

**Growth performance of giant freshwater prawn
(*Macrobrachium rosenbergii*) fed with supplementary diets
containing varying levels of shrimp processing discards**



A Thesis

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Growth performance of giant freshwater prawn
(*Macrobrachium rosenbergii*) fed with supplementary diets
containing varying levels of shrimp processing discards

Approved as to style and content by



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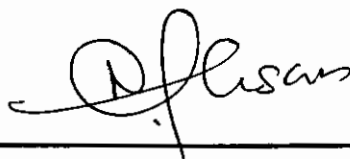
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DECLARATION

The results submitted in this thesis are entirely of the candidate's own investigations and no part of the results has been accepted for any degree, nor is it being concurrently submitted for any degree

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DEDICATED TO

My Beloved Parents



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Abstract

The growth performance of giant freshwater prawns (*Macrobrachium rosenbergii*), was observed using four experimental diets. Prawn larvae approximately weighing of 1.5g were reared for 93 days in 8 mini ponds at a stocking density of 3 larvae/m². Feeds were prepared using similar amount of locally available indigenous feed ingredients with varying levels of shrimp processing discards (shrimp meal) and fishmeal so as to obtain approximately 25% dietary protein on a dry weight basis. Feed-1 designated as control contained 100% fishmeal. Feed-2 contained 75% fishmeal, 25% shrimp meal and Feed-3 contained 50% fishmeal, 50% shrimp meal where as Feed-4 was prepared by 100% shrimp meal. The water quality of the experimental ponds was monitored and found within the acceptable limits. Initially feeds were supplied at a rate of 10% of the body weight of prawn twice a day followed by feeding at satiation level out clear with the help of feed trays. The highest and lowest weight gain was observed for Feed-2 (22.85g±0.19) and Feed-3 (18.33g ±0.11), respectively. There was a significant difference ($P<0.05$) among the treatments. The specific growth rate of prawn ranged between 2.51 ± 0.04 to 2.87 ± 0.09 in Feed-4 and Feed-2, respectively. The mean feed conversion ratio varied between 2.26 ± 0.20 (Feed-2) to 3.33 ± 0.03 (Feed-4). The highest value was found in Feed-2. The protein efficiency ratio values of prawn ranged from 1.16 ± 0.09 to 1.71 ± 0.15 in Feed-4 and Feed-2, respectively. There was no significant difference ($P> 0.05$) in the various growth parameters among the treatments however Feed-2 apparently indicated the best growth performance in respect of control and other feeds. Muscle composition was examined after harvesting. The highest protein content of body flesh was found from Feed-3 ($18.77 \pm 1.39\%$) and the lowest was found from Feed-4 ($17.10 \pm 0.28\%$). On the other hand, the highest protein content of head flesh was found from Feed-1 ($15.88 \pm 0.17\%$) and the lowest was found from prawn receiving Feed-2 ($13.21 \pm 1.01\%$). In conclusion, 25% shrimp meal containing supplemental feed could be used to obtain satisfactory production of *M. rosenbergii*.

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LIST OF ABBREVIATION

Abbreviation	Elaboration
F-1	Feed-1
F-2	Feed-2
F-3	Feed-3
F-4	Feed-4
Tk.	Taka
Kg	Kilogram
ha	Hectare
Yr	Year
DO	Dissolve oxygen
g	Gram
DoF	Department of Fisheries
FRI	Fisheries Research Institute
PL	Post larvae
NFE	Nitrogen free extract
J.	Journal
Fish.	Fisheries
Res.	Research
Aquacult.	Aquaculture
Maricult.	Mariculture
Soc.	Society
Univ.	University
Stud.	Studies
Sci.	Science
Environ.	Environment
FAO	Food and Agriculture Organization
Manage.	Management
Ecol.	Ecology
eds.	Editors
ed.	Editor
Rep.	Report
BAU	Bangladesh Agricultural University
Nat.	National
Acad.	Academy
Ltd.	Limited
Nutri.	Nutrition
Limnol.	Limnology
Zool.	Zoology
SPSS	Statistical package for social science
SD	Standard deviation

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CHAPTER ONE

INTRODUCTION

1.0 Introduction

Bangladesh is the darling children of nature. She has best owed her with vast water resources in the form of ponds, beels, haors (Natural depressions), baors (Ox-bow lakes), canals, rivers, flood plains, impounded brackish water and so on that are excellent for fisheries production. These fisheries resources play a vital role in the development of our country.

Bangladesh is the third largest producer of inland capture fisheries in the world, after China and India (FAO, 1999). It contributes 4.7% to the GDP and 8% to the export earnings of the country. The fisheries sector provides full time employment for an estimated 2 million fishermen, small fish traders, fish transporters and packer and another 10 million people partly depend on fishing such as part time fishing for family subsistence. Fish production in the country for the year 2001-2002 was 18.90 million metric ton, in which 79.91% came from inland waters and 20.09% from marine waters (DoF, 2003).

Like other countries of the third world, Bangladesh today is faced with the severe and widespread protein-calorie malnutrition problem resulting from low per capita consumption of protein on one hand and low intake of food (Chowdhuri, 1981). At present, fish consumption per capita per day is only 25g, whereas the minimum requirement is about 38g for normal growth. To meet up animal protein deficiency of the people, greater emphasis should be given to boost up fish production in this country through proper management of open and closed water fishery (Kohinoor, 2000).

The giant fresh water prawn, *Macrobrachium rosenbergii*, has attracted an enormous interest as an aquaculture species in many of the tropical and subtropical countries throughout the world (Perry and Tarver 1987) and particularly its benthographic omnivore feeding habit makes the prawn good for monoculture.

The production of prawn from natural sources is declining due to environmental degradation and habitat destruction. Most prawn farms in Bangladesh are operated on a very extensive basis, relying on natural productivity and having little and no managements. A few farmers are claiming a production levels of 900 kg/ ha/year with improved cultural practices. This can be achieved to an average production of 4,500 to 7,200 kg/ha/year by encouraging the introduction of more intensive prawn farming methods. Considering potentials, prawn is much more suitable for semi-intensive culture system. Semi-intensive culture of prawn in this country has developed recently. Semi-intensive culture of prawn requires good water quality management and proper utilization of supplied feeding may afford a fruitful result. In this aspect proper food rationing plays important role. The success of intensive and semi-intensive fish culture depends to large extent on the application of suitable feed.

Fishmeal is generally used as the protein source in feed formulation. However, it is quite often so scarce and expensive that a suitable alternative has always been a prime concern. Moreover, the massive aquaculture intensification program of the government is expected to result in a total annual fish and shrimp production of about 3.0 million tons during the course of the Sixth Five Year plan that would require approximately 1.5 million tons of nutritionally rich and balanced fish feed (Mazid, 2002). This would necessarily mean a huge gap between the demand and supply of fish feed under the backdrop of only 22,000 metric tons annual fish feed production capacity of the four existing feed manufacturers (Mazid, 2002). One of the vital factors that may contribute to success of semi-intensive and intensive fish culture is the availability of low cost feed that is suitable for small-scale farmers in the developing countries. Use of well-balanced artificial feed is the primary oasis for success of intensive fish culture. To meet this requirement it is essential to formulate a low cost aquafeed from locally available indigenous feed ingredients. Traditionally, fishmeal has been the major source protein in commercial fish feeds elsewhere in the world. Shrimp meals are cheap source of ingredient which are locally available that can replace the fishmeal without changing the protein level and the cost of feeds become lower.

