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Effect of spirulina (*Spirulina platensis*) fortified diets on growth performance of two important cold water fishes viz. *Barilius bendelisis* and *Schizothorax richardsonii*

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ABSTRACT

Two important coldwater species viz. *Barilius bendelisis* and *Schizothorax richardsonii* of almost similar length and weights were collected from local streams and reared in laboratory condition for sixty days in triplicate to study the effect of spirulina (*Spirulina platensis*) fortified diets (0, 3, 5, 7 & 10 %) on their growth performance. Both the species are important coldwater species and very much considered as food and ornamental value. Supplementing 7-10% spirulina in the diets of both the fishes resulted increased weight gain (WG- 224& 226 %, respectively), specific growth rate (SGR-2.0 for both the species) and decreased food conversion ratio (FCR-1.2 for both the species) in comparison to control (T0) group (WG 88 %; SGR 1.0 % and FCR 3.4). Results revealed that supplementing 7-10% of spirulina in fish diet results higher growth rate, decreased FCR with higher survival rate, leads to higher return from the fisheries business.

Keywords: Coldwater fishes, Spirulina, Growth, Survival, FCR.

Introduction

The Indian hill trout (*Barilius bendelisis*) and Snow trout (*Schizothorax richardsonii*) are small indigenous fish endemic to Himalaya, thrives well in coldwater streams, lakes and rivers (Jha et al., 2010). Both are having commercial importance due to their ornamental and food value hence widely cultured in hilly regions of Himalaya (Jha *et al*., 2012).

The food value of fish is determined with the quality and quantity of protein and other nutrients present in the muscle while the ornamental value is associated to the coloration due to carotenoids or pigment bearing substance in the tissue (Halten *et al*., 1997). Inadequate pigmentation, retarded growth with degraded muscle composition is always noticed in cultured fishes due to lack of carotenoid and other nutrient content in their artificial diets (Jha *et al*., 2010). In wild, fishes are getting quality food required for their proper growth, pigmentation and nutrient profile. But, in captive condition, lack of nutrients and pigment bearing substance, results in retarded growth, faded coloration and degraded nutrient profile of the fish.

In an aquaculture system, natural food is not sufficient to sustain optimum production. Hence it is vital to provide a nutritionally balanced diet for optimum aquaculture productivity. Nutritionally balanced diet contains carbohydrate, fat, proteins, vitamins, minerals and carotenoids for sufficient growth and pigmentations (Jha *et al*., 2010).In aquaculture industry, many feed additives like carrot, beet root, red pepper, marigold flower, rose petals, China rose, chestnut flowers, spirulina, crustacean wastes, yeast, synthetic astaxanthin, vitamin C and vitamin E have been utilized since long to achieve desired flesh quality of various fish species (Chapmann, 2000; Gocer *et al*., 2006; Ezhil *et al*., 2008; Jha *et al*., 2012).

As feed additive, dried algae improve growth, feed efficiency, carcass quality and physiological response to stress and disease in several species (Mustafa and Nakagawa, 1995).Amongst various algae, spirulina is considered a rich source of protein having 65-70% protein (Lornz, 1999), vitamins, minerals, essential amino acids, fatty acids (gama-linolenic acid (GLA), antioxidant and pigment such as carotenoids (Belay *et al*., 1996) in addition, it is also effective as an immune-modulator (Takeuchi *et al*., 2002). Spirulina is the only microalgae additive, which demonstrates benefits to growers that offset the initial cost and provide a significant cost/performance ratio. Spirulina has been studied over the globe by the scientists as a feed supplement for various fishes and found to significantly improve growth, survival and feed utilization (Belay *et* *al*., 1996; Takeuchi, 2002). Therefore, the purpose of this study was to investigate the effect of spirulina (*Spirulina platensis*) fortified diets on growth performance of above mentioned two important coldwater fishes in order to increase their production.

Materials and Methods

Experimental animal

Fingerlings of *B. bendelisis* and *S. richardsonii* of the average weight of about 5.6g were collected from a local stream of Nainital (Uttarakhand), transported in a circular container (500 L) with sufficient aeration, to the experimental site at hatchery complex of Directorate of Coldwater Fisheries Research (ICAR), Bhimtal and were acclimatized to the experimental rearing conditions for one week. During acclimation, fish were fed with control diet. After acclimatization, fishes were transferred to 15 uniform size experimental fiberglass tanks (separately for both the fishes) of 100L capacity and reared for 60 days.

