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Growth performance of fresh water prawn *Macrobrachium rosenbergii* under different supplemental feeding options

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Abstract
The effect of five different supplementary feeds on growth, survival and production were investigated for juveniles of *Macrobrachium rosenbergii*. The best growth was obtained with the feed containing 31.50% dietary protein. Feed conversion ratio decreased with increasing weight of prawn and is negatively correlated with dietary protein level. The highest average weight gain (48.03g) of prawn was found in treatment T_1. The mean survival rates were found at 86.46, 81.33, 75.33, and 79.44 and 78.33% in T_1, T_2, T_3, T_4 and T_5 treatments, respectively. The comparable net production of freshwater prawn was (166.14kg/bigha) significantly higher ($P \leq 0.05$) in treatment T_1 among all the treatments. The feed conversion ratio was the lowest (1.13) and specific growth rate was the highest (2.19%) found in treatment T_1.Considering all facts, the better growth performance was recorded in treatment T_1 compared to other treatments T_2, T_3, T_4 and T_5.

Keywords: *Macrobrachium rosenbergii,* Supplementary Feed, Growth, Survival, Production.

1. Introduction
The giant fresh water prawn *M. rosenbergii* offers high farming potential with its qualities such as fast growth rate, better survival, high tolerance to wide range of temperature and salinity, absence of major disease problems, compatibility with non-predacious species of fish, high internal and export value and acceptance of both plant and animal diet (Indulkar *et al*., 2007) [11]. Growth performance of prawn is not subjected to only one factor but combination of several factors like: water quality, stocking density, feeding system etc. Growth increases significantly with increase in the temperature (Niu *et al*., 2003) [15]. At the same time, good water quality assurance will help to increase survival and growth. Use of supplementary feed has become inevitable for the success of fish culture. In order to get maximum fish yield from confined water, it is essential to use supplementary feed along with fertilizer and organic manure. Supplementary feeding is known to increase the carrying capacity of culture systems and can enhance production by many folds (Devaraj *et al*., 1976) [8]. Both the distribution pattern and frequency of feeding have the effects on the growth of prawn. Distribution of feed twice a day increase growth of prawns than single time feeding (Marques *et al*., 1999) [14]. Data on the nutritional requirements of *M. rosenbergii* are scarce. Several workers have tried to develop artificial diets capable of sustaining good growth using a variety of foodstuffs (Kanazawa *et al*., 1970; Das *et al.,* 1996; Venkataramani *et al.,* 2002; Anh *et al.,* 2009) [13, 7, 20, 3]. Like other animals, shellfish (crustacean) require nutrients which can support growth, maintain life and resistance against diseases. These substances include proteins, lipids, carbohydrates, vitamins and minerals. The proteins are primarily necessary for growth and defense while, fats and carbohydrates provide energy. All these nutrients are interrelated and have to be the part of diets to be fully utilized by the body (Feliciates, 1983; Pascal e*t al.,* 1983) [9, 16]. 36-40% of given diets for *M. rosenbergii* was found to be lost in the water and not ingested. Since, feed composition protein, lipid, carbohydrate etc. largely influences the growth of prawn; the determination of optimal feed is needed for maximization of its culture production as well as to ensure the sustainable higher growth rate, survival and breeding efficiency (Teshima and Kanazawa, 1987) [17]. In this regard, the present study was designed to work out the effect of different supplementary diets (Artificial) on the growth perspectives of *M. rosenbergii*.

2. Materials and Methods

This research work was conducted in five treatments with three replications for each to study the effect of different supplementary feeds on growth, survival and production of *M. rosenbergii*.

2.1. Study area and duration

A 150-days experiment was conducted during August to December 2014 at Sadar Upzilla, under Bagerhat district (22.6633° N, 89.7917° E).

