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Original Article

Effects of Feeding Frequency on Growth Performance and Survival Rate of Angel Fish, *Pterophyllum scalare* (Perciformes: Cichlidae)

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Abstract

The freshwater angel fish (*Pterophyllum scalare* Schultze, 1823) is South American cichlid become very popular among aquarists. There is little information on their culture and aquarium husbandry. In this study growth performance and survival rate of angelfish subjected to different feeding frequencies were evaluated. Four groups of angel fish juveniles (0.87 ± 0.01 g; 3.98 ± 0.08 mm) were fed either four meals per day (F1), two meals per day (F2), one meal per day (F3) and every other day (F4) for 90 days. Final live weight and specific growth rate (SGR) values of group F1 and F2 were significantly higher than those of the other groups ($P < 0.05$). There was no significant difference ($P > 0.05$) in survival rate among the treatments. The best feed conversion ration (FCR) was obtained from four daily feeding (F1) ($P < 0.05$). Condition factor (CF) did not show a significant difference ($P > 0.05$) among experimental groups. In conclusion, the best results in growth performance were obtained by feeding four meals per day (F1) and two meals per day (F2), so they were recommended for angel fish feeding.
Key words: Angel fish (*Pterophyllum scalare*), Feeding frequency, Growth, Feed conversion ratio, Condition factor.

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Introduction

Ornamental fish farming is an important primary industry.[1] Ornamental fishes are often referred as living jewels due to their color, shape and behavior. They are peaceful, generally tiny, attractively colored and could be accommodated in confined spaces. Modern ornamental fish culture and breeding operations, have become vertically and horizontally intensified, necessitating a continuous supply of nutritionally balanced, cost-effective feed.[2] Among the most popular freshwater fish species in the aquarium trade industry is the angel fish (*Petrophyllum scalare*).[3] Angel fish, native to Amazon region of South America, is a cichlid in great demand due to its elegance, reproductive capacity and adaptability to captivity with high economic value.[4] In contrast to the culture of edible fish, information on the dietary requirements and feeding practices of ornamental fishes are limited.[5]

Nutrition is one of the most important factors influencing the ability of cultured fish to exhibit its genetic potential for growth and reproduction. They are also greatly influenced by factors such as behavior of fish, quality of feed, daily ratio size, feed intake or water temperature. Since the feed cost accounts approximately 40 - 60 % of the operating costs in intensive culture systems.[6] Therefore, in different fish species cultured under various environmental and husbandry conditions, more effort is needed to calculate the optimum feeding rates and frequencies.[7-10] Many authors studied the effect of feeding frequency on food intake and growth in edible fishes,[11-14] but little attention has been paid to the impact of feeding frequency on growth and reproductive performance in ornamental fishes.[15]

The present study was aimed at determining optimum daily feeding frequencies of fresh water angel fish.

Materials and Methods

This experiment was carried out in the institute of ornamental fish hatchery in Babol (Iran). For this purpose twenty juvenile angelfish which were produced (average weight 0.87 ± 0.01 g and average length 3.98 ± 0.08 mm) in hatchery were randomly stocked into each aquarium with three replications per treatment. The feeding trials were conducted in 12 (80 × 30 × 40 cm) glass aquaria. Gentle aeration was provided by air stones. Before beginning the experiment, the fish wet weight of each treatment was weighed on an electronic scale. During the experiment, the water quality parameters were monitored during the trial and average value for temperature, dissolved oxygen, hydrogen ion concentration (pH) and salinity were 27 ± 2°C, 5.7-7.7 mg l^{-1}, 6.9 - 7.8 units and 0.1 mg l^{-1} respectively. The light-dark cycle of 12:12 h was maintained during the feeding trial. In experiments, fishes were fed by commercial extruder diet (Biomar) to satiation. The analyzed proximate composition of the basal diet is shown in Table 1. Triplicates of four feeding schedules were tested: four meal in days (F1) (9 a.m., 12 p.m., 15 p.m. and 18 p.m.), two meals per day (9 a.m. and 18 p.m.) (F2), one meal per day (9 a.m.) (F3) and every other day (9 a.m.) (F4) for 90 days.

Accumulated feed and fecal waste were removed from tanks twice a week. The fish in each aquarium were collected and weighed every 10 days and basic water qualities were recorded daily. The mean live weight was calculated by dividing the total fish live weight in the aquarium by the number of fish in the aquarium. Total lengths of the fish were also measured.

