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Growth of Black Tiger Shrimp, *Penaeus monodon,* on Fishmeal Based Formulated Diet in a Southeastern Coastal Shrimp Farm of Bangladesh

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Abstract.- Growth of black tiger shrimp, *Penaeus monodon,* was tested under field condition with four experimental diets having different protein percentages for a period of 120 days in a southeastern coastal shrimp farm. Four formulated diet with crude protein level of 30 to 45% were examined; eight ponds were used for the study. The experiment was designed on completely randomized design (CRD) with four treatments, each with two replications. Nursery reared juveniles of black tiger was used in the experiment. The water quality parameters such as temperature (28-28.75°C), pH (8.0-8.5), DO (5.21-5.65 ppm), alkalinity (152-155 ppm) etc., were found with in acceptable range of aquaculture. The lowest food conversion ratio (1.60±0.20) was obtained under the dietary protein level of 40% ($p < 0.05$). On the other hand, reed with both 40% and 45% crude protein resulted in similar but significantly highest specific growth rate (SGR in 40% protein diet 25.77±0.55 and in 45% protein diet 25.33±0.41). Therefore, under the experimental condition, feed with 40% protein level may be recommended for culture of black tiger shrimp.

Key words: Specific growth rate (SGR), food conversion ratio (FCR), diet, protein.

INTRODUCTION

Black tiger shrimp, *Penaeus monodon,* is an economically important shell fish in Bangladesh. The species is now contributing significantly to the export earnings. of the country. It is widely cultured in traditional shrimp *gher* in the southeastern coastal belt (Chokoria, Cox's Bazar and Teknaf) with very low level of production per unit area. Recent1y, however, some shrimp farm started semi-intensive culture of the species with reasonable success. Keeping with the demand in international market, the culture of black tiger shrimp has increased at a rapid pace in the coastal region of Bangladesh. At present, the number of shrimp farms increased many folds than before with concurrent increase of export earnings. In 1989-90, the area under shrimp culture was 0.064 m ha which has grown to 0.14 m ha today. To sustain this phenomenal success, biological research on this species is necessary. Feed is the most essential input for culture of any aquatic species, and protein is pivotal in fish and shellfish teed. As most plant material is deficient of one or more essential amino acids, protein from animal origin has gotten prime attention in formulating aqua feed. Among the animal proteins, fishmea1 is, by far, the best source of protein in fish feed (Lovell, 1980). In formulating diet for fish and shell fish, low cost feed ingredients are generally used to compose appropriate cost effective feed. A wide variety of ingredients are available for use in crustacean feeds (New and Singholka, 1982). In Bangladesh, generally mustard oil cake, rice bran, wheat bran etc. are used as fish and shell fish feed ingredients. In designing fish and shell fish feed, fishmeal based formulated diet has been receiving wide attention world wide (Furuchi, 1980). In fish and shell fish nutrition research, it has been observed that inclusion of fishmeal as a protein source in diet generally results in increased growth (Hepher, 1975). Review of available literature reveals that information regarding nutritional requirement of black tiger shrimp is pretty rich from abroad (Cook, 1976; Dabrowski and Kozak, 1979; Forster and Beam, 1974; Liao, 1977; Wilson and Halver, 1986); alternatively, information on protein requirement of *P. monodon* is rather scanty from Bangladesh. The present paper reports the effect of

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different leve1s of proteins on growth and food conversion of *P. monodon* with an objective to develop appropriate diet/diets for optimum growth performances of the species.