2.2. Experimental Design

To study the growth performance and production of *Macrobrachium rosenbergii*, five treatments were selected in the present experiment, each with three replications (Table-1). The treatments were market available prawn feed Quality Gold (T_1), Quality Special (T_2), Soudi-Bangla (T_3), One Feed (T_4) and Jamuna Feed (T_5).

Table 1: Experimental design

Treatments	Feeds	Replication	Stocking density per Bigha
T_1	Quality Gold	3	4000
T_2	Quality Special	3	4000
T_3	Soudi-Bangla	3	4000
T_4	One Feed	3	4000
T_5	Jamuna Feed	3	4000

2.3. Pre-stocking management

2.3.1. Pond preparation

All unwanted fishes were eradicated by drying the pond. Lime was applied at 1 kilogram per decimal (5 days after drying). After liming, two days later the ponds were filled with water from adjacent deep tube well. All ponds were fertilized initially with urea and triple super phosphate (TSP) at the rates of 100g and 100g per decimal respectively. After fertilization, the ponds were left 3 days to allow plankton development in water column.

2.3.2. Collection of prawn juveniles

The juveniles of Fresh water prawn (*M. rosenbergii)* were collected from the local nursery of Bagerhat district. These juveniles were brought to the experimental sites in oxygenated plastic bags.

2.4. Stocking

Good quality juveniles were collected from local nursery and transported to the experimental site. The juveniles were stocked at the rate of 4000 juveniles /Bigha in all treatments. The juveniles were acclimatized before being released into the experimental ponds. Before stocking initial weight and length of each juvenile were measured.

2.5. Post-stocking management

2.5.1. Feeding

The supplementary feeds were applied daily for better growth. Feeds were applied at 7% of their body weight up to 60 days and 5% at 3rd month and were continued till the end of the experiment. The daily ration (feed) was adjusted based on the determination of total bio-mass through monthly sampling. The market available commercial feeds were subjected to proximate composition analysis (Table 2).

Table 2: Analyzed proximate composition (±SD) of different locally available prawn feed which have used in the experiment

Treatments	Components	Moisture (%)	Protein (%)	Lipid (%)	Ash (%)
T_1	Quality Gold	8.98±0.11	31.50±0.07	6.79±0.02	4.91±0.20
T_2	Quality Special	7.33±0.09	28.82±0.02	5.60±0.04	7.66±0.23
T_3	Soudi-Bangla	8.84±0.13	26.54±0.12	4.79±0.03	19.55±0.17
T_4	One Feed	8.66±0.05	27.37±0.06	4.43±0.04	18.78±0.14
T_5	Jamuna Feed	5.95±0.05	27.62±0.08	5.45±0.03	19.53±0.15

2.5.2. Water quality monitoring

Throughout the experimental period, the water quality parameters were recorded monthly. Transparency (cm), temperature (°C), pH, Dissolved oxygen (mg/l), Alkalinity (mg/l), Hardness (mg/l) were measured monthly. Temperature and transparency were measured on the spot. The analyses of other water quality parameters were done in the Fisheries and Marine Bioscience Lab at Jessore University of Science and Technology and sometimes measured in the field manually.

2.5.3. Growth measurement

The growth of prawn was monitored monthly. The sampling was done with the help of a cast net for the determination of their total body weight and length. Experimental data collected during the growth trial were used to determine the growth parameters as follows:

i) Weight gain (g):

Weight gain = Mean final weight − Mean initial weight

ii) Percent weight gain (%):

$$\% \text{ Weight gain} = \frac{\text{(Mean final prawn weight-Mean initial prawn weight)}}{\text{(Mean initial weight)}} \times 100$$

iii) Specific growth rate (% per day):

$$\text{SGR (\% per day)} = \frac{\ln W_2 - \ln W_1}{T2 - T1} \times 100$$

Where,

W_1= Initial live body weight (g) at time T_1 (day)

