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Optimum dietary protein requirement of striped murrel *Channa striatus* fry

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ABSTRACT This article deals with the dietary requirement of protein of *Channa striatus* fry, five different semi moist diets were formulated separately using semi purified ingredients (chicken intestine, fish waste and silk worm pupae). The highest specific growth rate (1.613%/day), food conversion ratio (1.526) weight gain (267.21%) average daily growth rate (0.824 %) and survival (96.66%) for fry were recorded in 55% of protein diet. Similarly carcass composition of fry differed according to the different protein levels.

(**Key words**: Channa striatus fry, nutrition, growth, survival)

INTRODUCTION

Protein requirement study is one of the most important aspects of fish nutrition. Protein as a major fish feed component not only provides essential amino acid, but also used for tissue repair and growth (1). (2) Observed that unless sufficient dietary energy provided, the quality and quantity of dietary protein couldn't reflect protein synthesis. The optimum protein to energy (E/P) ratio in diet is very important to maintain fish quality and to reduce the dietary cost. In recent years, the higher cost of fishmeal has generated renewed interest in the use of the alternative protein sources for fish feed. The evaluation of various alternative protein sources such as partial or complete dietary replacement for fishmeal has been carried out by several workers for different fish species (3). Majority of the fish species require 40-50% protein in diets (4). Several marine fish species require more than half of the diet ingredients as protein components and thus are more carnivorous than terrestrial carnivorous (5). However freshwater teleost requires comparably less protein diet than those of marine species. Fishmeal has been an important source of protein in the diets of carnivorous fish species such as the morone hybrids, because of its high protein quality and palatability. The quantity of protein required by aquaculture on animal varies with species age, condition and reproductive state as well as variation in the environment (6). In general the values ranged from 30% to 55% crude protein for maximum growth of fishes.

The major nutritional needs of a number of species is important in aquaculture have been enlisted by (6) and reviewed by several workers (7, 8 9, 10). Protein, being the principal dietary component for growth has received greater attention in nutritional studies (11, 12, 13, and 14). Knowledge of protein requirement of the species to be cultured is prerequisite to the formulation of well-balanced, cost effective artificial diets for feeding. It is known that the requirement level of protein for various body functions varies with species and culture environment.
The *C. striatus* do not accept the purified diets, because of its carnivorous in nature (15). Therefore different crude protein levels were prepared for the fry of *C. striatus*. (16) Postulated that high levels of protein without sufficient energy in the diet might be harmful to fish. (17) observed that larger size fish require more energy and less protein when compared to small fish. In the nutritional point of view no published work is available so far on the crude dietary protein requirement of *C. striatus* using different biowaste. The present study was conducted to determine the optimum dietary protein requirement of *C. striatus* fry under laboratory conditions.

MATERIAL AND METHODS

Bio-waste collection and estimation:
The bio-wastes of chicken intestine and fish waste were collected from the local market and silkworm pupae from Government Silk reeling center, Tenkasi, Tirunelveli District, Tamil Nadu. All the ingredients were oven dried and powdered separately in the mixer grinder and sieved through a 200μ mesh. Biochemical analyses were performed on all the ingredients of different biowaste in order to evaluate their nutritive value. The estimation of crude protein was done by the method of (18), lipid (19) and carbohydrate (20). Moisture content was determined by drying a 5 g sample at 95°C for 24 hr (21) and ash content by burning in an electric muffle furnace from 6 to 8hrs at 560 o C (22).

Feed composition and preparation:

The powdered feed ingredients such as ground nut oil cake, soybean flour, rice bran, tapioca flour and cod liver oil etc were mixed in different quantity along with bio waste such as chicken intestine, fish waste and silk worm pupae which were used as a major source of protein to prepare the different crude protein levels ranged from 40%, 45%, 50%, 55%, and 60%. And the feed composition and the nutrient content of the different dietary protein levels were presented in table 1 Required quantity of water was added to the dry homogenate in order to make dough. The dough was cooked for 10 minutes in a pressure cooker. After cooling, required amount of vitamin and mineral mix were added and thoroughly mixed. The prepared crude protein feed is going to determine the optimum dietary protein requirement of *C. striatus* fry.

