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## RESEARCH ARTICLE

## Effect of periphyton diet on the growth of snow trout, *Schizothorax richardsonii* (Gray)

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### Abstract

One year experiment was conducted in three raceways of the size 8.73m x 1.63m x 0.84m with a view to develop diet for an indigenous cold water fish, *Schizothorax richardsonii* (Gray). Prior to growth experiment Periphyton biomass was developed in the raceways by using plastic sheets and bamboo splits as suitable substrates. First group of the fish was fed with formulated artificial diet having 25% crude protein @5% of their body weight as control. Second group of the fish was fed with exclusive natural periphyton based diet. The third group was fed with combined feeding of formulated artificial diet @ 3% of their body weight as well as the natural periphyton diet. Artificial diet and periphyton diet were analysed for proximate composition. Acclimatized healthy Fry of snow trout having the average weight  $1.11 \pm 0.04$  to  $1.85 \pm 0.07$ g. were stocked @8-10 fry/m<sup>2</sup> in raceways. The ranges of water quality parameters recorded in different raceways were: temperature 12.0-20.0°C, pH 7.0-8.5, DO content 6.0- 8.0ppm, free CO<sub>2</sub> 2.0-2.4 ppm and total alkalinity 167-170 ppm. All Physico- chemical parameters were in acceptable range for the growth of snow trout. The highest average final weight (21.9 g) of snow trout was found in the raceway (R3) having combined supplementary feeding and natural periphyton diet with total production as 2.540 kg. (18.14 kg/100m<sup>2</sup>/yr) and 97% survival. The average final weight of the fish was 47% more than the control (R1), while the total production was 57.9% higher over the control. SGR in R3 was 3.05, which was 47.8% more than the control with FCR as 3.74. The values of K were recorded in the range of 0.931, 0.951 and 0.991 in Raceway R1, R2 and R3, respectively. An income of Rs.2408/100m<sup>2</sup>/yr with combined feeding, while it was Rs. 1980/100m<sup>2</sup>/yr with artificial feeding alone. These results indicated that combined feeding with formulated feed of 25% protein level and natural periphyton diet may be useful for profitable culture of snow trout in hills.

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## INTRODUCTION

Pond aquaculture in India is reliant on inputs of fertilizers and supplementary feed. However, external resources are expensive and beyond the reach of the resource- poor farmers. Moreover, nutrient use efficiency in ponds is low, with only about 30% of nutrient inputs being converted into harvestable products (i.e. fish). Some herbivorous fish species feeds largely on benthic, epilithic or epiphytic rather than on plankton.

There is thus growing interest in the potential of periphyton based culture of the fish, both to reduce feeding cost and to increase available nutrient utilization. Therefore, the trophic status of periphyton led researchers to realize it as a future potential of sustainable system hiding under the water. The possibility of consuming periphyton

by fish is more due to several reasons. The production of periphytic algae per unit water surface area is higher than phytoplankton. The periphytic algae are generally more stable than phytoplankton and the risk of collapse is much lower. Fish is mechanically more efficient to scrap or graze a two dimensional layer of periphyton than a filter algae from three dimensional planktonic environment. The periphyton community is an important component of aquatic eco-system (Wetzel 1983). The studies of this complex community are wide ranging in their application to the system as a whole including structure of the periphyton (Rounick and Winterbourn 1983; Collier and Winterbourn 1990), productivity (Elwood and Newbold 1972), herbivory and trophic status (Benke and Wallace 1980; Hill and Harvey 1990). In natural communities, periphyton contributes significantly to primary production (Minshall 1978; Cattaneo and Kalff 1980) and represents readily available food for many vertebrates (Lamberti and Moore 1984), including fish (Power et al. 1985). The abundance, productivity and structure of periphyton communities can be strongly influenced both by nutrient concentration and herbivory. Addition of nutrients to limited streams has resulted in increasing periphyton biomass and productivity as well as distinct changes in algal community structure (Stockner and Shortreed 1978; Elwood et al. 1981; Grimm and Fifher 1986; Pringle 1987; Hill and Knight 1988).

