J. Mountain Res. P-ISSN: 0974-3030, E-ISSN: 2582-5011
Vol. 15, (2020), 151-157 DOI: https://doi.org/10.51220/jmr.v15i1.18

STUDIES ON THE FEEDING OF SNOW TROUT, *SCHIZOTHORAX RICHARDSONII* (GRAY) BASED ON NATURAL AND ARTIFICIAL DIET

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Received: 09.09.2020; Revised: 30.11.2020; Accepted: 10.12.2020

Abstract: The present paper deals with food analysis and feeding behavior of the snow trout *Schizothorax richardsonii* (Gray) which is a cold water herbivore fish by nature. It is locally called Asela and is distributed in Himalayan and sub-Himalayan regions of Asia and has considerably attracted the attention of researchers due to its high productivity. The health and growth of fishes is greatly influenced by their nutrition and feeding. It has been observed in the present study that the adult fish naturally feeds on diatoms and algae. An experiment was conducted on artificial feeding of fish by giving three different types of food, i.e., formulated diet as control, periphton based diet and a mixture of both in different artificial raceways. It was observed that the fish conversion ratio (FCR) of the fish pooled in the raceway one (R1), i.e., feeding with formulated was high (6.85) due to balanced nutrients. It is recommended that with the introduction of balance artificial diet may be helpful in increasing the production of *S. richardsonii*.

Key words: Food analysis, growth, artificial feed, *S.richardsonii*.

Introduction

Schizothorax richardsonii belongs to the family Cyprinidae and sub-family Schizothoracinae. It has a strong body to resist the strong water current of the hill streams. Its food constitutes predominantly of the members of green algae, blue-green algae, diatoms, aquatic macrophytes and decayed organic matter, etc. The Schizothoracine fishes are typical detritophagus herbivore except when they are young. The young ones feed principally on small benthic crustaceans and insect larvae. Due to its high demand as a good sport fish and delightful taste, it is most favored fish among folks. The knowledge of the natural diet of an animal species is generally essential for the studies on its nutritional requirement, its interaction with other organisms and for its culture practice (Williams, 1981). Studies on the food and feeding of *S.richardsonii* are important from academic as well as commercial point of view. The food supply, including the quality and quantity of food, directly governs the growth of fish. Natural food of fishes in Uttarakhand has been studied by several workers (Badola and Singh, 1980; Singh and Bahuguna, 1983; Bisht et.al., 2005; Dobriyal et.al., 2013,). However the present study is conducted with an objective to analyse the growth of fish in relation to its natural versus artificial diet.

Material and Methods

This section deals with requisites and procedures, during experiment which were carried out during the study period. Healthy fry of the snow tout were procured from the experimental fish farm, DCFR Champawat during the month of the September'2008. Seed was transported in the oxygen packed polythene and acclimatized for 30 minutes before releasing in the raceways (size 8.73m x 1.63m with the average water depth of 0.84m). Healthy fry (360 nos.) from acclimatized fish group were taken for the experiment and were divided into three groups of 120 each. Each raceway was stocked with 120 fry of *Schizothorax richardsonii* (Stocking density 8-10 fish/m^2) of average weight 1.11 to 1.85 g. The initial length and weight of each fish was recorded before their stocking in the raceways. Prior to start the experiment, the raceways were cleaned thoroughly with the lime water and filled with tube well water. The flow rate of water was maintained 5 liter/minute in all the raceways. Periodically cleaning of the raceways was done at every 15 days interval for removal of tree leaves and excess algal biomass.

Feeding Pattern: The designed feeding pattern is give in Table 1.

Table 1: Experimental feeding pattern in three different raceways.

Raceway(size 8.73m x 1.63m with the average water depth of 0.84m)	**Types of feed**
Raceway 1 R1	Feeding with only formulated diet (control diet)
Raceway 2 R2	Feeding with only periphyton based diet
Raceway 3 R3	Feeding with formulated and natural periphyton based diet both.

The nitrogenous diets (approximately 25% crude protein) were prepared and feed ingredients were finely powdered with the help of grinder machine and used for daily feeding up to two months. For the feeding of the fish of the advanced stage, pelleted feed were prepared with the help of pelletizer. The experimental diet was prepared by using the ingredients-Mixture of rice bran (40%), mustardoil cake 25%, soyabean oil cake 25% and the fish meal 10%. Natural periphyton based diet grow on substrate of bamboo poles and plastic sheet, submerged in the water at the rate of 10 kg. Supplementary feeding was done twice a day @ of 5% body weight. All intercultural activities were similar for the all raceways.

Periphyton Analysis

This was done using both Qualitative and Quantitative analysis.

1. Qualitative Analysis: For qualitative analysis periphyton were collected in good living condition and were immediately qualitatively analysed. Identification was done under standard compound microscope. The containers with periphyton were then stored in a refrigerator at ambient temperature, to avoid shock to the organisms.

2. Quantitative Analysis: The standing crop of periphyton was estimated by the following methods:

A. Density: For the numerical estimation of periphyton, sample from 1cm^2 Area was used. Depending on the density of organisms the scraping was dispersed in 10 to 100 ml 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.