Fish Collection and Experimental Set up:

The fry (average weight 0.256 mg) of *C. striatus* were collected from the Thamirabarani River and carefully transported to CARE Aquafarm, St.Xavier's College (Autonomous) Palayamkottai, Tirunelveli, Tamil Nadu, India. The fish were fed on mixed plankton during the acclimation period, and they were trained to accept the respective experimental diets at least three days, before the commencement of the experiment. Triplicates were maintained for each experimental set up and the fish were fed with the semi moist respective diets twice a day (10.00 hr and 14.00 hr) at a rate of 5% of their body weight per day. Daily feed input was adjusted weekly based on the average weights of fish in each treatment. The unfed were separately collected from the trough by using an aspirator. The acceptability of all the diets was more or less similar. The feeding activities of fish were observed throughout the feeding trial and all the feed were consumed within 15 min of administration.

The duration of the feeding experiments of fry was 35 days conducted at room temperature (29° C to 30° C) under natural photoperiod. The water temperature varied from 27 °C to 29° C and the dissolved oxygen level fluctuated from 5.5 to 5.8 ppm and the pH ranged between 6.8 and 7.0. The experiments ten individuals of same size measuring 0.250 mg for fry were selected from the stock and after ensuring complete evacuation of their alimentary canal by starving them were introduced into plastic troughs of 13 Lt capacity (1x1x1m) and of continuous flow trough system was set up at the Center for Aquaculture Research and Extension (CARE) at St. Xavier's College, for conducting the experiments. Initial length and weight and final length and weights of the experimental fish in each plastic trough were recorded individually using an electronic balance (Metler PM 480, Delta range). At every week interval length and weight was recorded. Water in the aquaria was partially changed once day daily. No aeration was provided. The flow through system was stopped once a week for cleaning the troughs with least disturbance to the fish. Weight of the fish was recorded at weekly interval both for fry and fingerling.

Formula:

The energy budget of the fish was calculated by following the IBP formula

$$\text{Specific growth rate SGR (\%/day)} = \frac{\text{In log Final body weight-In log initial lives weight (g)}}{\text{Experimental duration}} \times 100$$

$$\text{Food conversion ratio (FCR)} = \frac{\text{Food consumed (g)}}{\text{Wet weight gain (g)}}$$

$$\text{Weight gain (\%)} = \frac{\text{Final live weight-Initial live weight}}{\text{Days}} \times 100$$

$$\text{Average daily growth rate (\%) (ADG \%)} = \frac{\text{Growth (live wt.g)}}{\text{Duration}} \times 100$$

$$\text{Survival (\%)} = \frac{\text{No of fish introduced}}{\text{No of fish survived}} \times 100$$

$$\text{Mean growth rate} = \frac{\text{Final mean weight}}{\text{Initial mean weight/days}}$$

Carcass composition:
At the beginning of the experiment 5 fish from the stock were sacrificed and used for proximate composition analysis, which was considered as the initial carcass composition of fish. At the end of the experiment all the fish in each triplicate group were sampled for final carcass analysis.

Statistical analysis:

Statistical analyses were performed using SPSS Version 13.0 Software and, one way analysis of variance (ANOVA) followed by Duncan's Multiple Range Test **(DMRT)** were made to find out the difference between the treatment.

RESULTS

The nutrient contents of the different dietary protein levels prepared for the test animals. The proximate compositions of the experimental diets are shown in table 2. The protein content in different diets varied between 39.08 and 59.36%. The lipid values ranged from 7.97% to 13.25%. whereas the carbohydrate content ranged between 3.77 and 10.5%. The calculated gross energy contents varied between 279.94 Kcal/100g and 392.89Kcal/100g. The protein to energy ratio varied between 6.489 and 7.16.

The result of the biochemical analysis of the feed ingredients and the different biowaste are presented in Table 2 .The protein content observed in chicken intestine was 68.45%, fish waste 58.06% and silkworm pupae 55.02%. The carbohydrate content was highest in chicken intestine by 3.93% followed by fish waste 3.69% and silkworm pupae 1.0%. Lipid content was found to be highest in chicken intestine 10.12% followed by fish waste 6.18% and in silkworm pupae 17.12%. The highest calculated gross energy was recorded in chicken intestine 407.703 kcal/100g and followed silk worm pupae 396.73 kcal/100g and the lowest value was recorded in rice bran 175.11 Kcal/100g and the calculated E/P values is highest in tapioca and the lowest value is 5.625.

