

Dietary protein requirement of stunted fingerlings of the Indian major carp, *Catla catla* (Hamilton) during grow-out phase

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ABSTRACT

A 120 day experiment was conducted to investigate the dietary protein requirement of stunted fingerlings of the Indian major carp *Catla catla*, during the grow-out period. Fingerlings of average weight 7.10 g were fed on three different formulated diets with varying protein levels (20, 25 and 30%). Growth, survival, protein efficiency ratio (PER), food conversion ratio (FCR), specific growth rate (SGR) and ratio of protein deposition in the carcass were measured. Water quality parameters were analysed and found to be optimum for culture. The results indicated that fish fed diet containing 25% protein showed better growth performance in terms of the parameters measured.

Keywords: *Catla catla*, Dietary protein, Fingerling, Grow-out, Stunted

Introduction

Indian major carps (IMC) contribute to about 90% of total freshwater aquaculture production in India. Among the IMC, catla is a fast growing fish which contributes more than 50-60 % of total production in composite fish culture in ponds and hence, is regarded as a preferred fish among the farming community (Ayyappan and Jena, 2003). According to FAO (2012), global *Catla catla* production in 2010 was about 3869984 t in quantity and over years the production rate has shown increasing trend. Artificial and supplementary feeds play important role in achieving higher aquaculture production. Fish production can go up to ten times through artificial feeding in culture (Singh *et al.*, 1997). Protein is considered to be the most expensive ingredient and probably the most important feed element in the growth of cultured species.

Determination of the dietary protein requirement of fish is important for the development of nutritionally adequate diets for fish culture. Variation in dietary protein requirement of fish is due to difference in feeding habit, size of the fish, water temperature, feed quality, feed composition, biological value of protein and source of non-protein energy (Halver *et al.*, 1964; Garling and Wilson, 1976; Mazid *et al.*, 1979; Dabrowski *et al.*, 1989). Garling and Wilson (1976) reported a level of 25-36% crude protein in diets as optimum for warm water fishes. Usually small sized fishes require higher levels of proteins than the large ones. The estimated protein requirement for common carp is about 31% (Varghese *et al.*, 1976) and for stunted rohu (*Labeo rohita*) fingerlings in grow-out phase is 25 % (Kumar *et al.*, 2011).

The practice of stocking of stunted fingerlings in grow-out ponds is of recent origin. Production of stunted fingerlings is done in order to make available stocking material (seed) throughout the year. Stunted fingerlings exhibit better growth in the grow-out phase, with high survival rates. Production of stunted fingerlings is achieved by stocking normal fry at high stocking density with sub-optimal feeding and manuring (Veerina *et al.*, 1993). Radheyshyam and Saha (2009) reported fast growth in stunted fingerlings of carps. Nandeeshia *et al.* (1994) studied the growth performance of stunted yearlings of rohu and reported 25% protein and 37% carbohydrate as optimum dietary requirements. Growth and survival of stunted fingerling is dependent on level of protein in the diet (Kumar *et al.*, 2011). Swamy (2004) and Kumar *et al.* (2011) reported good growth performance in stunted fingerlings of mrigal and rohu at 25% dietary protein level.

The present study was carried out to find the dietary protein requirement of stunted catla (*Catla catla*) fingerlings in grow-out ponds.

Materials and methods

Experimental protocol

Grow-out of stunted fingerlings

Cement cisterns (25 m²) with soil base of 15 cm were drained out, limed @ 0.5 kg per 25 m² (200 kg ha⁻¹) and left for a week to dry. The cisterns were then filled with water drawn from a perennial farm pond. Water level was maintained at 70-75 cm throughout the experimental period. Subsequently, the cisterns were manured with

cow dung @ 5 kg per 25 m² (2000kg ha⁻¹) initially and @ 2.5 kg per 25 m² (1000 kg ha⁻¹) once a month.

Stunted fingerlings of catla were stocked in duplicate @ 5600 no. ha⁻¹ (14 no. per 25 m²). The average initial length and weight of the fishes were 9.68 cm and 7.10 g respectively. The experimental feed was prepared using locally available ingredients mixed in different proportion (Table 1). The experiment consisted of four treatments in duplicate *viz.*, diet having 20% (T₁), 25% (T₂), and 30% protein (T₃) and control without supplementary feed (T₀). The stunted fingerlings were fed daily @ 2% of the body weight and the quantity of feed given was adjusted based on the growth ascertained during fortnightly sampling. The experiment was conducted at the Fish farm of the College of Fisheries, Mangalore, over a period of 120 days.

Table 1. Ingredient proportion of the experimental diets.

Ingredients (%)	T ₁ (20%)	T ₂ (25%)	T ₃ (30%)
Fish meal	12	20	26
Groundnut oil cake	25	28	35
Rice bran	43	38	29
Tapioca flour	19	13	09
Mineral premix* (Supplevite M)	01	01	01

* Supplied by Sarabhai Chemicals, Wadi, Baroda, India

Analytical methods

Analysis of water quality parameters (pH, dissolved oxygen, carbon dioxide, total alkalinity, ammonia) was carried out every 15 days following standard protocol (APHA, 1995). Wet and dry weight of plankton in the experimental cisterns was determined by collecting plankton from 50 l of water using plankton net.