In this regard, utilization of shrimp processing waste offers an excellent source of cheap and abundant substitute of fishmeal. Shrimp processing is done usually to obtain peeled and de-headed exportable items leaving behind shrimp head, tail, hull and exoskeleton. Although no systematic studies have so far been done on the total amount of wastes produced and their utilization, it is estimated that 1, 14,000 metric tons of shrimp head is produced annually from the shrimp processing industries located in the coastal region (Khan and Hussain, 1996). The processed waste of shellfish also contains chitin and its derivative chitosan. The shells of these animals are richest source of chitin. Chitin is the most abundant natural polymer after cellulose. The natural occurrence of chitin is widespread, but the only practical and considerable source is the exoskeleton of shellfishes which contains 18-24% chitin on a dry basis (Ockerman, 1992). Some recent studies indicate that the use of supplemented feed with required amount of chitin could result in faster growth rate of Bagda shrimp. Studies on protein digestibility of Bagda shrimp by using chitin as supplement in the diet confirm that the use of chitin at 5% to the diet could enhance protein digestibility and mineral uptake, hence growth, significantly than using normal commercial shrimp feeds (Shiau And Yu, 1998; Kamal 1999; Shiau and Liu, 1994). Under this consideration, present investigations were designed to fulfill the following objectives.

Objectives:

Main objective:

Low cost prawn feed formulation using available ingredients.

Specific objectives:

1. To find out suitable role of supplementation of fishmeal with shrimp meal.
2. To examine the production performance of prepared prawn feed.
3. To find out environment sustainability of prepared feed.

CHAPTER TWO

REVIEW OF LITERATURE

2.0 Review of literature

Alam *et al.* (2001) observed the effects of three stocking densities, viz., 35, 50 and 65/decimal (1 decimal = 40.48 m²) of juvenile fresh water prawn (*Macrobrachium rosenbergii*) on prawn in a polyculture system with silver carp (*Hypophthalmichthys molitrix*), catla (*Catla catla*), grass carp (*Ctenopharyngodon idella*) and silver barb (*Barbodes gonionotus*). In a 8 months culture period, the prawn yield of 423 ±144 kg/ha was significantly lower ($P < 0.5$) with the prawn stocking density of 35/ decimal than that of 548 ±178 kg/ha and 662 ±243 kg/ha with 50 and 65/ decimal, respectively.

Asadujjaman *et al.* (1998) observed catla (*Catla catla*) fry was fed with four formulated balanced feeds of which three were isonitrogenous (30%) prepared from indigenous ingredients and the fourth one was a conventional type of feed (control 22.3% protein) prepared with mustard oil cake (50%) and rice bran (50%). The fry (initial length ranging from 2.29 to 2.31 cm and weight from 0.26g to 0.28g) was stocked at the density of 400000/ha. Best growth (length 8.60 cm, weight 5.14g) and cost benefit ratio (1:1.87) were obtained by the fish fed containing 24.1% fishmeal 33.9% sesame oil cake, 35% rice bran, 6% wheat flower and 1% vitamin and mineral premix.

Ashmore *et al.* (1986) conducted an experiment on the growth and apparent digestibility of diets varying in growth source and protein in *M. rosenbergii*. They found that at the 30% dietary protein level barely appears to have been efficiently utilized than wheat.

Azim *et al.* (2001) observed that the fresh water giant prawn (galda), *M. rosenbergii* and tiger shrimp (Bagda) *Penaeus monodon* were stocked together with or without finishes at different stocking rates in semi-saline waters at Khulna region and their growth, survival, yield and cost return analysis were made. Survival rate of galda and bagda ranged from 23 to 36.8% and 8.2 to 24%, respectively. The average final weight of galda and bagda ranged 62.4g to 73.3g and 32.0g to 66.4g. They stated that their stocking density significantly affected the both species.

Azimuddin *et al.* (1999) observed a three-month experiment to study the effect of stocking density on the growth of *Pangasius sutchi* in net cages. The size of each cage

was 1 m³. The three stocking density used were 40, 50 and 60 fishes / m³. The fish in all the net cages were fed diet containing 34% protein. The specific growth rate (SGR) ranged between 3.51 and 3.09 while the feed conversion ratio (FCR) ranged between 1.73 to 2.04. The protein efficiency ratio (PER) was 1.69, 1.16 and 1.43 in three treatment.

Boonyaratpalin and New (1982) evaluated diets with different protein contents for the giant prawn. They found that growth, production, survival and feed conversion of prawn feed with 15%, 25%, 35% protein diets and broiler starter feed were not significantly different. They stated that the 15% protein diet might be a desirable formula from commercial standpoint, at least for the first four months of rearing. Absence of a vitamin mix did not appear to cause any problem in their experiment, but they could not establish whether inclusion of vitamin would improve the performance of any of test diets.

Chakraborty *et al.* (1997) conducted an experiment on the effect of stocking density on growth of tiger shrimp (*Penaeus monodon* Fab.) fed on commercial formulated diets. Three different stocking densities in a semi-intensive pilot shrimp project was adopted in duplicate of three treatments having initial per square meter stocking of shrimp of 40, 44 and 51 respectively of 0.025g size of post larva. Feed rationing was based on the survivality, body weight, and tray checking. Significantly higher FCR was found in containing stocking density 51. They showed significantly negative correlation between individual growth and density.

Chisty and Rahman (1999) observed effect of low cost feed on the growth performance of prawn, (*M. rosenbergii*) in gher farming system with a stocking density and initial weight of 2 individuals/m² and 7.88 ± 0.023g. There were four treatments each of which had three replications. The control was done by feeding the prawns with a commercial prawn feed. Two farms made low cost feed, incorporating soybean and mustard oil cake, were prepared and fed the prawns to compare the growth performance with the commercial prawn feed. In another treatment, prawns were kept in natural condition. Good growth performance was observed in control and soybean meal containing farm made feed and no significant difference (P>0.05) was found between them. The authors stated that 20% soybean containing supplemental feed could be used to obtain satisfactory production in relation to economics of production.

Daniels *et al.* (1995) found that density had a significant effect on average whole body weight of *M. rosenbergii* at harvest but no significant effect on either survival or feed conversion where juveniles of 0.11 ± 0.058 g were stocked into triplicate earthen ponds of each 0.04- 0.07 ha at densities of 39,540, 59300 and 79100 per hectare grown for 131 to 134 days by feeding a specially formulated and as additional three were stocked at 39540/ha by using a commercial sinking cat fish feed. They reported that the mean weight was significantly higher for prawn's stocked 39540/ha by using a commercially sinking catfish feed. They reported the mean weight was significantly higher for prawn stock at 19500/ha (34.3g) than that for those stocks at either 59300/ha (26.7g) or 79100/ha (26.3g) and average total yield ranged from 1041 to 1662 kg per ha for stocking densities from 39540 to 39100 per ha.

Das *et al.* (1990) showed five different feed items were prepared making use locally available feedstuff and were fed for 40 days to juvenile *Penaeus monodon*. Major protein sources that have been introduced were fishmeal and shrimp head meal. Diets were prepared in dry pellet form at protein level ranging from 28.19% to 40.11%. Better growth was registered with feeds supplemented with attractants like squid meal and shrimp head meal. They suggested that combination of the ingredients having plant and animal origin in the diets is good for growth of the animal and can be utilized in shrimp feed formulation.