W_2= Final live body weight (g) at time T_2 (day)

iv) Survival rate (%)

$$\text{Survival Rate (\%)} = \frac{\text{No. of total live prawn}}{\text{Total no. of prawn stocked}} \times 100$$

v) FCR (Feed Conversion Ratio):

$$\text{FCR} = \frac{\text{Total feed consumed(kg)}}{\text{Total yield(kg)}}$$

vi) Production

The net production (kg/Bigha) of prawn was calculated by the following formula:

$$\text{Net Production } \left(\frac{\text{kg}}{\text{Bigha}}\right) = \frac{\text{Survival rate} \times \text{Stocking density} \times \text{Weight gain (gm)}}{100 \times 1000}$$

2.5.4. Statistical analysis
For the statistical analysis of the data, one-way ANOVA (Analysis of Variance) was used to determine the effect of different feeds on the growth of prawn. Data analysis was done by using the SPSS software (Statistical Package for Social Science) version-20 according to Post-Hoc Tukey Kramer Test to identify the significance level of variance among the different treatment means.

3. Results
3.1. Water quality parameters
Table 3 shows the means values ±SE of water quality parameters throughout the experimental period. All the water quality was within the acceptable range for freshwater prawn.

Table 3: Mean (±SD) values of water quality parameters recorded from different treatments.

Parameters	Treatments				
	T1	T2	T3	T4	T5
Temperature (°C)	25.60±4.53	25.21±4.90	25.67±4.47	25.13±4.60	25.37±4.32
Transparency (cm)	32.75±3.09	33.18±3.02	33.09±2.69	32.33±2.95	33.11±2.84
pH	7.86±0.29	7.71±0.42	7.62±0.37	7.35±0.31	7.34±0.24
DO (mg/l)	4.13±0.27	3.92±0.31	4.04±0.29	4.13±0.40	3.88±0.35
Total Alkalinity (mg/l)	116.65±9.69	116.04±10.47	113.51±8.04	112.23±7.47	112.93±8.13
Total Hardness (mg/l)	196.61±7.65	191.47±9.49	189.95±9.33	193.13±6.53	193.27±8.40

Means are not significantly different ($P>0.05$).

3.2. Growth performance of freshwater prawn
The growth of freshwater prawn in different treatments was different. The different growth performance namely length (cm) and weight (gm) gain, specific growth rate (%), survival rate (%), FCR and Net Production (kg/decimal) were recorded monthly.

3.2.1. Mean length (cm) and weight gain (gm)
The mean initial length of the prawns were (4.40±0.10 cm) and initial weight of the prawns were (1.87±0.15 gm) in all the treatments. At the end of the study, the mean final length of the prawns were 14.43±3.59, 13.53±2.48, 12.4±2.15, 13.33±2.69 and 13.57±3.1 cm and mean final weight of the harvested prawns were 49.90±6.42, 43.2±6.75, 31.97±5.64, 41.2±4.25 and 42.71±5.09 gm in T_1, T_2, T_3, T_4 and T_5 treatments, respectively. The mean weight gain found with a mean value of 48.03±6.39, 41.33±6.90, 30.10±5.79, 39.33±4.39 and 40.85±5.23 gm in T_1, T_2, T_3, T_4 and T_5 treatments, respectively. There was no significant difference ($P>0.05$) in initial weights but final weight and weight gain of prawns were significantly different among all the treatments ($P\leq0.05$). Table 4-9 shows the growth performance of *M. rosenbergii* at different sampling months (Mean length and body weight).

Table 4: Growth performance of *Macrobrachium rosenbergii* at 1st day of stocking.

Treatments	Mean Length (cm)	Mean Weight (gm)
T1	4.40±0.10	1.87±0.15
T2	4.40±0.10	1.87±0.15
T3	4.40±0.10	1.87±0.15
T4	4.40±0.10	1.87±0.15
T5	4.40±0.10	1.87±0.15

Table 5: Growth performance of *Macrobrachium rosenbergii at* 30 days later after stocking.

