D	2D	1EOD	2EOD
Mean weight gain (g)	1.970	6.029	1.755	2.446
Feed consumption (g/fish)	3.081	9.00	1.753	3.963
Feed supply cost (RM)	0.0060	0.0180	0.0037	0.0080
Total initial biomass cost (RM)	0.0130	0.0130	0.0130	0.0130
Total final biomass cost (RM)	0.0290	0.0613	0.0270	0.0327
Biomass gain cost (RM)	0.0160	0.0483	0.0140	0.0197
Profit	0.0097	0.0303	0.0107	0.0117
Feed cost for 1 kg fish production (RM)	3.137	2.990	2.057	3.247

Mean weight gain = Final mean weight (g) – initial mean weight (g)
Price of feed= 2.00/kg
Price of fish = 8.00 RM/kg
Feed cost /fish = per fish feed consumption x price of feed
Profit = (mean final biomass cost – mean initial biomass cost) - feeding cost
Biomass gain cost = (Mean final weight– mean initial weight) x Price of feed
Feed cost for 1 kg fish production (RM) = (Feed cost/mean weight gain) x 1kg

once every other day resulted in optimal growth, while weight gains were reduced in fish fed every 3, 4, or 5 days. In hybrid sunfish, fish fed once/day were smaller than fish fed 2, 3, or 4 times per day; however, there were no differences among the latter three feeding frequencies. These results are in contrast to reports by Webster *et al.* [54] growth performance (percentage weight gain and SGR) of channel catfish, *Ictalurus punctatus*, fed with once/day and twice/ day no significant difference was noticed. The closed related African catfish species, *Clarias lazera*, achieved the maximum growth when fed continuously [26]. Rainbow trout, *Oncorhynchus mykiss*, attained higher growth rates when fed three or four times per day when compared to fish fed once or twice per day [42], while the channel catfish, *Ictalurus punctatus*, showed a decrease in weight gain when fed 24 times per day [1]. In the case of the channel catfish, the authors stated that feeding twice per day resulted in better growth rate and food efficiency.

The present study similar to Davies *et al.* [11] who reported that catfish *Heterobranchus longifilis* fed twice/day had higher percentage weight gains, SGR and average final weight compared to fish fed once/day, once on alternate day and twice on alternate day. Data on Atlantic salmon, *Salmo salar*, has shown that feeding regimen has little influence on growth provided that the fish are fed at *ad libitum* [29,46]. A study by Alanara [1] also confirmed that frequent feeding with an automatic feeder had a negative effect on rainbow trout. Normally fish species exhibits a rapid increase in activity during feeding; this may suggest that frequent feeding is a stress factor that elicits great expenditures of energy thus reducing the fish growth.

With regards to food conversion ratio, low FCR values were recoded in African catfish fed with twice every other day followed by once a day and twice/day respectively whereas significantly no difference in FCR values observed in fingerlings fed with all the feedings regimes except once every other day fed groups. This indicates that the efficiency of feed utilization and feed conversion was not influenced by the feed frequency. This might indicate that African catfish fed more frequently might utilize

diet less efficiently than fish fed less frequently. Webster *et al.* [54] reported too in channel catfish fed once/day or twice/day had similar FCR values. Wang *et al.* [52] found that there was no difference in FCR among hybrid sunfish fed one, two, three, or four times /day. Hepher *et al.* [24] stated that feeding frequency had little effect on FCR. This may indicate that food consumption is the growth limiting factor. As found for other fish species [20,48,32,16], the greater the feed intake, the greater the growth response. This was the expected result since a higher amount of nutrients become available to the fish when they are fed more often. The water temperature, pH and dissolved oxygen recorded in this study fall between the acceptable range for fish growth and health [5,52,49,18]. In the present study, poor survival rate (76.70%) was observed in fingerlings fed with once every other day groups. However, no survival difference was observed in the other feeding regimes. This could be due to the time interval between the next meal is longer than the other feeding regimes that could have given more appetite, aggressive behavior and cannibalistic behaviour in the once every other day fed groups. Survival in the present study was higher than the range reported by Webster et al. (2001) in juvenile sunshine bass, *Morone chrysops X M. saxatifilis*, had survival rate between 62-75%. The survival rate range (68-90 %) was recorded in the catfish *H. longifilis* which is more or less similar to the present study. In fishes, cannibalism is usually associated with heterogeneous size variation, limited food availability, high population densities, limited refuge areas, and light conditions [39]. In the present study size variation and food availability are considered the primary causes of cannibalism.

This study suggests that body composition of African catfish fingerlings is affected by the frequency of feeding. African catfish fed once a day and once every other day had less lipid content than fish fed twice/day and twice every other day. Higher protein and lipid content was recorded in the fish fed with twice a day groups. Noeske-Hallin *et al.* [38] reported increased lipid levels in channel catfish fed twice daily compared to fish fed once daily. Webster *et al.* [56] reported, no significant differences in percentage moisture, protein, and lipid in fillet of channel catfish fed either once or twice daily. It has been demonstrated that, low body lipid content of fish resulted from declined feeding frequency [1,10,44,30,43,54,33,16]. Sveier and Lied [47] reported that body composition was not influenced when Atlantic salmon were fed once a day. The results of the present study based on the growth performance and feed utilization suggests that *C. gariepinus* fingerlings (1.623 ± 0.013 g) should be fed at twice a day for maximum growth and better survival.

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