Hossain *et al.* (2000) conducted an experiment for 105 days in 12 earthen mini ponds of each 30 m² size. Five different experimental diets containing 32% protein were formulated and prepared using fishmeal, soybean meal, mustard oil cake, sesame meal, wheat bran and rice bran. A commercial diet (SABINCO starter-III) was assigned to treatment six and considered as the control. Prawns were stocked at the rate of 2.5 fry /m². The FCR of diets ranged between 3.06 to 4.85. The survival (%) of the prawns ranged between 46.6 to 66.6 % and the production ranged between 304.5 to 563.3 kg/ha/105 days. They suggested that diet containing 30% fishmeal, 5% shrimp meal, 5% soybean meal, 10% mustard oilcake, 10% sesame meal, 20% whet bran, 18% rice bran, 1% oyster shell and 1% vitamin premix might be recommended for monoculture of *M. rosenbergii*.

Hossain *et al.* (2000) conducted an experiment in a seawater recirculatory system to study the nutrient digestibility coefficients of diets with varying energy to protein ratios in Japanese flounder *Paralichthys olivaceus*. Six different experimental diets with two protein levels (45 and 55%) having six different energy to protein ratio of 87, 94, 107, 110 and 114 were formulated with the white fish meal and casein as protein sources. The result of the study showed that apparent protein digestibility (APD) value ranged between 90.59 to 91.61 and there were no significant differences ($P > .05$) between the APD values of different diet. The apparent lipid digestibility (ALD) values ranged between 88.24 to 90.18%. The apparent energy digestibility values (AED) ranged between 80.55 to 87.52%.

Jia mo *et al.* (1988) conducted a monoculture experiment on *M. rosenbergii* in earthen ponds and found the total yield of 547.7 kg/ha with an average yield of 91.28 kg for 142 days culture period when the survival rate was 57.68% and the average size of the prawn was 17.58g. They also reported that the food conversion rate was 3:1 with "Camaronia" (35% protein), the water temperature fluctuated from 28.5°C to 33°C, the pH from 7.5 to 8.5 and the dissolved oxygen was 4.5 ppm.

Law *et al.* (1990) conducted an experiment on digestibility of low cost ingredients in pelleted feeds by *M. rosenbergii*. They found that adult prawns were able to digest nutrients of the low cost ingredients better than the juveniles. In addition both juveniles and adult prawns could digest the nutrients of copra cake, soybean cake, soybean meal and wheat flower than those of fishmeal and shrimp meal. They also found that the carbohydrate and dry of wheat flower were well digested by the prawns with digestion coefficients of 93-100% and 85-97%, respectively. From these findings they suggested that copra cake, soybean meal and wheat flower are good sources of nutrients for the culture of *M. rosenbergii*.

Nahar *et al.* (2000) conducted an experiment to study the effect of different feeds on growth, survival and production of African catfish (*Clarias gariepinus*, Burchell) in six cemented tanks (3 m² each) over a period of 120 days. Three different feeds namely feed A (Saudi-Bangla fish feed, 33.43% protein), feed B (Formulated feed, 40.12% protein) and feed C (chicken raw intestine, 59.58% protein) were applied to treatments I, II and III respectively. The feed conversion ratio (FCR) ranged from 2.52 to 6.40. Survival rate of

fish varied between 83 and 96%. Treatment II yielded the highest (5000kg/ha/120days) production with the highest survival rate of fish.

Sarkar *et al.* (2000) conducted an experiment by *Labeo rohita* fingerlings in an indoor static fish rearing water system of glass made aquaria. Five experimental diets were formulated containing 33% dietary protein level in five treatments each having two replicates containing 12 fingerlings of mean total initial weight of $13.00 \pm 0.2\text{g}$. Feed conversion ratio (FCR) and protein efficiency ratio (PER) ranged between 1.37 to 2.17 and 1.38 to 2.18 respectively.

Siddiqui and Al-Hinty (1993) studied the feasibility of fresh water prawn, *M. rosenbergii* monoculture in the central region of Saudi Arabia where juveniles with an average weight of $2.98 \pm 0.2\text{g}$ were stocked in 1210 m² concrete tanks at 2, 4, 8 and 16 m² and reared for 175 days by feeding twice daily a combination of fresh fish meat (25%) and dry fish feed (75%). they reported that the survival rate varied from 71 to 93% which was influenced by the stocking density and the growth rate was negatively related to stocking density with mean weights of 25.4g, 19.5g, 17.6g, and 13.38g at stocking densities 2, 4, 8 and 16 m² respectively where the corresponding yield at those densities were 46.3g, 61.9g, 96.1 g and 172 g/m².

Stanly and Moore (1983) conducted an experiment on the growth of *M. rosenbergii* fed with commercial feed in pond cages. In their experiment, feeds were delivered to juvenile *M. rosenbergii* in cage within commercial prawn fed. Feeds were supplied at a rate of 5% body weight daily for 10 weeks. They observed best growth on low water stability ration with 27% protein. Followed in order by more water stable feeds with 41%, 28% and 44% protein respectively. They also found that there was no difference in growth of prawns fed with bound and unbound forms of a given diet.

Tidewell *et al.* (1992) studied distillers dried grains soluble (DDGS) as a protein source in practical diets for fresh water shrimp (*M. rosenbergii*) raised in ponds where juvenile shrimp averaging 0.66g were randomly stocked into nine 0.02 ha ponds at 19760 by using three isonitrogenous diets (35% crude protein) containing 20 or 40% DDGS and observed that average yield, survival, individual weight and feed conversion did not differ significantly among treatments. They reported that the yield, survival, individual weight

and feed conversion were 833 kg/ha, 75%, 57g and 3.1 from which it appeared that DDGS is a suitable ingredient for use in practical diets for fresh water prawn at inclusion rates of up to at least 40% of the total formulation.

Tidewell *et al.* (1993) conducted a study to evaluate the effect of partially or completely replacing fish meal with soybean meal and distillers dried grains with soluble (DDGS) in diets for pond raised freshwater prawns (*M. rosenbergii*) where juvenile prawn averaging 0.51 were stocked into nine 0.02 ha earthen ponds at 39,520/ha by using three isonitrogenous diets (32% crude protein) containing 15, 7.5 and 0% fish meal where a percentage of soybean meal and feed percentage (40%) of DDGS replaced fish meal. They noted that the yield, survival, individual weight, and feed conversion were 1368, kg/ha, 78.1%, 42g, 2.9, respectively which are not significantly among shrimp feed three diets and indicated that fish meal can be partially or totally replaced with soybean meal and distillers by products in diets for pond production of fresh water prawns in temperate areas.

Wahab *et al.* (2001) observed the optimization of stocking density of Thai silver barb (*Barbodes gonionotus* Bleeker) in the polyculture with *Labeo rohita*, *Catla catla*, and *Cyprinus carpio* in seasonal ponds. Three different stocking densities of Thai silver barb i.e., 5000, 6000, 7000 fingerlings/ha were tested with stocking density of carps fixed at the rate of 10,000 fingerling/ha. Duckweed was applied to all ponds with rice bran and oil cake. They recorded significantly higher fish production ($P>0.05$) was in the ponds where medium stocking of Thai silver barb was maintained.

CHAPTER THREE

MATERIALS AND METHODS

3.0 Materials and methods

3.1 Profile of the study area

The experiment was conducted in 8 earthen rain fed mini ponds situated in the Khulna University Campus near the Life Science building, for a period of three months commencing 27 June to 30 September 2004.

The ponds were equal in size (50 m²) and similar in shape, basin, configuration, and pattern type including water supply facilities. There is well-organized inflow and outflow system to maintain the water level. Leaves of coconut tree were used for shelter for prawn.

3.2 Experimental design

Dietary protein levels (%)	Feed name	Replication	No. of prawn stocked
25	Feed-1	Feed-1-1	150
		Feed-1-2	150
25	Feed-2	Feed-2-1	150
		Feed-2-2	150
25	Feed-3	Feed-3-1	150
		Feed-3-2	150
25	Feed-4	Feed-4-1	150
		Feed-4-2	150

3.3 Pond preparation

Preparation of pond is the important factor to increase the survival rate and for the better production. All ponds were prepared properly before stocking. The ponds were dried completely before the experiment. Ponds were numbered by lottery.