In hills, among other important food and game fishes one of the specialised and specific groups of economic significance is the snow-trout belonging to the family Cyprinidae and subfamily Schizothoracinae. They form an important natural fishery inhabiting torrential streams, but which are later on adapted to lentic systems as well in the upper regions of most of the SAARC countries. Though, the growth of this fish is slow due to the low thermal regime, but market demand and consumer's liking is high.

Asela is a phytophagous fish and has developed a special mouth adapted to scraping attached algae from the surfaces of stones. According to Sunder (1992) snow-trout is mostly illiophagic herbivore in nature occasionally resorting to column feeding due to transverse and inferior mouth, the rapid overall development and ever-increasing population lead to anthropogenic activities resulted in disturbing the fragile aquatic ecosystems and fish fauna. To fulfill the demand of fish in uplands, emphasis should be given to develop the coldwater aquaculture practice. So, the present study was carried out to evaluate the growth of snow-trout with periphyton based diet in captive conditions.

## MATERIALS AND METHODS

Experiment was carried out in the raceways (Size-8.73m x 1.63m x 0.84m) at Department of Zoology, D.S.B Campus, Kumaun University, Nainital ( Uttarakhand) at an altitude of 1938 msl. (Long. 29<sup>o</sup> 23 'N, lat. 79<sup>o</sup> 30 'E) during the period April 2008 to Aug.2009 (5 months for periphyton production and 12 months for fish rearing). Raceways were cleaned and filled with tube well water. The flow rate of water was maintained 5 liter/minute in all the raceways. Bamboo splits (Dead organic materials) and Plastic sheets (non - degradable organic material) were inoculated in the water of raceway as substrates for the production of periphyton. Incubated bamboo splits and plastic sheet strips having total surface area of 3m<sup>2</sup> were placed in the raceways (R2 & R3). Healthy fry (360 nos.) from acclimatized fish group were taken for the experiment and these specimens were divided into three groups of 120 nos. each. Each raceway was stocked with 120 fry of *Schizothorax richardsonii* (Stocking density 8-10 fish/m<sup>2</sup>) of average weight 1.11±0.04 to 1.85±0.07g. The palated artificial feed (25% crude protein) was prepared by using mixture of rice bran (40%), mustard oil cake 25%, soyabean oil cake 25% and fish meal 10%.

Fortnightly analysis of water samples was carried out following the standard methods of APHA (1985). First group of the fish (R1) was fed with formulated artificial diet having @5% of their body weight as control. Second group of the fish (R2) was fed with exclusive natural periphyton based diet. The third group (R3) was fed with combined feeding of formulated artificial diet @ 3% of their body weight as well as the natural periphyton diet. Artificial diet and periphyton diet were analysed for proximate composition (crude protein, crude fat, moisture and ash content) by the AOAC method (1995). For the numerical estimation of periphyton, sample from 1cm<sup>2</sup> area was used. Depending on the density of organisms the scraping was dispersed in 10 to 100ml water in a beaker. One ml of the dispersed material was placed in the sedgewick rafter counting cell and the counting was done. The counts were expressed as cells or filaments per square centimeter of substrate area.

$$\text{Cells/cm}^2 \text{ area} = \text{cells/ml suspended scrapings}$$

Generally wet and dry biomass was considered for the estimation of periphytons. For wet biomass analysis 1cm<sup>2</sup> of scraping was taken from natural substrate and then by using pre-weighted filter paper, extra moisture was removed by putting scrapping material on this filter paper and there after weight of filter paper with periphyton

sample was taken using Digital balance and obtained biomass was expressed in mg/cm<sup>2</sup>. Randomly 10 fishes from each raceway were selected for taking length weight data for computing C.F and S.G.R. Each harvested fish was measured and weighed to quantify the production. Weight gain, condition factor (CF), specific growth rate (SGR), feed conversion ratio (FCR), survival and yield were calculated according to Castell and Tiews (1980) and Devendra (1989). The mean values were compared and data were analysed using analysis of variance. Results were considered statistically significant at 5% (P<0.05) level.