Cells/cm^2area = cells/ml suspended scrapings

B. Biomass: Generally wet and dry biomass was considered for the estimation of periphyton. For wet biomass analysis 1cm^2 of scrapping was taken from natural substrate and weighed using digital

balance and obtained biomass was expressed in mg/cm^2.While in dry biomass method the material was kept in oven for drying at 60^o C for overnight and weighed. The results were expressed in terms of dry weight mg/cm^2 periphyton area. The primary production of periphyton was measured by "light and dark bottle method" (Gaarder and Gran, 1927). D.O. of the samples was measured before and after each experiment using Winkler's method. The gross oxygen concentration in light and dark bottles. The productivity was calculated in terms of carbon by multiplying GOP with a factor 0.375 (Westlake, 1963; Serrnivasam, 1964). The following equations were used for calculating gross production.

Gross production (g C m^{-3} hr-^{1})=Lo-Do ×0.375×1000/ T×P.Q.

Net production (g C m^{-3} hr^{-1}) = Lo-Io×0.375×1000 / T×P.Q.

Where,

Lo = dissolved oxygen in light bottle after exposure

Do = dissolved oxygen in dark bottle after exposure

Io = intial oxygen concentration

PQ = is the photosynthesis quotient which is assumed at 1.2 (Fog, 1963)

T = time (hrs.)

3. Biochemical Analysis of fish, Periphyton Biomass and Formulated Feed: The fish was analyzed biochemically twice, once at the starting of the experiment by the AOAC method (1995) for estimating Percent moisture and Crude proteins using Kjeldahl method. Crude fat was determined by using soxlet apparatus where the crude lipid was determined by the difference between the final and initial weight.

Crude fat (%) = weight of fat (g)×100/ Weight of sample (g)

The ash content was determined by igniting the weighed amount of the sample in a muffle furnace at 550± 50^o C for 5-6 hours. Feed sample and periphyton sample collected from substrates were analyses for crude protein, crude fat and crude fiber (crude protein and crude fat was estimated following the methods for biochemical analysis of fish). Crude fiber was estimated following the method A.O.A.C. (1980).

C (%) = (loss in wt. on ignition-loss in wt. of asbestos blank)×100/ wt. of sample

Gut Analysis of the Fish

The measured fishes were dissected and entire alimentary canal of each fish (from fingerlings to adult) was removed from the body cavity and gut content was preserved in 5% formalin. The qualitative and quantitative analysis was made under the microscope. The gut contents were studied by using Hynes (1950) as authentic literature.

Result

(a) Natural food Habit of *Schizothorax richardsonii:* A total of twenty one organisms were identified within the alimentary canal of the *Schizothorax richardsonii* (Table 2). Detritus was observed in every alimentary canal with the majority being made from small pieces of macrophyte. Occurrence of organisms was rare in the case of fish reared on artificial diet as control, while almost all organisms were prominent in the gut of fish reared on completely periphyton diet and on mixed periphyton and artificial diet. Periphyton species were *Pediastrum* spp, *Chlamydomonas* sp., *Eudorina, Scenedesmus spp., Chlorella spp., Pendorina, actinophyres., Anabaena* sp. and *Pinnularia* sp. with dominance of S*cenedesmus, Tabelaria* and *Navicula* spp. Diatoms were limited in variety with only *Tabelaria, Navicula* spp. and *Pinnularia* being successfully identified.

These diatoms were present in alimentary canal of all tested specimen. One of the most prominent organisms identified was *Scenedesmus. Cladoceran* was predominant in most of the smaller specimen with rare occurrence in lager fish. Main species identified were *Daphnia, Moina* and *Bosmina*. Rotifers were also dominant in both types of specimen (R1, R2). The occurrence of Copepod and Dipterans was noticed in both experimental raceways (Table 3).

Table 2: Proximate composition of periphyton biomass and artificial fish feed (%)

Nutrients	***S. richardsonii* feed**	**Periphyton biomass**
Crude Protein	25.8	61.2
Crude Fat	6.2	4.8
Crude Fiber	10.8	8.2

Table 3: Different Organisms found in the gut of *S.richardsonii* after gut analysis

Species present in fish gut	**R1**	**R2**	**R3**
(A) Chlorophyceae			
pediastrum spp.	+	++	+
*Chlamydmona*s sp.		+	+
Eudorina		-	+
Scenedesmus spp.	+	+++	+++
Chlorella spp.	++	++	-
Pendorina		-	+
Actinophyres.		+	-
(B) Bacillariophyce-ae			
Navicula spp.	++	++	+
*Tabelari*a.		+	++
Pinnularia	+	-	+
(C) Cynophyceae			
Anabaena sp.	+	++	+
(D) Rotifera			
Brachionus spp.	+	++	++
Keratella	+	+	+++
(E) Cladocera			
Daphnia spp.	++	+++	++
Moina sp.	++	++	+
Bosmina sp.	+	+	++
(F) Copepoda			
Cyclops spp.	+	+	++
(G) Diptera			
Larva *Chironomus*	-	+	++
Larva mosquito *Aedes culicidae*	-	+	++

These all have low observed frequency but do occur in vary distinct specimen. In control raceway with only artificial feeding, all organisms except Dipterans were observed with comparatively very low frequency. Some unidentifiable material was also found in the alimentary canal. The result of the gut analysis clearly reflected that this fish is a typical detritophagus herbivore and young ones also feed on small crustaceans and benthic insect larvae.