3.3.1 Liming:

Limestone (Calcium carbonate, CaCO₃) was diluted overnight with the tap water and was spread over the pond bottom properly at a rate of 1 Kg/decimal as recommended by Paal (1995).



3.3.2 Fertilizing:

Fertilizing was done by (FRI leaflet, 1993) at a rate of cow dung 10 Kg/ decimal, urea 100 gm/ decimal and TSP 100 gm/ decimal

3. 4 Feed formulation, manufacture and costing

3. 4. 1 Selection and Collection of feed ingredients:

Locally available feed ingredients (Table-1), considering both protein supplement and price were selected for feed formulation. For the formulation of experimental feed, different feed ingredients such as fish meal, shrimp meal, wheat flour, wheat bran by product, rice polish, oyster shell, shark oil, pegabind binder were collected from Khulna local market. The fishmeal was Australian origin, pegabind binder origin (Bentoli, Inc. USA) and other ingredient were indigenous origin. The ingredients protein components are shown in Table-1.

Table-1. Different feed ingredients, their cost (Tk / Kg) and protein (%)

Feed ingredients	Cost (Tk / Kg)	Protein (%)
Fish meal	40.00	60.40
Shrimp meal	11.50	29.12
Wheat flour	10.50	15.75
Wheat flour by product	9.25	19.00
Rice polish	6.00	14.81
Oyster shell	2.50	-
Shark oil	50.00	-
Pegabind binder	190.00	-

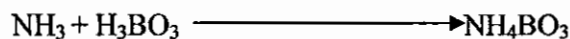
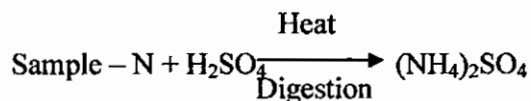
3. 4. 2 Method of analyzing proximate composition

The level of crude protein, crude lipid, and ash in samples were determined according to AOAC (1980).

3. 4. 2 (i) Crude protein

Principle:

The procedure involves two steps: (a) digestion of the sample to convert the Nitrogen to ammonium sulphate and (b) determination of nitrogen in the digest sample through distillation process.



Apparatus:

- Kjeldahl Nitrogen digestion unit (model No. OSK 8408A, OGAWA SEIKI CO. Ltd.)
- 100 ml Kjeldahl flask
- Kjeldahl Nitrogen distillation unit (model No. OSK 8416A, OGAWA SEIKI CO. Ltd.)
- Conical flask
- Measuring cylinders
- Pipette
- Burette
- Burette stand

Sample:

- 0.02 to 0.5g

Reagents:

- Resolvent: 2g approximately

Potassium sulfate and mercuric oxide ratio was 10: 0.7

- Concentrated sulfuric acid: 5 ml approximately
- 2 % Boric acid solution: 10 to 20 ml
- Indicator (Tashiro's indicator): 2 to 4 drops
- Sandy zinc: 0.5g approximately
- 40 % NaOH: 25 ml
- 0.1 N HCl

Procedure:

About 0.2-0.5g sample was taken in a Kjeldahl flask and about 2g solvent was added into the flask. About 5 ml of concentrated sulfuric acid was added in to the flask slowly. Then the flask was kept on to Kjeldahl nitrogen digesting apparatus and heated until a clear digestion mixture appeared. After digestion, the flask was removed from the digestion unit and kept at room temperature until cooling. After cooling the digestion mixture, 70 ml distilled water was poured slowly along the flask's inner wall and 0.5g of sandy zinc was also added to the mixture. About 25 ml of 40% sodium hydroxide solution (containing 1% potassium sulfide) was poured slowly along the flask's inner wall and washed down the remaining solution on the mouth with a small amount of water. The flask was then placed to the Kjeldahl nitrogen distillation apparatus (model no. OSK 8416A, OGAWA SEIKI CO. Ltd.) and turned the switch on. Before connecting the sample flask with the distillation plant, 10-20 ml of 2% boric acid was taken in another Erlenmeyer flask (conical flask) and 2-4 drops of Tashiro's indicator was added into it. Then the distillation tube was poured into the Erlenmeyer flask so that the end of the glass tube was immersed in the boric acid solution. Distillation procedure was continued for about 30 minutes to obtain about 30 ml distilled solution. After completion of distillation, the solution was titrated against 0.1 N hydrochloric acid (HCl).

Calculation:

$$\% \text{ Total nitrogen (\% N)} = \frac{\text{Titrant (ml)} \times \text{Strength of titrant} \times 0.014}{\text{Weight of sample (g)}} \times 100$$

$$\% \text{ Crude protein} = \% \text{ N} \times 6.25 \text{ (Pearson, 1976)}$$

3. 4. 2 (ii) Crude lipid

Procedure:

About 70 ml of acetone was poured in the round bottom flask of the extractor. About 2-5 g of sample was taken into a thimble paper. The thimble paper was placed into the chamber of a Soxhlet fat extractor (model no. OSK 8407A, OGAWA SEIKI CO. Ltd.) . The extractor was placed on the heater and the switch of the extractor was turned on. After 4 -5 hours, acetone extract with lipid was collected in a clean beaker from the extractor and acetone was evaporated by placing the beaker in an oven (model no. N 400, Philip Haris. Ltd., London) at 65-70° C for over night. The weight of residue in beaker was taken by using an electronic balance (model no. B303 - S, Metter Toledo,Switzerland).

Calculation:

$$\% \text{ Lipid} = \frac{W - w}{\text{Weight of sample (g)}} \times 100$$

Where,

W = weight of residue + beaker

w = weight of empty beaker

3. 4. 2 (iii) Ash

Procedure:

About 2-5g sample was taken in a porcelain crucible. The crucible with the sample was placed in a Muffle furnace for ignition for about 6 hours at 550°C. After ignition the crucible was taken out from the furnace and kept in a desiccators for an hour. The weight of the ash in the crucible was taken by an electrical balance (model no. B 303 - S, Metter Toledo,Switzerland).

Calculation:

$$\text{Ash content (\%)} = \frac{W - w}{\text{Weight of sample}} \times 100$$

Where,

W = weight of residue + crucible

w = weight of crucible

3. 4. 2 (iv) Moisture

The moisture content (%) in sample was determined by using an electric moisture determination apparatus (model no. MA 30 – 000V3, SARTORIUS AG Gottingen, Germany).

3. 4. 2 (v) Crude fiber

Apparatus:

- Analytical balance
- Muffle
- Porcelain crucible
- Oven

Sample:

- Sample with out fat

Reagents:

- 5 % Sulfuric acid (50 ml Sulfuric acid in every 1 litre distilled water)
- 1 % HCl (10 ml concentrated HCl in every 1 litre distilled water)
- 40 % NaOH (400 g in every 1 litre distilled water)
- 1 % Phenolphthalein indicator in ethanol
- Boiled water

Procedure:

1 to 2g of dry sample, filter paper (541) and porcelain crucible were weighed and the dry sample was placed in 800 ml beaker. 50 ml 5% sulfuric acid and 150 ml of distilled water were added into the beaker. The beaker was connected with a condenser, refluxed it for 30 minutes and the temperature was decreased. Then 2 to 3 drops of Phenolphthalein indicator and 10 ml 40 % NaOH were added into the beaker and the mixture was refluxed for another 30 minutes. The solution was collected and filtered with Whatman (541) through a funnel. The residue from the beaker was rinsed with boiling water, 1 % HCl and again by the boiling water to remove HCl. Then the funnel was rinsed with

methyated sprit. The filter paper with the sample was transferred to the porcelain crucible and placed in the oven at 105°C to a constant weight. After cooling down, the porcelain crucible was weighed and placed into the muffle at 550°C for about 5 hours and left until a white ash. Finally the crucible with residue was weighed.