Treatments	Mean Length (cm)	Mean Weight (gm)
T1	6.33±1.15	8.87±1.64
T2	5.8±1.05	8.03±1.27
T3	4.67±1.02	6.97±1.4
T4	5.13±1.32	7.6±1.9
T5	5.17±1.01	7.73±1.06

Table 6: Growth performance of *Macrobrachium rosenbergii* at 60 days later after stocking.

Treatments	Mean Length (cm)	Mean Weight (gm)
T1	9.33±2.04	17.63±2.2
T2	8.27±1.8	15.87±2.41
T3	7.97±1.6	13.33±2.64
T4	8.67±1.46	14.77±2.12
T5	8.93±1.96	15.03±2.71

Table 7: Growth performance of *Macrobrachium rosenbergii* at 90 days later after stocking.

Treatments	Mean Length (cm)	Mean Weight (gm)
T1	11.33±2.26	30.83±3.25
T2	10.67±2.31	27.2±2.91
T3	9.73±1.68	23.23±2.25
T4	10.8±2.39	26.34±2.52
T5	9.53±2.15	26.97±2.3

Table 8: Growth performance of *Macrobrachium rosenbergii* at 120 days later after stocking.

Treatments	Mean Length (cm)	Mean Weight (gm)
T1	13.37±3.12	39.23±3.35
T2	12.63±3.04	34.13±4.51
T3	11.1±3.52	28.7±2.46
T4	12.23±3.06	32.77±2.99
T5	12.43±3.15	33.8±3.35

Table 9: Growth performance of *Macrobrachium rosenbergii* at 150 days later after stocking.

Treatments	Mean Length (cm)	Mean Weight (gm)
T1	14.43±3.59	49.8±6.52
T2	13.53±2.48	43.2±6.75
T3	12.4±2.15	35.93±5.78
T4	13.33±2.69	41.2±4.25
T5	13.57±3.1	42.71±5.09

3.2.2. Specific growth rate (% body weight)
The mean specific growth rates were 2.19±1.8, 2.09±1.68, 1.89±1.59, 2.06±1.61 and 2.08±1.63 % body weight in T_1, T_2, T_3, T_4 and T_5 treatments, respectively. The highest value was obtained from T_1 and the lowest value was obtained from T_3. There was no significant difference ($P>0.05$) in specific

growth rates of prawn among different treatments. The SGR of five treatments are shown in Fig. 1.

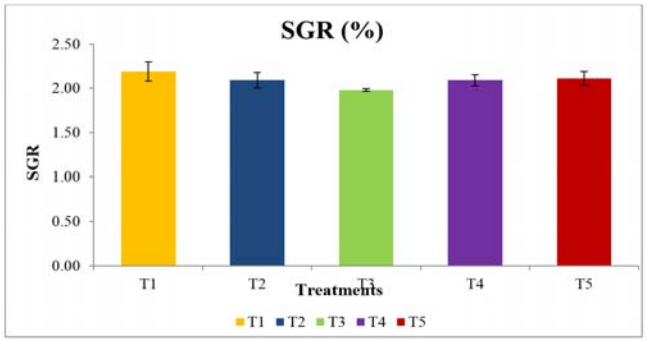

Fig 1: Comparison of SGR of prawns in different treatments during experimental period.

3.2.3. Survival rate (%)

The mean survival rates were found at 86.46±4.61, 81.33±2.08, 75.33±5.01, 79.44±2.40 and 78.33±3.21 % in T_1, T_2, T_3, T_4 and T_5 treatments, respectively. The highest value was obtained from T_1 and the lowest value was obtained from T_3.There was significant difference ($P \leq 0.05$) in survival rates of prawn among the treatments. The survival rates of five treatments are shown in Fig.2.

