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Effect of Different Feed Types on Growth and Feed Conversation Ratio of Angel Fish (*Pterophyllum scalare* Lictenstein, 1823)

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ABSTRACT

In this study, effects of commercial extruder diet (CED), commercial flakes (CF), *Daphnia magna* (DM) and 50 % commercial flakes + 50 % daphnia (CFD) on feed conversion ratio, specific growth rate and survival rate of angel fish (average weight 0,73±0,02 g) (*Pterophyllum scalare* Lictenstein, 1823) were investigated. The experiment groups were fed for 60 days. According to the results of this study, the best weight gain, specific growth rate and condition factor were found on commercial extruder diet group. The worst of growth was found on commercial flakes group. However, growth of CFD group fed with addition live food to commercial flakes (CF) containing low protein showed parallel growth to fish fed with commercial extruder diet contain high protein (CED).

Key Words: Angel fish, growth, feed conversion ratio, live feed

INTRODUCTION

Ornamental fish farming is an important primary industry [11]. Among the most popular fresh water fish species in the aquarium trade industry is the angel fish [5]. Due to its body coloration, shape and economical value [15], the angel fish represents one of the most important ornamental cichlid species. The freshwater angelfish, *Pterophyllum scalare* native to Brazil, of which most species are native to Africa and the Americans [9].

Lim et al., [12] reviewed importance of live feeds for feeding fish larvae, fry and fingerlings in ornamental fish culture. They reported that the success in the hatchery production of fish fingerlings for stocking in the grow-out production system is largely dependent on the availability of suitable live food organisms for feeding fish larvae, fry and fingerlings. In freshwater ornamental fish culture, Moina which is closely related with daphnia [17], used to be the most common live feed organism for feeding young fish in the industry [12]. However, the common live food used for growing of most ornamental fish is limited to macro-zooplankton such as Moina, Daphnia and Artemia nauplii [11]. Yurkowski and Tabachek [20] reported that essential amino acid levels in the cladoceran *Daphnia pulex* and the copepod *Diaptomus sp.* were equal or greater than fish requirements.Large commercial producers of aquarium fish in Singapore emphasise the importance of regular supplementation of formulated feeds with live feed, as the inclusion of live feed improves growth [4]. Daily supplementation of Daphnia spp. as live feed to swordtail (*Xiphophorus helleri*) broodstock maintained on an artificial flake diet resulted in a significant increase in fecundity as a result of more rapid growth, a higher number of embryos, and an improved feed conversion ratio, while supplementation of diets with Artemia increased growth of juvenile angelfish (*Pterophylum scalare*) [3]. Artificial diets, which are normally elaborated with dried live organisms that are processed in different presentations such as flakes, meals or small pellets, are also used. Although it is known that the angel fish accepts artificial diets [14], lower growth and survival rates of *P. scalare* are commonly obtained when such diets are used as the sole feed [13], mainly during the fry and juvenile stages [7,5].The purpose of this study is to examine the effect of various diets Commercial flakes (CF), *Daphnia magna* (DM), commercial flakes + daphnia (CFD) and commercial extruder feed (CED)) on the growth of fry *P. Scalare*.

MATERIALS AND METHODS

This experiment was carried out in the aquarium unit in Egirdir Fisheries Faculty Suleyman Demirel University in Turkey. The fifteen angelfish which are produced (average weight of 0,73±0,02 g) in University were randomly stocked into each aquarium with three replications per treatment. The feeding trials were conducted in 12 (70x30x40 cm) glass aquaria. Gentle aeration was provided by air stones. The water temperature was maintained at 26±2 ºC during the experiment. In experiments, we used four diets which were include commercial extruder diet with 49 % protein (CED), commercial flakes with 44 % protein (CF), *Daphnia magna* (DM) with 42 % protein and 50% daphnia + 50% commercial flakes (CFD). Nutrient compositions of four experimental diets are given Table 1.

Table 1 Nutrient composition of experimental diets (%)

Diets	*Daphnia magna* (DM)	Commercial flakes feed (CF)	Commercial Extruder Diet (CED)
Crude Protein	42.05	44	49
Moisture	-	9	8.21
Crude cellulose	13.5	4.92	2.35
Crude lipid	16.2	1.45	2.85
Crude ash	14.7	4.34	11.33

Commercial flakes and commercial extruder feeds were obtained from a special commercial feed plant and *Daphnia magna* was produced in circular tanks fertilized with horse feces. The experiment was conducted for 60 days with angelfish. Feeding ratio was adjusted as 4% for CED, CF, CFD and DM (according to dry matter). The daily ration was divided into three feedings and was fed by hand at 08:30, 12:30 and 16:30 hours. Each day, 15% of the total water volume of the aquarium was exchanged and feces and food waste were extracted out by siphoning.