Calculation:

$$\% \text{ Crude fiber} = \frac{W_2 - W_3}{W_1}$$

Where,

W_1 = Weight of sample taken

W_2 = Weight of dried sample + filter paper + crucible

W_3 = Weight of residue + filter paper + crucible

3. 4. 2 (vi) Nitrogen free extract (Carbohydrate)

Carbohydrate content was determined by deducting the total amount of crude protein, crude lipid, ash, crude fiber and moisture from one hundred (Das *et al.*, 1995).

3. 4. 3 Feed formulations:

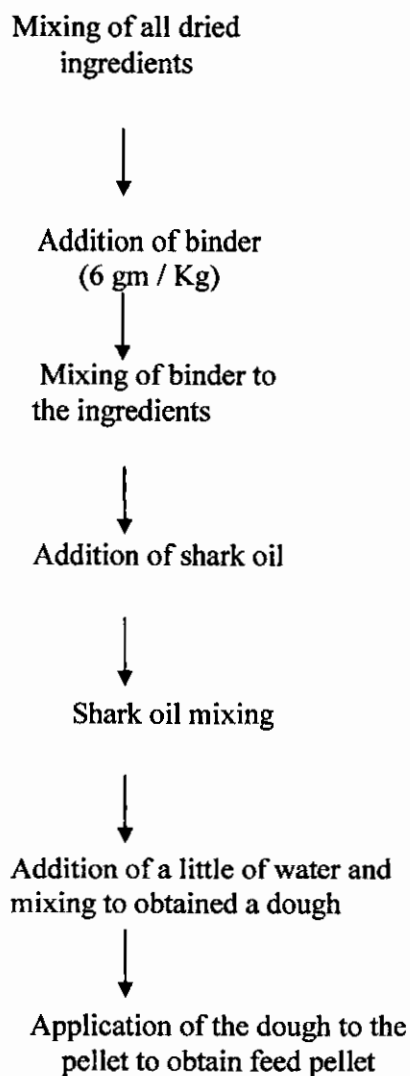
In the experiment, 4 types of feed were formulated by using 'Pearson square' method (De silva and Anderson, 1995) and the compositions are shown in Table-3.

Table-2. Formulation (%) of the different experimental feed

Feed	Amount of feed stuff (%)							
	Fish meal	Shrimp meal	Wheat flour	Wheat bran by product	Rice polish	Oyster shell	Shark oil	Pega bind binder
Feed-1 (100% fish meal)	21.524	0	22.109	31.579	19.019	3	2.8	0.006
Feed- 2 (75% fish meal & 25% shrimp meal)	16.143	10.943	22.109	31.579	19.019	3	2.8	0.006
Feed- 3 (50% fish meal & 50% shrimp meal)	10.762	21.886	22.109	31.579	19.019	3	2.8	0.006
Feed- 4 (100% shrimp meal)	0	43.771	22.109	31.579	19.019	3	2.8	0.006

3. 4. 4 Feed manufacturing:

The manufacturing process for the preparation of each feed is shown in the following scheme-



Flow chart of feed preparation process

3. 4. 5 Nutritional value of feed

In analyzing the nutrient composition of feed, the levels of crude protein, crude lipid, ash, and carbohydrate, crude fiber of the feed was determined as the results are shown in Table-4.

Table-3. Proximate composition of the experimental feed (Dry-weight basis)

Feed	Nutrient composition (Dry-weight basis)					
	Protein %	Lipid %	Ash %	Crude fiber %	NFE ¹	Dry matter
Feed – 1	25.48	7.70	10.51	6.95	49.36	85.02
Feed – 2	25.94	6.49	13.96	6.12	47.49	89.48
Feed – 3	24.86	5.31	15.45	5.09	49.29	89.84
Feed – 4	25.90	4.12	21.28	3.99	44.71	90.03

Nitrogen free extract (Carbohydrate) content was determined by $100 - (\text{crude protein} + \text{crude lipid} + \text{ash} + \text{crude fiber} + \text{moisture})$

¹ According to Das *et al.*, 1995.

3.4.6 Feed cost:

Feed cost claimed only the cost of raw materials. The costs of each feed are shown in Table -5.

Table- 4. The cost of experimental feed (Tk/Kg)

Feed	Cost (Tk/Kg)
Feed – 1	18.44
Feed – 2	17.57
Feed – 3	16.69
Feed – 4	14.95

3.5 Collection and stocking of post larvae (PL):

The PLs of *Macrobrachium rosenbergii* were collected from Chuknagar bazaar, Khulna. The sizes of PL were of 45 days old. The prices of PLs were 5 Tk. /piece. These were brought to Khulna university campus in polythene bags with oxygen. The PLs were stout and naturally moving at the time of release into the pond. Prawn (*M. rosenbergii*) juvenile locally called 'Piece Chingri' of $1.40 \pm 0g$ were hand counted and stocked at a rate of $3/m^2$. Prior to release juvenile into the pond, juveniles were acclimatized. For this purpose, pond water was added to the container of prawn juvenile and then juveniles were kept in the mixed water for several minutes.

3. 6 Grow - out management

3. 6. 1 Feeding profile

In considering feeding behavior, water quality and other environmental factors, feeds were served by using feeding tray. Feeding trays consisted of a metal frame across which was stretched a fine mesh net. The frame dimensions varied between 80 cm X 80 cm to 90 cm X 90 cm. Feeding trays rested about 7-8 inches above the pond bottom.

Feed was served on the trays in the early morning and late afternoon every day. Less percentage of the daily ration allotted to the pond was distributed between all trays in a farm in the morning and more percentage was distributed in late afternoon. Firstly feed at the rate of 10 % of body weight was served. At the time of feeding daily, the trays were carefully lifted and an estimate of daily feed requirement was made.

3. 6. 2 Water quality monitoring

3. 6. 2. 1 Temperature

Water temperature was determined every two days a week in morning between 10 A.M. to 11.30 A.M and evening between 5.0 P.M. to 6.0 P.M by using mercury-filled centigrade thermometer.

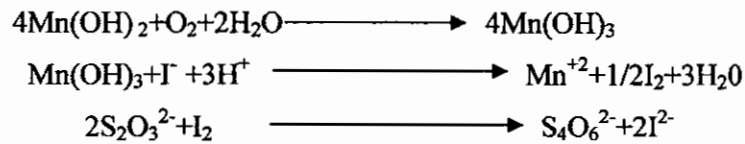
3. 6. 2. 2 Dissolve oxygen

Water oxygen was measured once a week by Winkler method (Azide modification of iodometric method, APHA, 1992) in the time between 10 A.M. and 11.30 A.M.

Principle:

The iodometric test is the major precise and reliable titrametric method for DO analysis. It is based on the addition of divalent Manganese solution, followed by strongly alkali, to the sample in a glass-stopped bottle. Dissolve oxygen rapidly oxidizes an equivalent amount of the dispersed divalent manganese hydroxides to higher valiancy states.in the presence of iodine ions in an acidic solution, the oxidized manganese reverts to the

divalent state with the liberation of iodine equivalent to original dissolve content. The iodine is then titrated with a standard solution of thiosulphate. The titration end point can be detected visually with a starch indicator.