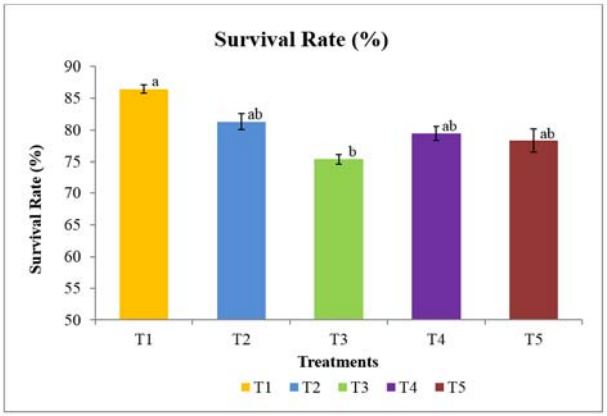

Fig 2: Comparison of survival rates of prawns in different treatments after harvesting.

3.2.3. Feed conversion ratio (FCR)

The mean feed conversion ratios were 1.13±0.15, 1.31±0.08, 2.27±0.43, 1.19±0.24 and 1.36±0.26 in T_1, T_2, T_3, T_4 and T_5 treatments, respectively. The highest value was obtained from T_3 and the lowest value was obtained from T_1. There was highly significant difference ($P \leq 0.01$) in FCR of prawn among the treatments. The FCR of five treatments are shown in Fig. 3.

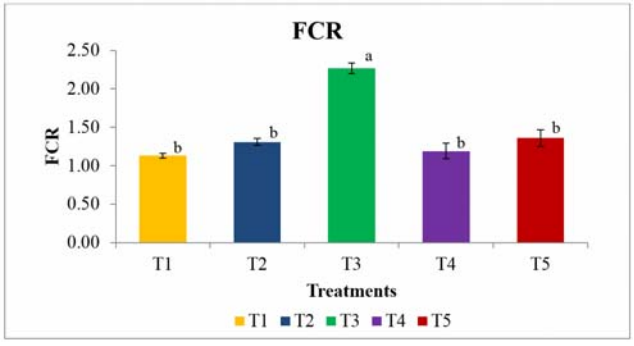

Fig 3: Comparison of FCR of prawns in different treatments during experimental period.

3.2.4. Net production (kg/bigha)

The mean net productions of fresh water prawn were 166.14±24.76, 134.66±24.22, 91.45±23.73, 124.91±13.58 and 127.54±11.39 kg/bigha in T_1, T_2, T_3, T_4 and T_5 treatments, respectively. The highest value was obtained from T_1 and the lowest value was obtained from T_3. There was significant difference ($P \leq 0.05$) in net production of prawn among the five treatments. The net production of five treatments are shown in Fig. 4.

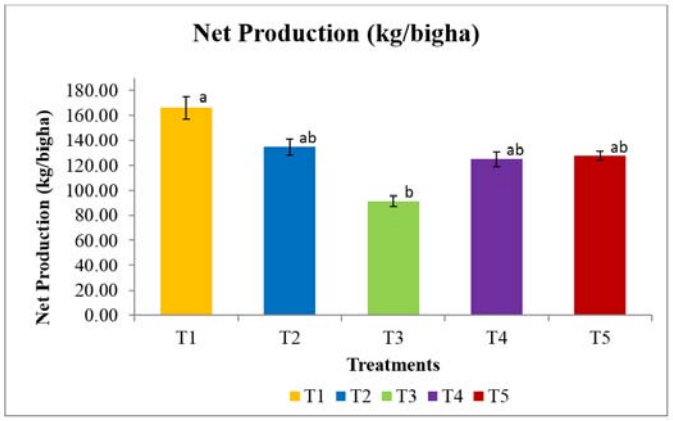

Fig 4: Comparison of net production of prawns in different treatments after harvesting.