## RESULTS AND DISCUSSION

Higher population of periphyton community was produced with bamboo splits (1608 nos./cm<sup>2</sup>) followed by plastic sheet (1433 nos./cm<sup>2</sup>). The present result regarding the periphyton population is in higher side than the previous reports. Sukumaran et al. (1996) found 14-66 nos./cm<sup>2</sup> periphyton population in Lalbagh tank of Karnataka state. The maximum periphyton biomass was observed in bamboo splits (6.01 mg/cm<sup>2</sup>) followed by plastic sheet (5.45 mg/cm<sup>2</sup>) on dry matter base. In general, periphyton population and biomass was comparatively higher on biodegradable substrates than the non-biodegradable substrates. All water quality parameters were found in acceptable limit without any adverse effect on water quality during the incubation period of periphyton community.

Periphyton has significant role of providing food for fish and other fauna in natural and controlled environment (Jones et al. 1997). In present experiment, natural periphyton based diet grow on substrate of bamboo splits and plastic sheet was the main source of the food to the fishes of the R2& R3 raceways. Fishes of R3 were also additionally fed with supplementary artificial feed, which was provided to the control group. The natural food, Periphyton contains the crude protein as 61.2%, while it was 25.55 in the artificial feed. The fat content was lower in natural diet i.e. 4.8%, while it was 6.2% in the case of artificial diet.

Snow trout is a cold water fish species and found abundantly in rivers and lakes of Uttarakhand and migrate for short-distance, locally known as Asela enters tributaries for breeding. It migrates downstream during winter and upstream during early June when water becomes turbid. The migration pattern varies from species to species and also depends on the volume of water in rivers and on water temperature.

The highest average final (21.9 gm) weight of snow trout was found in the raceway having combined supplementary feeding and natural periphyton diet by placing bamboo splits and plastic sheet as substrate for the attachment of periphyton (Figure 1). The total production from this raceway (R3) was obtained as 2.540 kg. (18.14 kg/100m<sup>2</sup>/yr) with 97% survival. The average final weight of the fish was 47% more than the control, while the total production was 57.9% higher over the control. 10.9% increase in the production was due to the better survival. SGR of this group of the fish was 3.05, which was 47.8% more than the control. FCR of the fish was 3.74 while it was 6.85 in the fish fed with artificial diet in control without periphyton. In the raceway (R2) having only periphyton based diet, the average final weight was found as 18.8 gm. with 2.143 kg. (15.31 kg/100m<sup>2</sup>/yr) total production. It was 26.2% higher in average growth and 33.2% higher in total production over the control. 7% increase was due to the better survival (95%) of this group. SGR of this group of the fish was 2.90, which was 8.6% more than the control. Nutritive value of the fish was best for this group with protein content as 17.98% on carcass analysis. In the control, raceway (R1), the average weight gain was 14.9gm with total production of 1.609Kg. (11.50 kg/100m<sup>2</sup>/yr) and survival of 90%. SGR of this group of the fish was 2.67 with protein content as 17.76 in the carcass (Table 1). The results of weight gain in the present study are superior to the previous reports. Joshi et al. (2005) reported that fish merely attained an average length of 8.4 cm, 12.1 cm, 15.6 cm, 18.2 cm, 20.4 cm, with corresponding weight of 5.2 g, 10.6 g, 25.8 g, 44.6 g and 72.0 g. during 1st to 5th year life span, respectively.

Recently, a group of aquaculturists from Wageningen University showed major developments in periphyton based pond aquaculture research (Azim et al. 2001) Using different substrates. Keshavanath et al. (2002) observed the highest fish yield without feed supplement as 491kg/ ha/ 90days with bamboo substrate. Azim et al. (2001) studied growth and production of Indian major carps, rohu (*Labeo rohita* H. and *Labeo gonius* L.) using bamboo substrate in ponds and recorded a 77% higher production of rohu with bamboo substrates than the ponds without substrates. Assessment of fish condition based on weight at given length is thought to be reliable indicators of the energetic condition or energy reserves in fish (Lambert and Dutil, 1997). Poor condition is usually associated with poor feeding and/or environmental conditions. The values of condition factor (K) in present study were computed in the range of 0.931, 0.951 and 0.991 in Raceway R1, R2 and R3, respectively showed that the fishes of experimental unit are more robust than that of the control unit.

The water quality parameters recorded in different raceways were: water temperature 12.0-20.0°C, pH 7.0-8.5, DO content 6.0- 8.0ppm, free CO<sub>2</sub> 2.0- 2.4 ppm and total alkalinity 167-170 ppm. All Physico- chemical parameters were in acceptable range for the growth of snow trout (Table 2).