Apparatus:

- BOD bottles (300 ml)
- Burette (25 ml)
- Pipette (10 ml)
- Funnel
- Conical flask (250 ml)
- Measuring flask (100 ml)
- Beaker
- Burette stand

Reagents:

- Manganese Sulfate ($\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$)
- Concentrated sulfuric acid
- Starch indicator
- Standard sodium thiosulphate, Na_2SO_3 (0.025N)
- Alkali iodide – azide reagent

Procedure:

- The sample was taken into a 'BOD bottle' in proper way.
- 1 ml MnSO_4 solution was added into the sample followed by 1 ml of alkali iodide – azide reagent added into the sample.
- Then the sample was stoppered carefully to exclude air bubbles, mixed by inverting bottles and then was kept for 10 minutes.
- When the precipitate was settled sufficiently to leave clear supernatant above the Manganese Hydroxide floc, 1 ml conc. H_2SO_4 was added to dissolve the precipitate.

- Restopper and mixing by inverting bottle well until dissolution was completed.
- Then the 50 ml sample from the bottle was taken in a conical flask.
- The burette was rinsed with distilled water then rinsed with Na_2SO_3 up to mark.
- Then in the 50 ml sample, few drops of starch were added.
- The sample was titrated with Na_2SO_3 solution until the 'blue' color disappeared

Calculation:

1 ml of 0.025N $\text{Na}_2\text{S}_2\text{O}_3$ is equivalent to 0.2 mg of O_2 .

Since the volume of the sample is 50 ml

Dissolve oxygen (in mg/l) = $y \times 200 / X$

Where,

y = ml of the titration

X = ml of the sample

3. 6. 2. 3 Hardness

Hardness of the water sample was determined by complexometric titration (EDTA titration).

Principle:

For determining hardness of waters, concentration of Ca and Mg in water are first determined. The values are then converted to respective equivalents of CaCO_3 and added to get total hardness of water.

Apparatus:

- Glassware
- Volumetric flask
- Burette
- Pipette
- Conical flask

Reagents:

- 0.01N calcium solution
- Ammonium purpurate (murexide) indicator
- erichrome black T indicator
- 4N sodium hydroxide
- Ammonium chloride
- 0.01N EDTA solution.

Procedure:

(a) Standardization of EDTA solution:

- 5 ml 0.01N Ca solution was taken in a 100ml conical flask and dilutes it to about 25 ml with distilled water.
- Then 5 ml 4N NaOH solution was added and about 25 mg of murexide indicator was added.
- The content was mixed well to get an orange red coloration.
- Then it was titrated with 0.01N EDTA solution against a white background until the color changes to purple.
- The color changes were not very distinct and hence the titration during end point was carried out cautiously.
- The strength of EDTA solution was determined by using the following relationship.

$$\text{Strength factor} = S/V$$

Where, V = volume of EDTA solution.

Titration:

- 10 ml of water sample was taken in a 100 ml conical flask.
- Then 1 ml of $\text{NH}_4\text{Cl-NH}_4\text{OH}$ buffer solution and 1 drop of erichrome black T indicator was added to get a wine red color.
- It was then titrated against 0.01N EDTA solution until the color change to blue.

Calculation:

$$\text{Hardness} = (A \times B \times 1000) / \text{ml sample.}$$

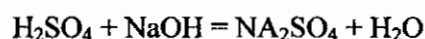
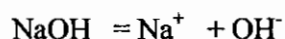
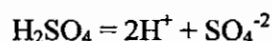
Where, A = ml of titrant and B = 1.0

3. 6. 2. 4 Alkalinity

The alkalinity of water measurements were made once a week with the use of procedure cited by APHA, 1992.

Principle:

Hydroxyl ions present in a sample as a result of dissociation or hydrolysis of solutes react with additions of standard acid which neutralized the sample at the end point.



Apparatus:

- Burette(25 ml)
- Pipette (10 ml)
- Funnel
- Conical flask (250 ml)
- Measuring flask (100 ml)
- Beaker
- Burette stand

Reagents:

- Carbon dioxide-free distilled water (by adding distilled water for 15 minutes)
- Standard sulfuric acid 0.1 N titrant
- Sodium Carbonate 0.02 N solution
- Phenolphthalein indicator
- Methyl orange indicator

Procedure:

- At first the burette was rinsed with distilled water and then rinsed with 0.1 N H_2SO_4 by pipette.
- The burette was taken clamped and filled with 0.1N H_2SO_4 solution up to mark.
- 50 ml of the sample was taken into conical flask and 3 drops of Methyl orange indicator solution was added into it.
- Finally, the sample was titrated with 0.1N H_2SO_4 until the color becomes 'light pink.'

Calculation:

$$\text{Alkalinity, mg CaCO}_3/\text{l} = A \times N \times 50000 / \text{ml sample}$$

Where,

A = ml titrant

N = Normality of titrant

3. 6. 2. 5 pH

The water pH was determined once a week by using RI 02895 (Woon Socket, HANNA) pH meter.

3. 7 Growth monitoring

3. 7. 1 Sampling:

During the investigation, a sample of 10% individuals from each pond was sampled fortnightly and individual prawn was weighed (wet-weight) to nearest unit and then returned to respective pond. Sampling procedures were conducted on the same dates in all experimental ponds.

3. 7. 2 Growth rate:

The growth rate (by weight) of the prawns was calculated following Mahmud *et al.*, (1993):

$$\text{Growth Rate: (g/day)} = \frac{W_2 - W_1}{T_2 - T_1}$$

Where,

W_2 = Weight (g) at time T_2

W_1 = Weight (g) at time T_1

T_2 = Date of last sampling.

T_1 = Date of previous sampling.

3. 7. 3 Specific growth rate (%/day):

The specific growth rate of prawn was determined by following formula:

$$\text{Specific growth rate\%} = \frac{\text{Ln final weight (g)} - \text{Ln initial weight (g)}}{\text{Time (days)}} \times 100$$

3. 7. 4 Survival rate (%):

The survival rate was calculated by using the following formula:

$$\text{Survival rate \%} = \frac{\text{No. of prawn harvested}}{\text{Total no. of prawn stocked}} \times 100$$

3. 8 Determination of the quality of feed

The qualitative value of feed was evaluated by the following parameters (De silva and Anderson, 1995).

$$\text{3. 8. 1 FCR (Feed conversion ratio)} = \frac{\text{Mass of food consumed (dry)}}{\text{Increase in mass of animal produced (wet-weight)}}$$

$$\text{3. 8. 2 PER (Protein efficiency ratio)} = \frac{\text{Increase in the mass of animal produced (wet-weight)}}{\text{Mass of protein in fed (dry weight)}}$$

3. 9 Data Analysis and presentation

3. 9. 1 Statistical analysis:

One way analysis of variance (ANOVA) was used to determine the effect of water quality and different feeds on the growth of prawn. Data analysis was taken by SPSS software according to Duncan's New Multiple Range Test (Duncan, 1955) to identify the 5% level of significance of variance among the different treatment means.

3. 9. 2 Data presentation:

Data presentation was done tabular and graphical and diagrammatical form.

CHAPTER FOUR

RESULTS

4.0 Results

4.1 Growth performance of prawn

In the selection of feed ingredient for present study, it was noticed that there were a huge amount of shrimp processing discards it is estimated that 1,14,000 metric tones (Khan and Hussain, 1996) available in the country that are worth to be used as the component of prawn diet. Results attained from the preliminary analysis showed that shrimp meal selected for the present study in addition to being cheaper, possessed almost all the major nutrient contents required for the growth of *Macrobrachium rosenbergii*.