MATERIALS AND METHODS

The study was conducted between March and July 1999 in a southeastern (Chokoria, Cox's Bazar) coastal shrimp farm (Aquafauna Ltd.) for a period of 120 days. Four experimental diets with different protein levels *viz.* 30%, 35%, 40% and 45% were tested on specific growth rate (SGR) and food conversion ratio (FCR) of black tiger shrimp. The experiment was designed on completely randomized design (CRD) having 4 treatments, each with two treatments. Eight ponds (400m2 area) were used for the: experiment. Prior to stocking, ponds were excavated to a depth of 1.5 m. The pond bottom was adequately ploughed and after few days filled with water to a depth of 1.5 cm and, limed ($CaCO_3$) at the rate of 1.5 kg/decimal. Ponds were manured with poultry droppings at the rate of 5 kg/decimal. Inorganic fertilizer urea, triple super phosphate (TSP) and muriate of potash (MP) were applied at the rate of l00gldecimal, 200g/decimal and 50g/decimal, respectively. Regular maintenance dose of inorganic fertilizer urea and TSP @ 70 and 35g/decimal, respectively was applied on weekly basis to maintain tight phytoplankton bloom. The ponds were provided with water exchange facilities during full grow out period. Brackishwater of 15%0 salinity was generally used during the experimental period. More or less 300.10 water was exchanged daily., For the experimental purpose, juvenile black tiger shrimps were collected from the fish farms nursery ponds. Juveniles were stocked at the rate of 15 fry/m^2. The experimental diets were administered in pelleted form. The feed ingredients for experimental diets were collected from local market. Proximate analyses of feed ingredients and the formulated diets were done in Bangladesh Council of Scientific and, Industrial Research (BCSIR) laboratory, Dhaka, fol1owing standard methods (AOAC, 1980). After preparation, feed was analyzed further to see if the protein percentage followed the formulation; almost intended levels of protein were found in the experimental diets. The diets were fortified with dicalciurn phosphate (OCP), salt (NaO), vitamin premix and trace elements to meet the nutritional needs of the organism. Feeding was maintained @ 5% body weight. At the termination of the experiment, average body weight of shrimps were taken to the nearest gram and recorded separately. Weights were taken by a balance (Tricle, Model TG 928 A). Water quality parameter during the experiment was measured by a portable test kit (Hach Kit, Model FF-2). Temperature was measured by a Celsius alcohol thermometer. Water pH was measured by digital pH meter (Jenway, Model, 9070). Food conversion ratio was calculated by using the formula, FCR = Mass of food consumed (dry)/increased mass of animal produced (wet). The specific growth rate was calculated by using the formula, SGR = loge W_2 – loge $W_1/T_2 – T_1$ (Brown, 1957). Where W2 = Final live weight (g), W_1 = Initial live weight (g), $T_2 – T_1$ = Period of time. To examine the effects of different feeds on specific growth rate and food conversion ratio, collected data were primarily processed under computer program MS Excel and after necessary transformation (logarithmic) were analyzed by one way analysis of variance (ANOVA) with the help of computer software SPSS (version 7.5). The sample means were separated by Duncan's New Multiple Range Test (DMRT) (Duncan, 1955).

RESULTS AND DISCUSSION

The physical and chemical qualities of water in different treatments are reported in Table I. Water temperature did not differ significantly ($F = 1.05$, $P<0.05$, Table I) among the treatments. The mean water temperature ranged from 28.0±0.60 to 28.75±0.90°C, a temperature within the range for optimum growth of fish and shell fish (Boyd, 1982). Dissolved oxygen concentration remained within the range of 5.21±0.11 to 5.65±0.30 ppm and did not vary significantly ($F = 3.01$, $P<0.05$, Table I). Generally, pH was varied between 8.30±0.20 and 8.50±0.10, being favorable for fish and shell fish culture (Boyd, 1982). There was no significant variation in the total hardness in different treatments, the hardness values were ranged from 1.52±3.0 to 155±4.0 ppm, a range suitable for

Table I.- Measured water quality parameters (Mean±SD) under different treatment during the experiment*.