Experimental design and feeding

Five iso-nitrogenous (35.25±0.9% crude protein) diets were prepared with graded level of (0, 3, 5, 7 and 10% of diet) spirulina (SP) meal. Both the fishes (150 nos. of each) were randomly distributed in 5 experimental groups, separately, in triplicate following a completely randomized design (CRD). There were 5 treatment groups, viz.T0 (control), T1 (3% SP), T2 (5% SP), T3 (7% SP) and T4 (10% SP). The control (T0) was common for both the fishes, while treatments were divided into eight group viz. for *Barilius bendelisis* it was BS-1 (fed on T1), BS-2 (fed on T2), BS-3 (fed on T3) and BS-4 (fed on T4) and for *Schizothorax richardsonii* it was SS-1 (fed on T1), SS-2 (fed on T2), SS-3 (fed on T3) and SS-4 (fed on T4). The physicochemical parameters of water were analyzed by APHA (1995) methodology, and were within the optimum range (dissolved oxygen: 6.0–8.5 mg/l, pH: 7.3–8.2 and temperature: 18–20 °C) throughout the experimental period. All the groups were fed their respective diets. Feeding was done at 5% of the body weight. Daily ration was divided into 2 split doses: about 2/3rd of total ration was given at 09:00 h and the rest at 18:00 h. The fecal matters were removed by siphoning and a constant water flow (2-3 L/M) was maintained by providing inlet at one and outlet at the other end to ensure optimum dissolved oxygen throughout the experimental period. A very few accidental mortality (10%) was observed during the 60 day experimental feeding trial. The composition of the diets are given in the Table-1.

Table1: Diet composition (%)

Ingredients	Diets				
	T_0	T_1	T_2	T_3	T_4
Fish meal	20.27	20.27	20.27	20.27	20.27
Soybean meal	20.27	20.27	20.27	20.27	20.27
Rice bran	29.73	26.73	24.73	22.73	19.73
Wheat bran	21.73	21.73	21.73	21.73	21.73
Vitamin-Mineral Mix[1]	2.00	2.00	2.00	2.00	2.00
Vegetable oil[2]	2.00	2.00	2.00	2.00	2.00
Fish oil[3]	2.00	2.00	2.00	2.00	2.00
Sodium alginate[4]	2.00	2.00	2.00	2.00	2.00
Spirulina meal	**0**	**3.00**	**5.00**	**7.00**	**10.00**
Total	100	100	100	100	100

[1]Agrimin Forte (Virbac Animal Health India Pvt. Ltd., Mumbai-59, India). Each kg contains- Vitamin A-7, 00,000 I.U., Vitamin D3-70, 000 I.U., Vitamin E-250 mg, Nicotinamide-1000mg, Cobalt-150 mg, Copper-1200 mg, Iodine-325 mg, Iron-1500 mg, Magnesium-6000 mg, Manganese-1500 mg, Potassium-100 mg, Selenium-10 mg, Sodium-5.9 mg, Sulphur-0.72%, Zinc-9600 mg, Calcium-25.5%, Phosphorus-12.75%. [2]Ruchi Soya Industries Ltd., Raigad, India. [3]Procured from local market; [4]Himedia Ltd. India

Growth study

Growth rate of fish was measured in terms of weight gain (WG %), specific growth rate (SGR %) and feed conversion ratio (FCR) using the following equations.

SGR (%) = [(Log final weight – Log initial weight) / number of experimental days] × 100

WG (%) = [(final mean weight – initial mean weight) / initial mean weight] × 100

FCR= feed given (dry weight) / body weight gain (wet weight)

Statistical analysis

Mean values of all the parameters were subjected to one way ANOVA to study the treatment effect, and Tukey's test (HSD) were used to determine the significant differences between two means. Comparisons were made at 5% probability level. All the data were analyzed using statistical package SPSS (Version 12.01).

Results and Discussion

The proximate composition of the diets used in this study is given in the Table-2. The proximate composition of the diets did not varied significantly.