Initial and final mean length, weights, percentage weight gain and SGR, average daily growth rate of *C. striatus* fry fed with the different experimental diets are presented in table 3. The best growth performance and weight gain (%), FCR, ADG (%) and SGR (%/day) recorded in 55% dietary protein fed groups. The mean length and weight increment of fish *C. striatus* fry was graphically shown in figure 2 and 3. The best SGR of fry was obtained in diet (D1) 1.613 whereas the lowest value was in D5 diet (1.14) (Table 3). The best weight gain was noticed in those fed with the diet (D4) 267.21% and the lowest one is (D1) 148.77% (Table 3 and fig 1). The same trend was noticed in the case of the best value of average daily growth rate was obtained in those fed with the diet (D4) 0.824% and the lowest value was in (D1) 0.458% (Table 3). The (low) best FCR was noticed in those fed with the diet (D4) 1.526 and the highest value is (D5) 2.46 (Table 3 and Fig 4). The best survival rate of *C. striatus* fry fed with the diet (D4) was found to be 96.66% and the lowest (D5) 83.33 (Fig.5) respectively.

In the growth aspect of statistical analysis indicated that, the *C. striatus* fry the final length significantly higher value (3.57cm) was in diet D4 and in the poor value (2.31cm) was in diet D1were recorded. And in the weight significantly higher value (0.396 g) was in diet D4 and the least value (0.27 g) was in diet D2 were reported. And in the specific growth rate a significantly higher value (1.613%/day) was in diet D4 and the lowest value (1.135/day) was in diet D1 was noticed. And in the weight gain significantly higher value (267.21%) was in diet D4 and the lowest value (148.77%) was in diet D1 was recorded. And in the average daily growth rate significantly higher value (0.824%) was in diet D4 and the poor value (0.458%) was in diet D1 was observed. And in the survival the best value (96.66%) was in diet D4 and the poor value (83.33%) was in diet D1 and D5 was noticed.

The body composition of *C. striatus* fry at initial and end of the experiment was presented in table 4. Fish fed with the experimental diets had lower moisture content compared to that of the initial fish. The body protein content was higher in fish fed with diet D4 (60.32%) and lower in diet D5 (53.38%). And the lipid content of the fry was, the highest in diet D2 (7.55%) and the lowest in diet D5 (6.03%). And the carbohydrate more or less similar level ranged between 0.976% to 1.046%. And in the ash content values range from 21.66% to 23.83% was recorded. And the calculated high gross energy noticed in those fed with diet (D4) 321.27 kcal/100g) with 5.70 energy/protein and lower in diet (D5) 277.46 kcal/100g) along with 5.2 E/P.

In the body composition of *C. striatus* fry statistical analysis revealed that, significantly the higher protein value (60.32%) in the diet D4 and the least value (52.165) was observed in the initial fish. And in the carbohydrate significantly higher value (1.036%) in the initial fish and the least value (0.976%) were in D3 diet. And in the lipid a higher value (7.55%) was in diet D2 and followed (6.565) diet D3 and the least value (5.86%) was in initial fish were observed. And the significantly higher calculated gross energy value (321.27Kcal/100g) in diet D4 and the least value (277.46 Kcal/100g) were in diet D5. And the significantly higher energy/protein value (5.70) was in diet D2 and the least value (5.2) in diet D5 was reported. (Table 4 and Anova table 5).

DISCUSSION

In the present study the best specific growth, average daily growth rate and weight gain were observed for fry at 55% (D4). The hybrid tilapia *Oreochromis niloticus* X *O. aureus* showed satisfactory growth performance when the dietary protein content decreased from 24 to 21% and dietary lipid raised from 9 to 15% (23). Hybrid *Clarias* catfish *Clarias macrocephalus X C. gariepinus* also showed a protein-sparing effect when increase from 35 to 40% in dietary protein gave similar performance when lipids were increased from 11 to 15% (24).