Treatment	T_1	T_2	T_3	T_4
Temperature (°C)	28.00±0.60a	28.29±0.50a	28.75±0.90a	28.31±0.30a
Salinity (ppt)	15.0±2.0a	15.60±2.0a	14.70±1.0a	15.30±2.0a
DO (ppm)	5.50±0.68a	5.65±0.30a	5.21±0.11a	5.29±0.12a
pH	8.30±0.2a	8.50±0.10a	8.40±0.30a	8.30±0.5a
Total hardness (ppm)	155±4.0a	154±2.0a	153±5.0a	152±3.0a
Free NH_3 (ppm)	0.023±0.001a	0.022±0.001a	0.024±0.001	0.025±0.001a

*Means having the same superscript in the same row are not significantly different at 5% level of Duncan's New Multiple Range Test.

Table II.- Diet composition (ingredients) at different protein levels.

Ingredients	T_1 (30% protein)	T_2 (35% protein)	T_3 (40% protein)	T_4 (45% protein)
Mustard oil cake	31.50%	37.50%	44.0%	20.0$
Fishmeal	30.0%	40.0%	46.0%	72.0%
Wheat bran	35.65%	19.65%	7.15%	5.15%
Dicalcium phosphate	2.0%	2.0%	2.0%	2.0%
Sodium chloride	0.5%	0.5%	0.5%	0.5%
Vitamin premix	0.25%	0.25%	0.25%	0.25%
Trace element	0.10%	0.10%	0.10%	0.10%

Table III.- Proximate composition of formulated diets.

Composition	T_1	T_2	T_3	T_4
Protein	30.00%	35.00%	40.00%	45.00%
Carbohydrate	27.50%	23.50%	19%	5.00%
Fat	7.50%	8.20%	8.25%	7.15%
Fiber	16.90%	14.80%	14.70%	18.85%
Ash	18.10%	18.50%	18.05%	24.00%
Moisture	8.50%	8.90%	8.70%	8.35%

aquatic organisms (Stirling, 1985). Free ammonia did not exceed 0.025 ppm and never reached to harmful level for shrimp.

The feed formulation and proximate composition of experimental diets are given in Tables II and III. Data on specific growth rate (SGR) and food conversion ratio (FCR) under different levels of proteins are presented in Table IV and Figure 1. As evident from Table IV, black tiger shrimp fed 40% (T3) and 45% protein diet (T4) achieved highest weight gain and exhibited best specific growth rate (SGR) than the other two diets. Statistical analysis by one-way analysis of variance (ANOVA) indicated a significant difference ($P<0.05$; $F = 21.34$*) among different diets in regard to SGR (Table V). Further analysis by Duncan's

Fig. 1. Specific growth rate (SGR) and food conversion ratio (FCR) of *Peneaus monodon* in response to different levels of fishmeal based protein diet.

Table IV.- Effect of different dietary protein levels on growth and food conversion of black tiger shrimp, *Penaeus monodon*, for a period of 120 days*.

Treatment (Crude protein %)	Replication	Average initial body weight (g)	Final body weight (g)	Weight gain (g)	Food conversion ratio (FCR)	Specific growth rate (% / day)
T_1 (30%)	R_1	25.25	22.25	20.00	1.95	22.91
	R_2	2.26	23.12	20.86	1.98	23.25
Mean±SD		2.26±0.01	2269±0.62	20.43±0.61	1.97±0.02d	23.08±0.24b
T_2 (35%)	R_1	2.22	25.1	22.90	1.85	24.26
	R_2	2.24	24.45	22.21	1.81	23.90
Mean±SD		2.23±0.01	24.79±0.47	22.56±0.49	1.83±0.03c	24.08±0.25b
T_3 (40%	R_1	2.21	30.25	28.04	1.62	26.17
	R_2	2.23	28.22	25.99	1.57	25.38
Mean±SD		2.22±0.01	29.24±1.44	27.08±1.45	1.60±0.04a	25.77±0.55a
T_4 (45%)	R_1	2.25	29.55	27.50	1.71	25.82
	R_2	2.24	27.95	25.71	1.75	25.24
Mean±SD		2.25±0.01	28.85±1.27	26.61±1.27	1.73±0.03b	25.53±0.41a

*Mean having the same superscript in the same row are not significantly different at 5% level of Duncan's New Multiple Range Test.