From the data obtained during the periods following variables were calculated:

Specific growth rate (SGR) = $(\ln W_t - \ln W_0) \times 100\ t^{-1}$ (Hevroy et al 2005)[16]

Body weight gain (BWG) = $(W_t - W_0) \times N_t$ (Tacon 1990) [17]

Daily growth rate (DGR) = $[(W_t - W_0)/ t] \times 100$ (De Silva & Anderson 1995)[10]

Condition factor (CF) = $(W / L^3) \times 100$, (Ai et al 2006)[18]

Feed conversion ratios (FCR) = $P/ (W_t - W_0)$ (Shalaby et al 2006)[19]

Survival rate = $N_t \times 100\ N_0^{-1}$ (Ai et al 2006)[18]

W_t and W_0 were final and initial fish weights (g), respectively; N_t and N_0 were final and initial numbers of fish in each replicate, respectively; L (cm) was final length, P was amount of food offered (g), and t is the experimental period in days.

Statistical analysis of data was performed by One -Way ANOVA with Duncan test at the level of 95 % using SPSS 16. Statistical significance was set at the level of $P < 0.05$ with ± standard deviation (SD).

Results

Table 2 shows the growth performance in all different groups at the end of feeding trial. The mean body length and weight generally were improved by increasing the feeding frequency during the time (see figure 1 and 2). Additionally, specific growth rate (SGR) was improved significantly ($P < 0.05$) with increasing the feeding frequency. The growth data clearly indicated that SGR values of groups F1 (1.16 ± 0.05) and F2 (1.13 ± 0.05) were significantly higher than those of other groups ($P < 0.05$) and lowest SGR was observed in F4 (0.91 ± 0.04). Daily growth rate (DGR) was also promoted with the feeding frequency, and the difference was significant among treatments ($P < 0.05$). A significant difference was found in body weight gain (BWG) among angel fishes received two and four meals in a day (F1 and F2) with other two groups (F3 and F4). The highest BWG was observed in F1 (2.88 ± 0.12) and the lowest BWG was observed in treatment F4 (2.27 ± 0.09). Condition factor was checked at the end of the study. Differences among groups were not significant (Table 2). Considering the feed conversion, the best FCR was obtained from four meals a day feeding (F1) (1.45 ± 0.06) followed by two meals a day (F2) (1.49 ± 0.07) (Table 2). Effect of Feeding Frequency on survival rate did not show any significant differences among treatments.

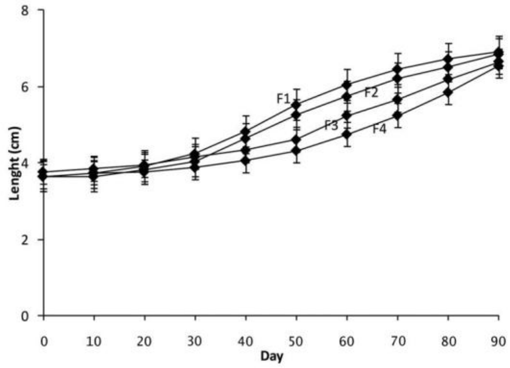

Fig 1. Average body length (± SD) of angel fish juveniles placed on different feeding frequency over a time period.

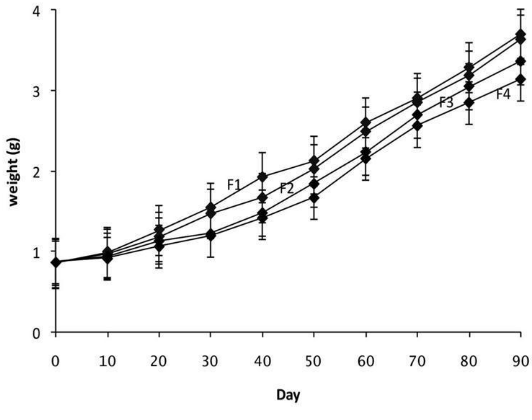

Fig 2. Average body weight (± SD) of angel fish juveniles placed on different feeding frequency over a time period.