A protein-sparing effect was reported for channel catfish (25), when a decrease from 36 to 24% in dietary protein gave similar performance when lipids were increased from 5 to 10%. Dietary protein level could be reduced from 50 to 45% when lipid level was increased from 14 to 17% in striped bass (26). The optimum protein requirement of grass carp fry was 41-43% (27) and mrigal and rohu fingerlings 45% (28, 29). The optimum protein requirement of Cyprinus carpio was 31-38% for Japanese common carp (Ogino and Saito, 1970 and Takeuchi *et al.*, 1979) while the optimum for Indian strain of common carp was 45% (29). The difference in the level of optimum protein requirements may be due to differences in strains (30) or environmental factors and size of fish (31).

(32) found better growth of *Heteropnestues fossilis* fry by feeding the diets containing 40% protein content. Majority of fresh water fish species require 40 to 50% protein in the diet (4). The optimal dietary protein requirement for the

growth of juveniles silver perch was estimated to be 42.5% when white fish meal was the sole protein source and the dietary energy value was 15.07 MJ/kg diet. This value is slightly higher than for other Omnivorous fish species (35-42%; (33). But lower than the commercial Juveniles sea bass feeds (45% crude protein or higher) used in Taiwan. Seabass as a carnivorous fish species with an optimum protein level around 50%. No further improvement of growth was observed even with a protein level higher than 50%. Protein quality appeared as an important factor to be considered to enhance fish growth reported by (34). In some of the study Indicated Atlantic Croaker required dietary crude protein (cp) of 45% (35) and red drum of 35% to 45% crude protein (36, 37, and 38) and large yellow croaker of 47% cp (39).

In the present study, the results revealed that the optimum dietary protein level was 55% for *Channa striatus* fry was tabulated. The high protein level (60%) did not enhance the fish growth significantly at either fry or at fingerlings stage. This result may be due to the fact that each fish size has a certain protein limit after which excess protein level could not be utilized efficiently. The dietary protein requirements of air breathing fishes *Channa striatus* and *C. micropeltes* have been reported as 50% in the case of fingerlings. (40). The difference may be due to different animal biowaste protein sources and components, and formulations methods, different environmental conditions, levels of dietary intake and experimental duration.

(41,42) found out that the better growth of Nile tilapia was obtained at high dietary protein levels (40 - 45%) rather than 25-35%. (43) studied the optimum dietary protein levels for Nile tilapia. The best growth response of *Sparus aurata* in terms of final body weight was observed in fish fed diet of 55.6% crude protein with significant ($p<0.05$) difference between this protein level and followed by other diets was reported by (44) and further they reported that the levels of dietary protein producing maximum growth in fry of *S.aurata* is 55% when fed at a fixed dietary feeding rate of 5% body weight per day. A similar type of results was also observed in the present study of *Channa striatus* fry. Table 3 shows that SGR increased with increasing dietary protein content upto 55% and then decreased in SGR at a protein levels above the optimum may be due to a reduction in the dietary energy available for growth due to the energy required to deaminate and excrete excess absorbed amino acids (45). In marine carnivorous fish species such as *Seriola quinquerdiata* (46), *Sparuys aurata*, (47), *Oncorhynchus mykiss* (48) better growth rate was reported at 40 - 50% protein level. Cat fish such as *Clarias gariepinus*, *C. batrachus* (49) and *Mystus nemurus* (50) had produced better growth at the protein levels of 35 – 50%. However in the present study at an optimum level of 50% of the maximum growth was obtained in the *Channa striatus* fingerlings and the fry with a diet containing 55% crude protein was noticed.

(51) reported an optimum dietary protein requirement of 40% for *O.niloticus* fry (Initial weight 0.838 g) and 30 % for young fish. Reduced growth was also observed in yellow tail (52) and Chinese bream (53) fed with high protein diets. (54) observed the best growth performance and feed utilization in common carp fed a fishmeal based standard diet with a similar protein energy ratio of 21.2. In the present study, although all groups of fish were fed actively, comparatively poor growth response particularly during the later part of the experiment was observed. Fish fed with diet D4 (55% protein) only grew from 0.109 to 0.38 g fry in 35 days.

In the present study, the minimum level of dietary protein, this exhibited maximum growth in C. *striatus* fingerling, was estimated to be 50% based on weight gain, SGR, FCR and ADG. A similar dose response for dietary protein has been reported for rainbow trout, *Salmo gairdneri* (48), coho salmon, *Onchorhynchus kisutchi* (55).