Table 2: Proximate composition of different diets (% dry matter basis)

Particulars	Diets				
	T_0	T_1	T_2	T_3	T_4
Moisture	13.28±0.02	13.40±0.03	13.15±0.01	13.34±0.05	13.30±0.02
Crude protein	35.21±0.08	35.32±0.05	35.10±0.02	35.20±0.01	35.09±0.02
Ether extract	7.65±0.02	7.80±0.01	7.25±0.02	7.97±0.03	7.45±0.02
Ash	10.85±0.05	11.01±0.02	10.90±0.04	11.00±0.03	11.08±0.05

Data expressed as Mean±SE, n=3

The growth parameters of *Barilius bendelisis* and *Schizothorax richardsonii* in experimental groups at the end of feeding trial are shown in Table 3 and SGR-FCR are compared in Fig. 1. Supplementation of 10 % dietary spirulina meal (T4) significantly (P<0.05) increased specific growth rate (SGR %) and reduced feed conversion ratio (FCR) compared to control group (T0) in case of *B. bendelisis*, while in case of S. richardsonii7 % dietary spirulina meal (T3) reported significant (P<0.05) in terms of specific growth rate (SGR %) and reduced feed conversion ratio (FCR) compared to control group (T0). Improved growth rate and decreased FCR was noticed with the diet containing higher quantity of carotenoids in the form of spirulina meal and an inverse relation between SGR and FCR was also noticed in the present study (Fig. 1). This is due to the fact that utilization of carotenoids leads to improved growth and decreased FCR (Jha *et al*., 2013). Sarma *et al*. (2010) also observed the similar trend and reported that with increase in spirulina content in the fish diet as protein source, FCR decreases, the similar results were also confirmed by both the species in the present study.

Table 3: Growth performance of *Barilius bendelisis* and *Schizothorax richardsonii* fingerlings fed diets with graded level of spirulina meal, mean±SD, n=3 (10 fish per replicate).

Treatments	WG (%) Mean±SD	SGR (%) Mean±SD	FCR (Mean±SD)
Control	88±16^a	1±0.1^a	3.4±0.9^c
BS-1	148±6^b	1.5±0^b	1.8±0.1^b
BS-2	174±37^b	1.7±0.2^c	1.6±0.4^b
BS-3	203±24^b	1.8±0.1^c	1.3±0.2^a
BS-4	224±15^c	2±0.1^c	1.2±0.1^a
SS-1	166±7^b	1.6±0^b	1.6±0.1^a
SS-2	217±31^c	1.9±0.1^c	1.3±0.2^a
SS-3	226±6^c	2±0.1^c	1.2±0.1^a
SS-4	226±25^c	2±0^c	1.2±0^a

Values in a column with different superscripts differ significantly (p<0.05).

In resemblance with the present observation, Christiansen *et al*. (1995) used astaxanthin as a source of carotenoid and observed lower FCR in Atlantic salmon juveniles, similarly, the growth of fish was achieved higher when carotenoids from different sources were added in their diets (Jha *et al*., 2012) and a linear relationship between dietary supplementation of carotenoids (spirulina as source) and growth of fish was reported by Sarma and Jha (2010). Spirulina contains carotenoids and carotenoids are known to have a positive role in metabolism in fish (Tacon, 1981).

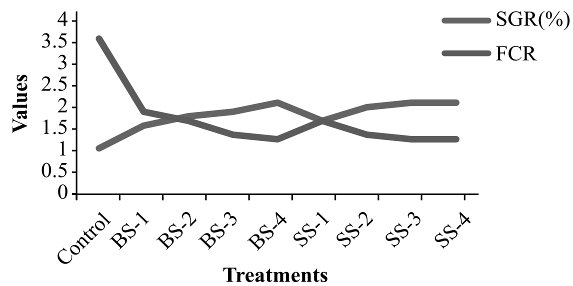

Fig. 1: Comparison of SGR and FCR of *B. bendelisis* and *S. richardsonii* fingerlings fed diets with graded levels of spirulina meal.

It can be concluded from the above observations that supplementation of 7-10% of spirulina in fish diet results higher growth rate, decreased FCR with higher survival rate, leads to higher return from the fisheries business.

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