Table 1. Nutrient composition of experimental diets (%)

Diet	Commercial extruder diet
Protein	54
Lipid	15
Fiber	1.5
Ash	10
Vitamin	2

Table 2. Growth factors in experimental groups

Parameters	F1	F2	F3	F4
Initial fish length (cm)	3.65 ± 0.76[a]	3.65 ± 0.60[a]	3.77 ± 0.09[a]	3.64 ± 0.07[a]
Final fish length (cm)	6.91 ± 0.11[a]	6.86 ± 0.04[ab]	6.65 ± 0.17[bc]	6.54 ± 0.14[c]
Initial fish weight (g)	0.86 ± 0.02[a]	0.86 ± 0.05[a]	0.87 ± 0.01[a]	0.87 ± 0.02[a]
Final fish weight (g)	3.70 ± 0.13[a]	3.64 ± 0.12[a]	3.36 ± 0.07[b]	3.14 ± 0.09[c]
Body weight gain (BWG)	2.88 ± 0.12[a]	2.77 ± 0.12[a]	2.49 ± 0.08[b]	2.27 ± 0.09[c]
Daily growth rate (DGR)	3.16 ± 0.13[a]	3.08 ± 0.13[a]	2.77 ± 0.09[b]	2.52 ± 0.10[c]
Specific growth rate (SGR)	1.16 ± 0.05[a]	1.13 ± 0.05[a]	1.01 ± 0.036[b]	0.91 ± 0.04[c]
Condition factor (CF)	1.12 ± 0.05[a]	1.13 ± 0.06[a]	1.15 ± 0.07[a]	1.13 ± 0.06[a]
Feed conversation ratio (FCR)	1.45 ± 0.06[a]	1.49 ± 0.07[a]	1.64 ± 0.02[b]	1.81 ± 0.06[c]
Survival rate (%)	91.67 ± 5.77[a]	96.67 ± 2.89[a]	88.33 ± 5.77[a]	95.00 ± 5.00[a]

Groups with different alphabetic superscripts differ significantly at $P < 0.05$.

Discussion

Fish age, size, and culture conditions, including food quality, amount of feed provided, and water temperature affect the optimum feeding frequency for maximum growth of fish [20]. Studies conducted on other fish species have shown that feed consumption and growth generally increased with feeding frequency up to a given limit. [14,21] This is in agreement with our findings in this study that feeding frequency had a significant effect on feed conversation ratio and growth in the angelfish. The optimum feeding frequency may vary with species and size of fish.[22] For instance, Andrews and Page[7] reported that the channel catfish *Ictalurus punctatus* (53 g) grew more slowly when fed to satiation once per day than when fed 2 or 4 times; however, no differences was detected in the food conversion ratio. These findings agree with our results. In a study by Grayton and Beamish[23], who fed rainbow trout fry (16 g), 3 meals a day were better than 1 or 6. Tsevis et al.[24] reported that increasing feeding frequency resulted in an inferior feed efficiency by sea bass reared at around 20 °C. Lee et al.[25] observed that a better feed efficiency in 3.5 g flounder, *Paralichthys olivaceus*, fed to satiety was obtained at a feeding frequency of 2 or 3 times daily than once in 2 days.

This study demonstrated a significant effect of feeding frequency on growth and food conversation ratio in juvenile angelfish. The highest weight gain was obtained ($P < 0.05$) by feeding the fish frequently (Two and four times a day). It is evident that a higher growth rate depends on both higher and more frequent daily feed supply. In general, feed conversion improves increasing feeding frequency.[26] Fish in the F1 and F2 groups were able to consume sufficient feed to maintain more positive rates of growth than fish in the F3 and F4 group. Feed conversion ratio and specific growth were enhanced at two and four times a day feeding. It shows that these feeding frequencies are optimal for the condition of this trial suggesting that both growth and feed utilization are most efficient at these frequencies of feeding. However, the inter-individual size variation of fish in the treatment group fed four times daily was much lower than in the other treatment groups. This supports the hypothesis that more frequent feeding yields fish of more uniform sizes [27]; this could arise because dominant individuals are less aggressive under such circumstances, or because more food is distributed to locations occupied by subordinates. The same author equally stresses the need to determine different feeding rates and frequencies for each species and different sizes of the same species, under varying culture condition. The ability of an organism to utilize nutrients especially protein will positively influence its growth rate.[28] This is justified by the highest growth and low FCR in the F1and F2. This suggested that fish must have efficiently converted feed consumed to growth. Condition factor, which is related to both growth and feeding, was another variable checked in the study. There were no differences between condition factor values amongst the groups.

To sum up, it can be concluded that increasing frequency in the fish feeding results in a better food accessibility reducing feed competition stress leading to a better growth performance. The success of angel fish culture depends on effective feeding frequency. A feeding frequency of two and four times a day compared to other experimental groups in our study seemed sufficient for effective growth and nutrient utilization.

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