Fish sampling was done fortnightly to check the growth of fish in different treatment groups. During every sampling, at least 50% of stocked population in each cistern was measured for length and weight. At the end of the experiment, all the cement cisterns were drained to

collect the fishes, and the individual length and weight of each fish, as well as number of survivors were recorded. Finally, survival percentage, specific growth rate (% per day), food conversion ratio (FCR), hepatosomatic index (HSI), viscerosomatic index (VSI) and protein efficiency ratio (PER) were calculated using the formulae given below:

$$\text{Survival percentage} = \frac{\text{Number of survived fish}}{\text{Total number stocked}} \times 100$$

$$\text{Specific growth rate} = \frac{\log_e W_2 - \log_e W_1}{T_2 - T_1} \times 100$$

$$\text{Feed conversion ratio} = \frac{\text{Dry weight of feed given (g)}}{\text{Increment in wet biomass (g)}}$$

$$\text{Protein efficiency ratio} = \frac{\text{Increment in body weight (g)}}{\text{Protein intake (g)}}$$

$$\text{Hepatosomatic index} = \frac{\text{Weight of liver (g)}}{\text{Total weight of fish (g)}} \times 100$$

$$\text{Viscerosomatic index} = \frac{\text{Weight of viscera (g)}}{\text{Total weight of fish (g)}} \times 100$$

Carcass compositions of stunted fingerlings from different treatments were analysed. Proximate composition of feed ingredients, feed and carcass samples were analysed as per AOAC (1995). The data were subjected to statistical analysis using SPSS.16 software.

Results and discussion

Storage studies of the formulated test diet during the experimental period of 120 days showed slight increase in moisture content and decrease in crude protein and crude fat in all the diets (Table 2). High relative humidity, temperature and hygroscopic nature of the ingredients or incomplete ashing during the burning period may have resulted in increased moisture content of diets

Rearing water pH, dissolved oxygen and carbon dioxide ranged from 6.53 to 7.63, 4.48 to 9.70 and 0 to 14 respectively. Natural productivity in the cistern

Table 2. Proximate composition of the experimental diets (Values in parenthesis indicate standard error)

Parameters	Treatment T ₁ (20%)		Treatment T ₂ (25%)		Treatment T ₃ (30%)	
	Initial	Final	Initial	Final	Initial	Final
Moisture	1.08 (0.08)	3.02 (0.03)	0.95 (0.40)	3.26 (0.23)	3.40 (0.40)	3.80 (0.13)
Crude protein	19.26 (0.86)	19.06 (0.04)	24.08 (0.44)	23.86 (0.09)	29.33 (0.44)	28.95 (0.09)
Fat	2.55 (0.15)	2.50 (0.10)	3.05 (0.05)	2.55 (0.05)	4.00 (0.00)	3.00 (0.30)
Ash	16.50 (3.65)	28.50 (1.92)	20.70 (0.05)	31.37 (0.25)	21.71 (0.07)	31.43 (0.23)
Crude fiber	24.76 (0.25)	24.92 (0.08)	21.54 (0.51)	23.05 (0.37)	20.15 (0.00)	21.10 (0.05)
NFE	35.85	22.00	29.68	15.91	21.41	11.72

was analysed in terms of wet and dry weight of plankton. The average wet weight of plankton ranged from 0.026 to 0.239 mg per 50 l in T₀ (control), 0.08 to 0.998 mg per 50 l in T₁ (20%), 0.012 to 0.39 mg per 50 l in T₂ (25%) and 0.03 to 0.583 mg per 50 l of water in T₃ (30%) treatment. The average dry weight of plankton ranged from 0.0015 to 0.032 mg per 50 l in T₀ (control), 0.001 to 0.666 mg per 50 l in T₁ (20%), 0.001 to 0.14 mg per 50 l in T₂ (25%) and 0.001 to 0.025 mg per 50 l of water in T₃ (30%) treatment.

While formulating an artificial feed, due importance needs to be given to the protein component, as it contributes significantly towards the feed cost and growth rate of the fish. Hence, it is essential to determine the optimum dietary protein requirement to develop nutritionally balanced diet for fish culture. Garling and Wilson (1976) reported a level of 25-36% crude protein in diets as optimum for warm water fishes. Usually the recommended protein requirement is dependent on species, size and environment factors, particularly temperature. Optimum inclusion of protein is a prerequisite for the formulation of nutritionally adequate cost-effective diets. Fish meal used for the preparation of experimental diets in the present study, was of good quality, with an average protein content of 52.45%. Fish meal with protein content >50% is considered to be of good quality (NAS, 1979). Nandeesh et al. (1994) reported that 25% protein and 37% carbohydrate were the optimum requirements in natural feed for Indian major carps. Swamy (2004) and Kumar et al. (2011) found that diet with protein content of 25% had better impact than other diets on growth of stunted fingerlings of mrigal and rohu reared in manured ponds. Therefore crude protein levels of 20%, 25% and 30% were selected for the experimental diets used in the present study. Stunted fingerlings of catla fed with diet containing 25% of protein (T₂) showed the best growth performance followed by the treatment T₁ having 20% crude protein