4. Discussions

Growth and survival of prawn larvae are directly related to maintenance of good water quality, food quality and quantity and availability of the prawns (Baskerville-Bridges and Kling, 2000; Armstrong *et al.*, 1976; Aquacop, 1983) [5, 2, 1]. Marques *et al.*, (1999) [14] observed that supply of feed twice a day increased growth of prawns than single time feeding. In their experiment prawns were fed twice daily having 25-38% protein. The results of the present study have shown that treatment T_1 containing 31.50% dietary protein was recommended to achieve the optimum growth for *M. rosenbergii*. These results are in agreement with the findings of Teshima *et al.*, (2006) [18] and Kadir *et al.*, (2007) [12] who reported the increase of body fat content was observed when *M. rossenbergii* PL fed higher dietary protein diets (> 35% Crude Protein) as compared to the prawn fed diet of 35% Crude Protein. The specific growth rate (% SGR per day) of prawns of current study ranged 1.89±1.59 to 2.19±1.80 in T_3 and T_1 treatments respectively. Feed containing 31.50% protein showed the highest SGR value and feed containing 26.54% protein showed the lowest SGR value. Hossain, (2004) [10] observed SGR of prawn ranged between 2.74 to 3.12 and reported that SGR (% per day) of *M. rosenbergii* were higher when fed supplementary diet (starter and grower) and diet containing 32% protein. During the end of the study, the mean final weight of the harvested prawn were 49.80±6.52, 43.2±6.75, 35.93±5.78, 41.2±4.25 and 42.71±5.09 gm in T_1, T_2, T_3, T_4 and T_5 treatments, respectively. Daniels *et al.*, (1995) [6] reported that after grow out periods rearing from 131 to 134 days; mean final body weights of prawn were 26.3 to 34.3g, which was almost similar than that of the present study. In the present study, the mean survival rates were found 86.46±4.61, 81.33±2.08, 75.33±5.01, 79.44±2.40 and 78.33±3.21% in T_1, T_2, T_3, T_4 and T_5 treatments, respectively, with significant ($P \leq 0.05$) differences among the them. Daniels *et al.*, (1995) [6] reported highest survival rate of 73.7 to 81.9% with *M. rosenbergii* fed with specially formulated diet in

earthen ponds. Tidwell *et al.,* (1993) [19] reported that the survival and mean individual weight of 78 % and 42g respectively in monoculture of *M. rosenbergii* using formulated diet containing 32% protein. The mean feed conversion ratio (FCR) of the present experiment varied between 1.13±0.15 to 2.27±0.43. The highest value (1.13) was found in T_1 treatment and the lowest value (2.27) was found in T_3 treatment. Hossain (2004) [10] reported that FCR varied between 2.18 to 2.43 which were comparatively higher than that of the present study. Das *et al.,* (1996) [7] stated that FCR of pellets varied from 2.94 to 6.30. The net productions of fresh water prawn were 166.14±24.76, 134.66±24.22, 91.45±23.73, 124.91±13.58 and 127.54±11.39 kg/bigha in T_1, T_2, T_3, T_4 and T_5 treatments, respectively. Boonyaratpalin and New, (1980) [4] reported a production ranged from 639 to 698 kg/ha/112 days in *M. rosenbergii* monoculture. Yaqoob, (1999) [21] stocked 3.5 and 8.0g prawn juveniles and recorded the total productions of 658 and 754 kg/ha, respectively after harvesting. Considering the above discussion, in the present study the highest average weight of prawn was achieved in treatment T_1 which containing crude protein of 31.50% and lipid of 6.79% among all the treatments and these data suggested that supplementary feed containing crude protein of 31.50% and lipid of 6.79% is considered suitable to attain a suitable growth of freshwater prawn.

5. Conclusion

The investigation focused on the effect of different supplementary feed on the growth performance of prawn. The water quality parameters of the experimental ponds were studied. There was no adverse condition during the study period. Results indicated that treatment T_1 was superior to other feeds with regards to the growth rate, FCR, SGR, survival rate and production. Treatment T_1 containing crude protein of (31.50%), lipid of (6.79%), ash of (4.91%) and moisture of (8.98%) are recommended as a suitable supplementary feed for suitable growth of freshwater prawn *M. rosenbergii.*

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