All fish from each replicate were individually measured and weighed at the beginning and every two weeks until the end of the experiment. Wet weight (g) and standard length (cm) were determined at each sampling day, with an electronic balance (0,01 g sensitive) and a scale. Data were analyzed by analysis of variance (ANOVA) using the SPSS ANOVA procedure (Statistical Analysis Systems, 1988).

Duncan's multiple-range test was used to compare differences among individual means (P=0.05). Growth response parameters were calculated as follows:

Weight Gain (WG) = final fish weight – initial fish weight.

Feed Conversation Ratio (FCR) = total dry feed weight (g)/total wet weight gain (g)

Specific Growth Rate (SGR) = $(\ln W_f - \ln W_i \times 100) / t$,

$\ln W_f$ = the natural logarithm of the final weight

$\ln W_i$ = the natural logarithm of the initial weight

t = time (days) between $\ln W_f$ and $\ln W_i$

Survival (%) =100 x (final fish number / initial fish number)

Condition factor = Live weight/$(\text{Total length})^3 \times 100$

RESULTS AND DISCUSSION

Final mean weight, feed conversion ratio, specific growth ratio, weight gain (g), survival ratio, mean standard length are given in Table 2. Final mean weight angelfish fed with CED was shigher than fish fed with DM, CF, CFD diets. However, CED group is no statistical differences from CFD and DM group (P>0.05), but CED group was significantly different from CF group (P<0.05) [Table 2].

The best of the feed conversion ratio was found in DM group. Although DM group was similar to fish fed CFD and CED (P>0.05), was different than CF that exhibited the worst feed conversion (P<0.05).

Angelfish fed CED had the highest specific growth ratio (SGR), weight gain (WG) and fish survival ratio which was founded in CF, DM, CFD, CED groups 93.33, 86.66, 96.66, 100 %, respectively. The highest final mean length was obtained in DM group, while lowest final mean length obtained in CF group (P<0.05) [Table 2]. Condition factor in among groups was not showed significant different (P>0.05).

Table 2. Growth performance of the experimental diets fed with other grups and fish fed with CF obtained the lowest spesific growth ratio (SGR) and weight gain (WG).

Parameters	**Commercial flakes(CF)**	***Daphnia magna*(DM)**	**Commercial flakes + *D. magna*(CFD)**	**Commercial extruder diet (CED)**
Inital mean weight (g)	0,73±0,11[a]	0,75±0,04[a]	0,74±0,00[a]	0,75±0,04[a]
Final mean weight (g)	1,43±0,30[b]	1,99±0,06[ab]	1,96±0,04[ab]	2,23±0,40[a]
Food conversion ratio (FCR)	2,23±0,45a	1,48±0,08b	1,91±0,06ab	1,66±0,15ab
Weight gain (g)	0,70±0,14[b]	1,24±0,02[ab]	1,16±0,03[ab]	1,57±0,26[a]
Spesific growth ratio (SGR)	1,16±0,11[c]	1,69±0,03[b]	1,54±0,03[b]	2,08±0,22[a]
Survival rate (%)	93.33	86.66	96.66	100
Condition Factor (Initial of trial)	1,85±0,19a	1,98±0,03a	1,74±0,01a	1,94±0,02a
Condition Factor (Final of trial)	1,82±0,12a	1,80±0,08a	1,71±0,00a	1,87±0,02a
Initial mean lenght (cm)	3,40±0,20[a]	3,35±0,05[a]	3,59±0,03[a]	3,25±0,05[a]
Final mean lenght (cm)	4,43±0,07[c]	6,02±0,09[a]	5,12±0,06[b]	5,14±0,11[b]

Protein requirement in some aquarium fish including the angel fish (*P. scalare*) is exactly not known, in carnivorous fish, dietary protein requirement usually accounts approximately 40 to 50 % for fry [16,18]. According to some researches, it was declared that angel fish fed with diet containing high protein level was indicated better growth [3]. However, Zuanon et al., [21] reported that diets with 34% of crude protein can meet the protein nutritional requirements of freshwater angelfish fry. In this study; the highest weight gain of angelfish was obtained in CED group fed with commercial extruder diet including high protein (49 % protein). Lowest weight gain was found in group fed with commercial flakes including lower crude protein level. According to these data, it can be said that angelfish can better use higher level protein than lower protein. These findings agree with those of Degani [3] and Soriano-Salazar and Hernandez-Ocampo [18].