The growth performance data of *M. rosenbergii* fed diets containing different percentages of shrimp processing discards (shrimp meal) and fishmeal are shown in Table- 6. Among the treatments, the weight gains of prawn fed with these diets were significantly different from each other.

Table-5. Growth and food utilization of prawn fed different experimental diets

Parameters	Feed (replacement of fishmeal protein by shrimp meal protein)			
	Feed-1 (100% fish meal)	Feed-2 (75% fishmeal & 25% shrimp meal)	Feed-3 (50% fishmeal & 50% shrimp meal)	Feed-4 (100% shrimp meal)
Initial weight (g)	1.4 ±0.	1.4 ±0.	1.4 ±0.	1.4 ±0.
Weight gain (g)	20.10 ^b ±0.43	22.85 ^c ±0.19	18.33 ^a ±0.11	20.83 ^b ±0.99
FCR	2.44 ^a ±0.55	2.26 ^a ±0.20	2.97 ^{ab} ±0.09	3.33 ^b ±0.03
PER	1.65 ^a ±0.37	1.71 ^a ±0.15	1.33 ^a ±0.04	1.16 ^a ±0.09
SGR (%./day)	2.79 ^{ab} ±0.18	2.87 ^b ±0.09	2.67 ^{ab} ±0.07	2.51 ^a ±0.04
Survivality (%)	83.33 ^a ±16.49	83.66 ^a ±7.07	85.33 ^a ±5.66	67.33 ^a ±2.83
Yield (g/m ² /93 days)	52.68 ^{ab} ±9.5	56.70 ^b ±5.63	46.33 ^{ab} ±3.63	39.30 ^a ±1.81
Yield (Kg/ha/Year)	2107.2 ^{ab} ±380.14	2268 ^b ±225.14	1853.2 ^{ab} ±145.38	1572.00 ^a ±72.41

Data are mean values (± SD) of two replicates. Values within the same row having the same superscripts show no significant difference (P<0.05).

The results of this study showed that mean final weight of prawn fed Feed-1 (control) and Feed-4 have no significant difference (P>0.05) (Table- 6). The highest weight increment was observed in Feed-2. The growth increment is shown in (Fig. 1). Feed-2 and Feed-3 produced significantly different weight gain than that from Feed-1 and Feed-4. The highest and lowest weight gain was observed in Feed-2 (22.85 ±0.19g) and Feed-3 (18.33 ±0.11g), respectively (Table-6, Fig. 2). Prawn weight gain in four treatments was significantly (P <0.05) different from each other.

The mean feed conversion ratio (FCR) varied between 2.26 ± 0.20 to 3.33 ± 0.03 (Table-6, Fig. 3). The highest value was found in Feed-4 and lowest value was found in Feed-2. The mean FCR of Feed-1 and Feed-2 were significantly lower ($P < 0.05$) than Feed-3 and Feed-4. There was no significant difference in Feed-1, Feed-2 and Feed-3. Feed-3 and Feed-4 was significantly different from Feed-1 and Feed-2.

The protein efficiency ratio (PER) of prawn ranged from 1.16 ± 0.09 to 1.71 ± 0.15 in Feed-4 and Feed-2, respectively (Table-6, Fig. 4). There was no significant difference ($P > 0.05$) among the Feed-1, Feed-2, Feed-3 and Feed-4.

The specific growth rate of prawn ranged between 2.51 ± 0.04 to 2.87 ± 0.09 (Table-6). The highest value was obtained from Feed-2 and lowest value was obtained from Feed-4. There was no significant difference ($P > 0.05$) among the SGR of prawn fed Feed-1, Feed-3, Feed-4 and Feed-1, Feed-2, Feed-3, respectively. The SGR is shown in (Fig. 5).

The survival rate (%) of prawn ranged between 67.33 ± 2.83 (Feed-4) to 85.33 ± 5.66 (Feed-3; Table-6, Fig. 6). The lowest survival rate was observed in Feed-1 and Feed-2, respectively. There was no significant difference ($P > 0.05$) among the Feed-1, Feed-2, Feed-3 and Feed-4, respectively.

Yield ($\text{g/m}^2/93$ days) varied between 39.30 ± 1.81 to 56.70 ± 5.63 . The highest and lowest value was observed in Feed-2 and Feed-4, respectively (Table-6, Fig. 7). There was no significant difference among the yields of prawn fed Feed-1, Feed-2, Feed-3 and Feed-1, Feed-3, Feed-4, respectively. Mean yield (Kg/ha/Year) values were 2107.2 ± 380.14 , 2268 ± 225.14 , 1853.2 ± 145.38 and 1572.00 ± 72.41 in Feed-1, Feed-2, Feed-3 and Feed-4, respectively (Table-6, Fig. 8).

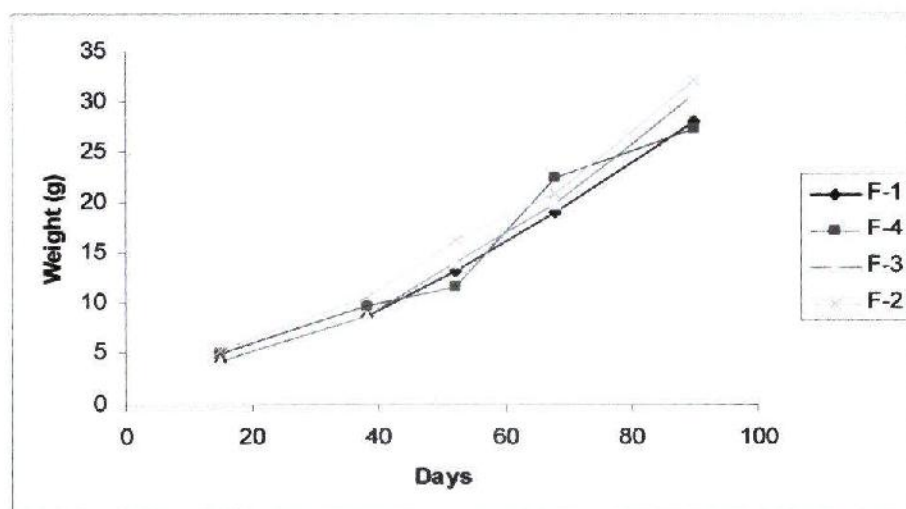


Fig. 1. Growth performance curve of prawn at different sampling

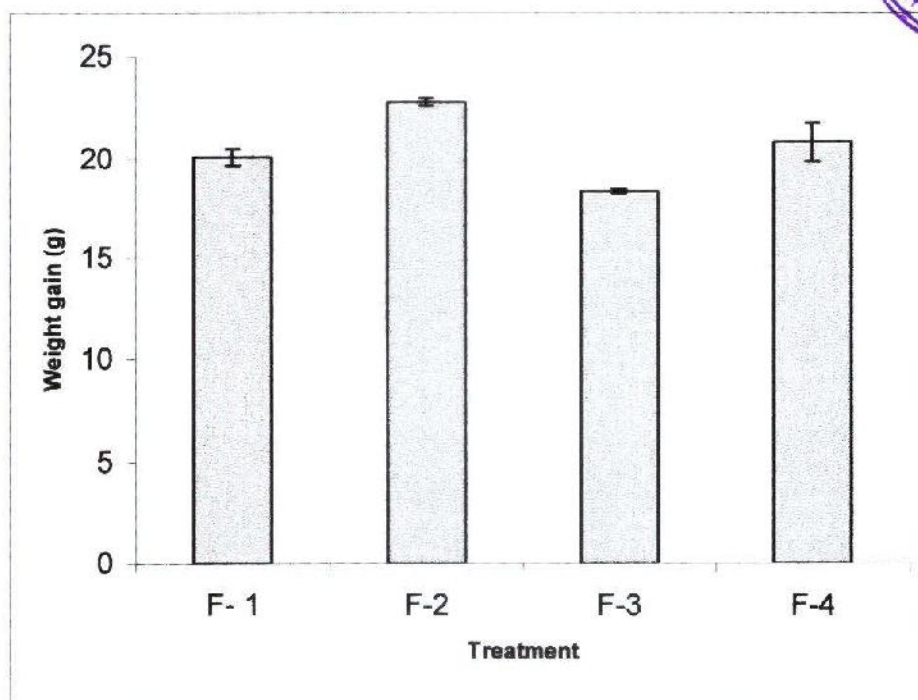


Fig. 2. Comparison of weight gain of prawns in different treatment during experimental period