In fish production, calculating the food conversion ratio is a common method to appraise nutritional value. The food conversion ratio is also considered when preparing the food and when predicting fish yield. In present study, the FCR of the fish pooled in the raceway RI was 6.85, while it was 3.74 for the fish of the raceway R3. The low value of FCR of the fishes of R3 may due to the combined effect of natural and artificial feeding.

Proximate composition of Natural (Periphyton) and artificial trout feed: For the present study, an isocaloric and a nitrogenous diet (approximately 25% crude protein) was prepared with similar ingredient composition having mixture of the rice bran (40%), mustard oil cake 25%, soyabean oil cake 25% and fish meal 10%. Natural periphyton based diet grow on substrate of bamboo poles and plastic sheet, submerged in the water of the raceway R2 was the main source of the food to the fishes of the R2 raceway. The natural food, periphyton, contains the crude protein at 61.2%, while it was 25.8 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 (Table 2).

(b) Artificial food Habit of *Schizothorax richardsonii*: Aquaculture is a feed based industry, with over 60 per cent of operational cost coming from feed source with shifting from extensive to semi- intensive or intensive farming, depending on farmed animals on exogenous feed supply in more and more pronounced as the standing crop of culture species exceeds, the "natural feeding capacity" of the pond.

The use of artificial feed balanced in protein, lipid, carbohydrate, fatty acids, vitamins, minerals and containing optimum protein / energy ration is the common practice for better yield. Production of the Plankton feeder fish is also enhanced by giving the supplementary feed to the growing fish in addition to the available natural feed in the form of plankton. The feed is directly consumed by the so-called feed eaters and, in turn, their excreta act as the manure in the pond water. This multiplies the natural food organisms of the plankton feeders. The most important factor to be taken into account when feeding carp with artificial food is feeding cost.

The food given must be simple and cheep and the fish must rely to the greatest possible extent on natural food which contains all the constituents of a complete diet – amino acids, vitamins, minerals, etc. A variety of ingredients of plant and animal origin has been screened for incorporation in supplementary feed for carp and used either singly or in combination (Lakshmanan et al., 1967). Chakrabarthy (1973) stated that animal protein based fish diet is very effective for the fish production and given excellent weight and length gain, also concluded that possible to successful replace fish meal with other animal protein sources.

Protein requirement decreases with increasing body weight (Pandian, 1989). (Pandian 1987) advocated that protein requirement of fish is uniformly high, mostly in the range of 32 to 40 per cent. In most of cases supplementary feed of grow out fish comprises only oil cakes of mustard / ground nut and rice/ wheat bran at 1 : 1 ratio by weight (Tripathi, 1990). (Medda et al., 1993) revealed that there is very specific variation in the relative growth rate of two carp species Catla catla and Labeo rohita is response to experimental feeding with amino acid and vitamin enriched diets.

All feeds whether pelleted or not, are being prepared by mixing various ingredients. However, by due to poor water stability most of the feed sinks to the bottom of fishpond causing economical loss to the fish farmer. The fermented feed is more nutrient rich compared to the non-fermented one and exhibits a more favorable impact on the fish growth (Kishan, 2000). Renukardhya and Varghese (1986) reported that a level of 30% protein in diet was optimum for the growth of *Cirrhinus mrigala*. The optimum dietary protein requirement for fingerlings of *Catla catla* was 35%. The 30% protein level is optimum for growth of carp fingerlings, also observed by Renukardhya and Varghese, 1986; Gangadhar et al. 1997, Rangacharyulu et al. 2000; Paul and Mohanty, 2002.

In fish production, calculating the food-conversion ratio is a common method to appraise nutritional value. The food conversion ratio is also considered when preparing the food and when predicting fish yield. In present study, the FCR of the fish pooled in the raceway R1 was 6.85, while it was 3.74 for the fish of the raceway R3. The low value of FCR of the fishes of R3 may be due to the combined effect of natural and artificial feeding.

Discussion

The present study reveals that the dietary proteins requirements for a particular species or a group of species are different. Commonly used plant origin ingredients are cereal grain, oil cakes, wheat bran and rice bran. Animal's origin ingredients are fish meal, Trash fish and earthworms etc. The foraging habits of some of epifaunal organisms (snails and chitonomids) indicate macrophytes along with periphyton being more preferred over macrophytes without periphyton (Mc Gaha, 1952; Pieczynska, 1970; Sozka, 1975). Grazing of periphyton by wild fish has also been reported (Hasson, 1989; Grrenwood et al., 1999), constructed a typical relation food web of Dal Lake in Kashmir Himalaya, India delineating the tropic relation of periphyton.

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