Good performance of live foods was explained and supported in earlier studies by Dabrowski and Glogowski [2]; Kolkovski et al., [8]. Soriano-Salazar and Hernandez-Ocampo [18] evaluated the use of live food and two inert commercial diets on the growth of *P. scalare*. According to their result, live food (*Daphnia pulex*) containing higher protein showed better fish growth performance and survival. Similar observations was made by Luna-Figueroa [15], who compared two live foods (*D. pulex* and *Culex quinquefasciatus* larvae, with 50.15 and 40.18% crude protein, respectively) and three commercial flakes with different protein levels (45, 43 and 27% crude protein) for on-growing angel fish juveniles. In conclusion organisms fed with *Daphnia pulex* and *C. quinquefasciatus* experimented a higher reproduction and growth influence than with commercial food.

Garcia-Ulloa and Gomez-Romero [5] fish fed with the decapsulated Artemia cysts (DAC) diets showed the highest mean standard length, wet weight and specific growth rate compared with the rest of the treatments.

But, in our study was found that live food provide similar growth with commercial diet including high protein in angel fish culture. It can be explain that protein ratio of commercial diet (CED) used in our experiment was higher than protein ratio of *Daphnia magna*.

Growth of angelfish fed with diets containing 37%, 41% or 47% protein did not show significant differences. However, the addition of live feed (artemia) to the diet significantly raised the growth rate, especially in the higher protein diets [3]. Sautter et al., [19] studied on catfish (*Synodontis petricola*) found statistically better results with enriched live feeds (58,5-60,6% protein) than artificial diet (51% protein). Gordon et al., [6] studied clownfish (*Amphiprion percula*) and found same final mean weight with three different diet (dry including high protein, dry\live and dry\natural).

Soriano-Salazar and Hernandez-Ocampo [18] indicated that in angel fish fed with live feed was obtained better FCR than angel fish was fed with commercial diets. Kruger et al., [10] observed that fish fed with supplementation of daily Daphnia to drum-dried flake feed grew faster and had a better feed conversion ratio (FCR) than those receiving weekly *Daphnia* supplementation or flake feed only. But Zuanon et al., [21] found same FCR in different protein levels. In the present study, the lowest FCR was found in group fed with live food (DM) group (1.48), the highest FCR was obtained group fed with commercial flakes contain low level protein (2.23). There is significant difference between DM and CF groups ($P<0.05$), but difference among other groups was not significant ($P>0.05$).

Abi-Ayad and Kestemont [1] were used three different diets for goldfish larvae: D1 (Artemia nauplii), D2 (Artemia nauplii + 50% dry feed) and D3 (dry feed). At the end of the second week, specific growth rate was high in the groups fed with diet D1, intermediate in the D2-fed groups and low in the D3-fed groups. During the third week, the best specific growth rate was observed in the groups fed the D2 diet. Soriano-Salazar and Hernandez-Ocampo [18] was reported the specific growth rate (SGR) (mg/day) for the *P. scalare* broods receiving *D. pulex* was greatest ($P<0.05$) at 4.86 mgday^{-1}. SGR in angelfish fed with Tetra-Bits and Sera was 3.58 mg day^{-1} and 3.35 mg day^{-1}, respectively. In the present study, the worst SGR was found in fish fed with CF diet including lower level protein and best result found in CED group.

The best survival ratio was obtained in commercial extruder feed group as 100 %. However, survival rates were similar in all groups between 86.6-100 %. García-Gómez [5] and Sautter et al., [19] also found similar results with our research.

Luna-Figueroa [15] indicated that while total length was 14.08%, 42.25%, 54.92% and 64.78% ($P<0.05$) greater with water fleas than with mosquito larvae and commercial food I, II and III respectively. Soriano-Salazar and Hernandez- Ocampo [18], found that angel fish fed with daphnia showed better final mean length from two different commercial diets. Total length in angelfish fed daphnia statistically was obtained better results than other groups in our study. Lowest length was found in flake diet. As a result, daphnia showed highest final mean length to angelfish that agree with Figueroa and Soriano-Salazar and Hernandez-Ocampo's result.

According to these results, it was found that angel fish fed with diet including higher level protein (49 %) was showed better growth. Hovewer, suplementation of live feed to diets containing lower level protein was indicated similar growth with diet containing higher level protein.

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