Table V.- ANOVA table for specific growth rate (SGR) under different levels of protein during the experimental period.

Source of variation		Sum of squares	DF (Degree of freedom)	Mean sum of square	F (Calculated)	F (Tabulated)
Specific growth rate (SGR)	Between treatments	9.65	3	3.21	24.34*	6.59
	Within treatments	0.60	4	0.15		
	Total	10.25	7			

*Significant at 5% level.

Table VI.- ANOVA table for food conversion ratio (FCR) under different levels of protein during the experimental period.

Source of variation		Sum of squares	DF (Degree of freedom)	Mean sum of square	F (Calculated)	F (Tabulated)
Food conversion ratio (FCR)	Between treatments	0.14	3	4.897E-02	59.35*	6.59
	Within treatments	3.300E-03	4	8.250E-04		
	Total	0.15	7			

*Significant at 5% level.

Multiple Range Test (DMRT; P<0.05) revealed that T_3 (40% protein) and T_4 (45% differed significantly than the other two diets in respect of SGR.

The food conversion ratio (FCR), as apparent from Table IV, is lowest in T_3 (40% protein). ANOVA applied on FCR data (Table VI) found a significant (P<0.05; F=59.35*) difference among different treatments. DMRT revealed (P<0.05) that 40% (T_3) protein diet performed significantly best than the other treatments.

In the present study, maximum live weight gain and highest specific growth rate (SGR) were obtained by T3 (40% protein) and T4 (45% protein). Tucker (1985) also demonstrated that black tiger

shrimp juveniles fed on 40% protein diet realized higher growth rate than low protein diet. The observation, therefore, closely agrees with the findings of the present study. The SGR of *P. monodon* fed 40% (SGR 25.77±0.55) protein feed in the present study was comparable to the result reported by Dabrowski and Kozak (1979) and inferior to the growth and food conversion observed by Winfree and Stickney (1984). Mollah (1987) reported that growth of magur *Clarias batrachus* varied under different levels of fish meal based protein.

In the present study, black tiger shrimp achived highest growth (weight gain and SGR) with diets containing 40% and 45% protein. The reason for such high growth under these levels of protein was perhaps due to specific protein requirement of the species. According to Lovell (1981) protein requirement of different aquatic organisms are generally species specific and some times varies within a narrow range.

De-Silva and Anderson (1995) stated that optimum protein requirement for nile tilapia (*Oreochromis niloticus*) as 30%. Watanabe *et al.* (1983) reported optimum protein reqirement for red sea bream, *Pargrus major*, as 45%. According to Wilson and Halver (1986), formulated feed must meet the nutritional requirements of the cultured organisms at different stages of their life cycle.

In the present study fisbmea1 was used. as one of the main ingredients of feed. Furuchi (1980) reported that quality animal protein, particularly fishmeal, constitutes good quality fish and shell fish diet. Top quality fishmeaI rich in energy and mineral is highly digestible and palatable to most fish and shell fish organisms (Lovell, 1981; Wilson and Halve, 1986). Most plant materials are deficient in certain amino acid (New and Singholk,; 1982). In the present study, diet with 40% and 45% protein level is mainly based on fishmeal and mustard oil cake (Table II), thus it served the protein requirement of both animal and plant origin and, therefore, balanced the need of essential amino acids (methionine and lysine) in the diet, which ultimately gave the highest growth and lowest FCR As feed with 40% protein resulted in lowest FCR and SGR did not increased significantly beyond 40% level of protein; therefore, from economic point of view, feed with 40% protein may be suggested for culture of black tiger shrimp under the experimental circumstances.

The agro climatic environment of Bangladesh is very favorable for culture of black tiger shrimp. Although remarkable success has' been achieved in the area of gross production, the per acre production of shrimp is still very low. As reed is the main component of fish and shell fish production, more research on feed and nutrition of *P. monodon* is warranted.

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