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Effect of *Spirulina platensis* Meal as Feed Additive on Growth Performance and Survival Rate in Golden Barb fish, *Puntius gelius* (Hamilton, 1822)

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Abstract: The effect of *Spirulina platensis* on the growth and survival rate of Golden Barb fish (*Puntius gelius*) was investigated as a protein source in a 2 months feeding trial. *S. platensis* was added to the basal diet at 0% (Control), 5, 10 and 20% and fed to Golden Barb fish. The growth of Golden Barb fish was related to the level of *S. platensis* containing. The final weight gain, specific growth rate, feed conversion ratio of fish were affected by spirulina supplementation ($p>0.05$). The highest Feed Conversion Ratio (FCR), 3.55±0.10 was found in the fishes that were cultured with 20% of *S. platensis*. The survival rate was not affected by different amount of spirulina. The results of the present study clearly demonstrate that *S. platensis* could be considered as a protein source for incorporation in Golden Barb fish diets to gain more weight.

Key words: *Spirulina platensis*, Golden Barb fish, growth performance cyanobacteria, FCR, Iran

INTRODUCTION

Puntius is a genus of ray-finned fishes in the family Cyprinidae of the order Cypriniformes (De Graaf *et al*., 2007). Fishes of this genus are known as the spotted barbs for the predominant pattern, though many have vertical black bands instead. Fishes of the genus *Puntius* are prolific and are known to occupy all niches (Jayaram, 1999). These fishes have been well studied and have been exploited for the aquarium trade and transported throughout the world. One such fish is *Puntius gelius* which was first described by Hamilton-Buchanan (1822) in his research on the fishes of the River Ganges. In the same research, he also described another fish very similar to *P. gelius* but for the characteristic spots on fin bases called *P. canius* which was later synonymized as *P. gelius* by Day (1878). *P. gelius* is a colorful fish which grows to a maximum of 5 cm in length (Menon, 1999).

Microalgae are the natural foods of all aquatic animals. The use of microalgae in aquaculture is favored by several factors: Microalgae are the natural feeds of many aquaculture species and the basis of the natural food chains on which such species depend in the wild. Microalgae have high nutrient value; containing specialty feed components including pigments essential fatty acids and vitamins (Benemann, 1992). The use of microalgae in aquaculture has potential advantages due to the high conversion efficiencies (Benemann, 1992). Microalgae and their products support fish growth and it might be practical to feed microalgae to fish with little or no processing (Stanley and Jones, 1976).

Spirulina is a source of phycobiliproteins that are used as fluorescent markers in biomedical research. Earlier studies examined how supplementing the diet with dry spirulina powder affected the taste and quality of fishes (El-Sayed, 1994; Mustafa *et al*., 1994; Watanabe *et al*., 1990). Watanabe *et al*. (1990, 1993) reported that 5% dietary spirulina supplementation depressed the lipid in the muscle and improved the taste and texture of striped jack *Pseudocaranx dentex*. Other studies suggested that using spirulina in the feed of seabreams resulted in a high value product with a good market and high prices, apparently because the spirulina significantly increased the stromal fraction which mainly contains collagen (El-Sayed, 1994; Mustafa *et al*., 1994). In the case of ayu *Plecoglossus altivelis*, it has been claimed that fish grown on feed containing spirulina are of better quality, with better flavor, firmer flesh and brighter skin color (Mori *et al*., 1987).

As the pigmentation additive, spirulina was also found to improve the color of Golden Barb. The feeding raw spirulina as uni-feed to tilapia *Puntius gelius* resulted in slightly better evaluations of color, texture and fatness than were obtained with commercial diets. The taste and smell evaluations were not different between the fish fed the spirulina and those fed commercial diets (Lu and

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Takeuchi, 2002; Lu *et al*., 2003). Only few data on growth performance are available for Golden Barb fed with diet containing *S. platensis*.

The objective of this present investigation was study the efficacy of a fresh cell of cyanobacterium (blue-green algae), *Spirulina platensis* as a feed ingredient, on growth and survival of Golden Barb in order to evaluate the suitability of the cyanobacterium as a feed ingredient.

MATERIALS AND METHODS

Experimental unit: About 12 aquaria of 80×30×40 cm (length x width x depth) was prepared at a private fishery laboratory in Gorgan, Iran.

Experimental animal: The fish were received from a general fish stores in Gorgan. A total of 108 fish, the average weight of each fish before the experiment was 1.35±0.10 g and total length of 2.7±0.25 cm.

Experimental diets: The different feeding combinations (4 formulas of diets) were prepared as follows:

Diet 1: The combination of feed containing 100% fish meal (T1 or control)
Diet 2: The combination of feed-stuff supplemented with 5% dried spirulina powder (T2)
Diet 3: The combination of feed-stuff supplemented with 10% dried spirulina powder (T3)
Diet 4: The combination of feed with 25% dried spirulina powder (T4)

Preparation of experimental diet: Well mixed feeding materials were packed in plastic bags and kept in the refrigerator at -18°C throughout the experiment. Micro-Kjeldahl methods were used to analyze protein content in feeds (AOAC, 1975). Fish were fed 2 times each day at 3% of Body Weight per day (BW day^{-1}) and the feeding rates were adjusted fortnightly.