It was concluded that the growth, survival, production, nutritive value and economic return is better with the combined feeding of supplementary feed and natural periphyton feed in the raceway culture of snow trout. Net yield of snow trout may be increased by providing substrates for periphyton production despite the fact that there was positive impact on growth and production without deteriorating water quality.

**Table 1. Growth performance of fish in control/ experimental raceways (R1, R2, R3).**

Parameter/ Raceway	<sup>1</sup> R <sub>1</sub> (Control)	<sup>2</sup> R <sub>2</sub>	Difference from control	<sup>3</sup> R <sub>3</sub>	Difference from control
Pond size (m <sup>2</sup> )	14.42	14.42	-	14.42	-
Stocking no.	120	120	-	120	-
Initial Av. Weight (gm.)	1.1	1.1	-	1.1	-
Final Av. Weight (gm.)	14.9	18.8	+3.9 (26.2%)	21.9	+7.0 (47.0%)
Net gain in Av. Weight (gm.)	13.8	17.7	-	20.8	-
Initial Av. Length (mm.)	18	19	-	18	-
Final Av. Length (mm.)	132	142	-	146	-
Net gain in Av. Length (mm.)	114	123	-	128	-
Total production (Kg.)	1.609	2.143	+0.534 (33.2%)	2.540	+0.931(57.9%)
Survival (%)	90	95		97	
SGR	2.67	2.90	+0.23 (8.6%)	3.05	+1.14 (42.8%)
FCR	6.85	-		3.74	
Condition factor(k)	0.931	0.951		0.991	
Protein content (%)	17.76	17.98		17.87	

<sup>1</sup>Fed with artificial diet, <sup>2</sup> fed with Periphyton diet, <sup>3</sup> fed with both artificial and periphyton diets.

**Table 2. Mean values (± SEM) of physico-chemical characteristics of water in raceways.**

Parameters	Raceways		
	R1	R2	R3

Water temperature (°C)	*15.98 ±2.709	15.96±2.667	15.8±2.670
pH	7.28±0.370	7.49±0.407	7.44±0.434
Dissolved oxygen (mg/l)	6.70±0.581	6.68±0.530	6.40±0.466
Free carbon dioxide (mg/l)	2.22±0.147	2.36±0.209	2.2±0.135
Total alkalinity (mg/l)	168.6±0.013	168.41±1.176	168.3±1.468
Ammonia-nitrogen (mg/l)	0.11±0.066	0.11±0.067	0.102±0.060
Nitrite-nitrogen (mg/l)	0.011±0.002	0.011±0.001	0.011±0.001
Nitrate-nitrogen (mg/l)	0.129±0.025	0.12±0.022	0.114±0.019
Phosphate-phosphorus (mg/l)	0.223±0.065	0.24±0.069	0.19±0.055

\*For each treatment the water quality was recorded using triplicate samples. Values are ranges (mean± SEM). Values are statistically non- significant (P>0.05).

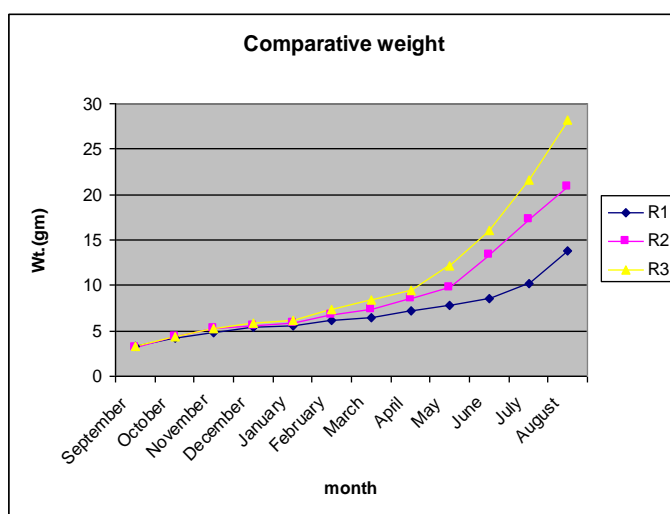


Figure 1: Weight of fish in control/experimental raceways (R1,R2,R3).

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