in feed (Table 3). The growth performance of stunted fingerlings of *C. catla*, in the present study are comparable with works of Nandeesh et al. (1994) on stunted yearlings of rohu, Swamy (2004) and Kumar et al. (2011) in stunted fingerlings of mrigal and rohu respectively. The decrease in growth of stunted fingerlings of *C. catla* with increasing level of protein above the optimum in the present study is similar to those reported for catla (Dars et al., 2010), grass carp (Dabrowsky et al., 1977) and stunted fingerlings of rohu (Kumar et al., 2011). This decreased growth may be attributed to the metabolic stress mediated by excess nitrogen content. The present study showed better growth of fish in the presence of natural food with lower levels of protein in the diet. This could be attributed to nutrient contribution by natural food.

In addition to growth, feed conversion ratio, specific growth rate and protein efficiency of the stunted fingerlings of catla showed better results with diets having 20% and 25% protein level (Table 3). Similar observations were made in advanced fingerlings of catla (Mahadeva, 1991) common carp fingerlings (Brinda and Aravindan, 1995), stunted fingerlings of rohu (Nandeesh et al., 1994; Kumar et al., 2011) and mrigal (Swamy, 2004).

Highest survival rate of 96.43% was recorded in T₂ followed by 89.29% in T₁, 85.71% in T₃ and 74.99% in T₀ (Control). Maximum net production of 2622.25 g per 25 m² was recorded in T₂ (25% protein diet) and minimum of 1507.25 g per 25 m² was observed in T₀ (Table 3). The hepatosomatic index and viscerosomatic index were highest in the group fed with a 25% protein diet (Table 3).

Carcass composition is known to be influenced by many factors like geographical location, age, sex, maturity and feeding conditions. Among these factors, the type and nature of feed ingested are considered to be the most important (Parove, 1976; Reimers and Meske,

Table 3. Growth, survival, net production and body indices of catla (values in parenthesis indicate standard error)

Parameters	T ₀	T ₁	T ₂	T ₃
Avg. initial weight (g)	7.10	7.10	7.10	7.10
Avg. final weight	60.29 (5.65) ^a	82.76 (1.19) ^b	104.89 (0.00) ^c	70.87 (5.12) ^d
Survival (%)	74.99 (3.57) ^a	89.29 (3.55) ^b	96.43 (3.57) ^c	85.71 (0.00) ^b
Net production (g 25m ⁻² 120 day ⁻¹)	1507.25	2069	2622.25	1771.75
VSI (%)	6.36 (0.21) ^b	4.91 (0.91) ^a	4.21 (0.12) ^a	6.24 (0.28) ^b
HSI (%)	0.67 (0.08) ^{ab}	0.77 (0.04) ^b	0.93 (0.10) ^c	0.6 (0.04) ^a
SGR (%)	1.504 (0.06) ^a	1.797 (0.02) ^b	1.995 (0.00) ^c	1.54 (0.07) ^a
FCR		1.14 (0.06) ^a	1.26 (0.07) ^a	1.45 (0.12) ^b
PER		4.57 (0.26) ^a	3.3 (0.19) ^b	2.37 (0.19) ^c

1977; Srikar *et al.*, 1979). The carcass composition and body indices of fishes from different treatments were analysed after completion of the experiment and the results presented in Tables 3 and 4. Increment in protein content of stunted catla is evident during the experimental period. The highest fat content was observed in fish from treatment T₁ (20%) followed by T₂ (25%). Protein values followed the same trend as that of fat, whereas moisture and ash content were highest in control group. The loss of protein in fish that received diet containing 20 and 30% crude protein could be attributed to the utilisation of tissue protein as energy source from the muscle (Mukhopadhyay *et al.*, 1978). Increased dietary lipid was found to enhance

deposition of body fat (Das, 1990; Bazaz, 1991). The fat content of fish marginally increased towards the end of the experiment. Kumar *et al.* (2011) opined that stunted rohu fingerlings have an inverse relation with the carcass lipid and protein level in the diet.

The results of the present investigation clearly indicates that the optimum dietary protein requirement for stunted fingerlings of catla is 25%.

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Table 4. Carcass composition of catla during the experimental period, (values in parenthesis indicate standard error)

Parameter	Initial	Final			
		T ₀	T ₁	T ₂	T ₃
Moisture	75.05 (1.86) ^b	77.72 (0.24) ^c	74.10 (0.05) ^b	73.61 (0.23) ^{ab}	72.39 (0.39) ^a
Protein	16.83 (0.66) ^a	18.59 (0.51) ^b	19.53 (0.00) ^c	20.69 (0.11) ^d	20.26 (0.74) ^{ed}
Fat	4.15 (0.05) ^c	1.92 (0.02) ^a	3.00 (0.20) ^b	2.30 (0.45) ^a	2.32 (0.13) ^a
Ash	2.86 (0.73) ^b	1.37 (0.13) ^a	0.88 (0.25) ^a	1.04 (0.00) ^a	1.05 (0.14) ^a
NFE	1.11	0.4	2.49	2.36	3.99

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