Feed analysis: Nutrient compositions of experimental diets (Biomar) are given in Table 1 and typical nutritional composition of spray-dried spirulina powder is in Table 2. Proximate composition of diets was carried out using the association of analytical chemists (AOAC, 1975) methods. Protein was determined by measuring nitrogen (N×6.25) using the Kjeldahl method; crude fat was determined using petroleum ether (40-60 bp) extraction method with Soxhlet apparatus and ash by combustion at 550°C.

Determination of growth parameters: Growth parameters were calculated as follows: Body Weight Gain (BWG) = Final fish weight (G) - Initial fish weight (G) (Tacon, 1990). Specific Growth Rate (SGR) = (Ln W_t - Ln W_0) × 100 t^{-1} (Hevroy *et al*., 2005). Survival rate = (N_t × 100 N_0^{-1}) (Ai *et al*., 2006).

Table 1: Nutrient composition of experimental diets (%)

Ingredients	Percentage
Protein	54.0
Lipid	18.0
Fiber	1.5
Ash	10.0
Vitamin	2.0

Table 2: Typical nutritional composition of spray-dried spirulina powder

Ingredients	Percentage
Crude protein	60.0
Carbohydrate	20.0
Fats	5.0
Minerals	9.0
Moisture	6.0
Carotenoids (Red/yellow)	0.3
Chlorophyll (Green)	1.0
Phycocyanin (Blue)	12.5

Statistical analysis: In order to determine significant differences, results were analyzed by one-way Analysis of Variance (ANOVA) and Duncan's multiple range tests were used to analyze the significance of the difference among the means of treatments by using the SPSS-17 programmer.

RESULTS AND DISCUSSION

Growth factors are summarized in Table 3. Results clearly show that the feeding rate showed a remarkable increment at 20% of *S. platensis* over the control. It, however, followed a decreasing trend beyond 20% of spirulina.

Fish larvae can be fed spirulina either through gut-loaded rotifers and Artemia or through formulated microparticulate diets. Spirulina powder mixes easily with other ingredients for pelletizing. Care should be taken not to overheat the product. Temperatures high enough to denature carbohydrates will destroy the beneficial properties found in spirulina. The basic method may be adapted to other species and local conditions. Best results are achieved when spirulina is used in combination with fat-rich, live algae like diatoms. Spirulina powder is very rich in protein and vitamins but does not contain enough fat for growing larvae. Fat-rich diatoms, together with dried spirulina can form an ideal diet that results in very strong postlarvae. Dried spirulina may be used at each feeding or the hatchery operator may want to alternate it with a high quality, artificial microparticulate diet and Artemia, depending on local conditions and availability.

Table 3: Growth parameters and survival rate of Golden Barb fish (*Puntius gelius*) in the experimental treatments

Parameters	Control	5%	10%	20%
Initial weight (g)	1.35±0.10	1.35±0.10	1.35±0.10	1.35±0.10
Final body weight (g)	3.30±0.03^{c}	3.80±0.20^{b}	3.90±0.05^{b}	4.20±0.07^{a}
Body weight gain (g)	1.95±0.07^{b}	2.45±0.18^{a}	2.55±0.05^{a}	2.85±0.03^{a}
Specific growth rate for weight (BW day^{-1} (%))	2.12±0.64^{b}	3.72±0.79^{a}	3.69±0.41^{a}	3.55±0.10^{a}
Survival rate (%)	100^{a}	100^{a}	100^{a}	100^{a}

Data are represented as mean±SD; means with the same letters in the same row are not significantly different

The present study demonstrates that the increased feed intake coupled with the improved food conversion could have enhanced the growth rate in the young ones of *Puntius gelius*; while, it is very well clear that the spirulina treated fish have better growth rate than the control, the maximum growth, however, is achieved from 20%. Next to 20%, 10% was found to be effective. However, the under 5% showed a declining trend in growth parameters.

Cyanobacteria have been found to be a good source of protein for fish (Nandesha *et al*., 2001). In addition, cyanobacteria have been reported to have no cell wall which results in improved digestion and absorption (Desikachary, 1959). The growth of Golden Barb being positively affected at all levels of *S. platensis* inclusion. The difference in the FCR may also be due to a difference in the chemical composition of the diets.

No significant different of survival of Golden Barb in this study possibly due to high protein content (54%) of the control diet that was enough to enhance immunity of the fish. The growth and survival rate of Golden Barb being positively affected at all levels of *S. platensis* inclusion, thus clearly indicate the suitability of *S. platensis* for incorporation in the diet.

CONCLUSION

Spirulina is a rich source of protein, vitamins, minerals and pigments. It also enhances the non-specific immune system, increasing the state of readiness of natural defenses. The combination of nutrients, pigments and immunostimulants explains reports of dietary spirulina yielding better growth, reduction of stress and better appearance. Golden Barb fed diet containing 20% of *S. platensis* gave the best result of growth, FCR. The results of the study clearly demonstrate that raw cyanobacterium *S. platensis* could be used as a protein and lipid sources to incorporate into Golden Barb diets to have a better culturing and gain market acceptance.

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