The apparent growth depressing effect fed with high protein diets in fish observed in this study has also been reported fish species, such as Snakehead *Channa striatus* grouper (56). For example in the experiment of (57) the increase of dietary protein level from 40-60% of diet resulted in a "Perplexing" decrease of growth rate at high level of feeding, while in our present study, the same type of results were observed in fry of *Channa striatus*, the optimum level of dietary protein is 55% for were reported from the present study.

The decrease in weight gain at higher dietary protein levels (above 45%) was also observed in grass carp fry (27) .The increase in weight gain 267.21% at the crude protein levels of 55% was observed in *Channa striatus* fry were reported. Improved growth and survival rate with increasing dietary protein levels was observed in our study are well documented with other species. (58) obtained a significant increase in weight gain with red drum (*Sciaenops ocellatus*) fed increasing levels of dietary protein and energy levels (from 32 to 44 % protein and 3.4 to 3.8 Kcal /kg energy). Similarly other authors have reported higher weight gain growth with increasing protein content of the diet with several other species of fish such as rainbow trout (59). (60) reported that silver perch fed a 45% protein diet showed better weight gain.

In general carnivorous fish require higher E/P ratio than omnivorous or herbivorous (61). E/P ratio of 88 mg protein $Kcal^{-1}$ between proteins levels of 24 – 36% for Channel cat fish *Ictalurus punctatus* (26), 87.6 mg/Kcal P/E for *C. batrachus* and 90.9 mg/kcal P/E for *Channa striatus* (40) have been reported as optimum levels. In addition to these (62) studied protein and energy requirements of *O. niloticus* fry fed on test diets varying in protein and energy levels. At all protein levels diets containing the lower energy level (300Kcal, GE /100g) produced extremely poor growth and survival rate. The importance of protein level in relation to the energy levels of the diets in fish was well recognized. The result of the present study showed that 55% protein with 321.27 kcal/g gross energy and with protein energy ratio (5.326) were found suitable for best growth based on the feed utilization of *Channa striatus* fry .This may be due to the fact that the protein level (55 and 50 %) in diet D4, D3 was optimum to promote growth and the energy supplied by this diet was also adequate for maintenance and growth of *C. striatus* fry.

In the present study of *C. striatus* fry maximum SGR (1.613%/d) was attained at diet D4 (55%). And the better FCR were obtained at 20% in *L.rohita* (63). But in our present study the best low FCR was obtained in those fed with the diet (D3) 1.57 for fingerling and the fry was (D4) 1.526. Dietary protein did not affect the body moisture and ash contents of several other fish species (36). Body protein content of carp was almost constant regardless of dietary protein levels (64). Body moisture content tended to increase with increasing dietary protein level, show an inverse relationship with body lipid content as has been reported for other fishes (65). The body crude lipid content generally decreased as dietary protein level increased, which was in contrast to results obtained in rain bow trout by (66). In the present study the moisture content of fish was higher before the experiment than in any of the treatments after the experiment. All the five experimental diets had about the slight difference in moisture content (27) found no change in the body moisture content of grass carp, *Ctenopharyngodon idella* when the dietary protein level was varied.

Carcass protein content of *T. aurea* was not clearly affected by the dietary E/P ratios (61). In contrast carcass protein content of *Channa striatus* fry increased significantly with different protein levels. An inverse relation between carcass moisture and protein content was observed in *H .fossillis* was reported for other fish species (25). The trends of changes in body composition as a response to dietary treatment were not always the same among various species of fish. The difference may be due to difference in the diet composition. (40) stated that the chemical changes in carcass composition in relation to dietary protein energy levels were less consistent. Body lipid content of fish slightly increased when dietary protein was above 55% and then decreased for dietary protein was above 60%. Protein and lipid contents in whole fish body were affected by fish size and dietary protein level, and the ash content was only affected by fish size. There is a slight difference, which was noticed, in the proximate composition of the fish.

From the above stated results optimum dietary protein requirement of *Channa striatus* fry was 55% which was needed for the growth performance and weight gain and the SGR were clearly shown that reported.

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