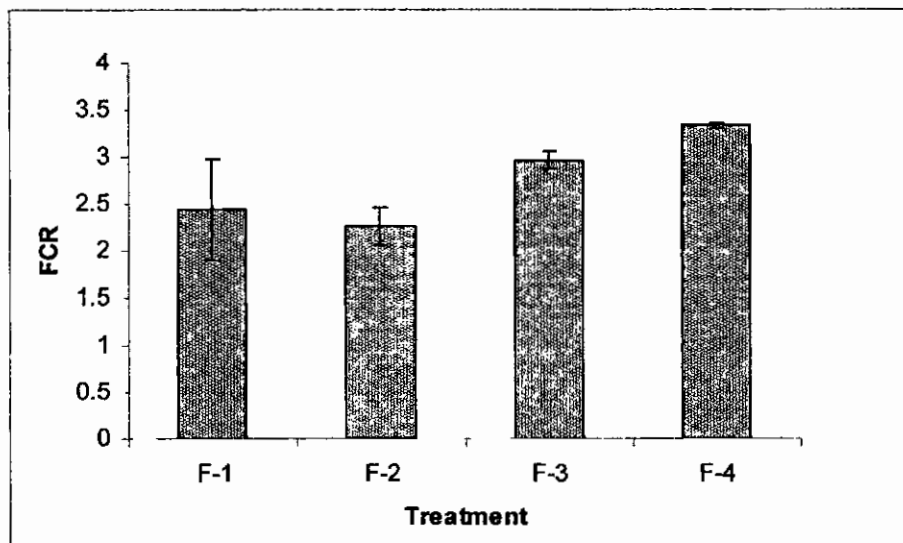


Fig. 3. Comparison of FCR of prawns in different treatment during experimental period

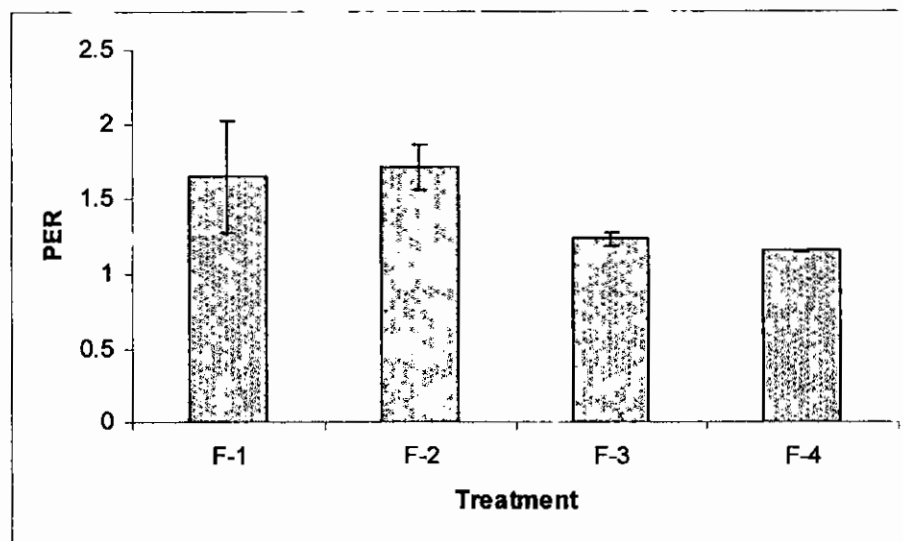


Fig. 4. Comparison of PER of prawns in different treatment during experimental period

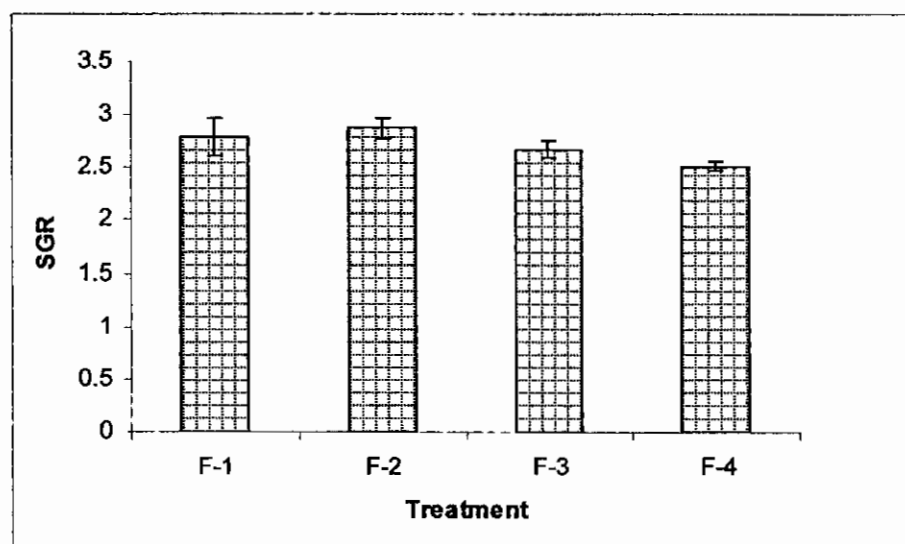


Fig. 5. Comparison of SGR of prawns in different treatment during experimental period

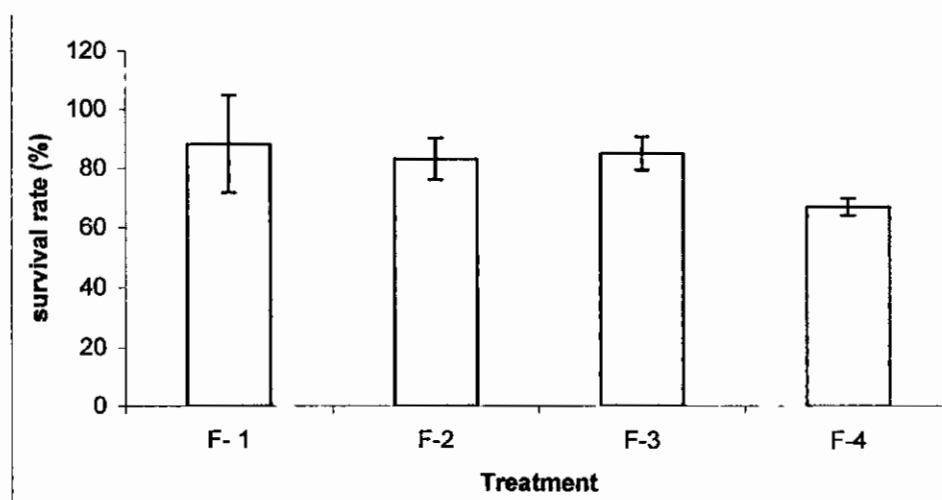


Fig. 6. Comparison of survival rate (%) of prawns in different treatment after harvesting

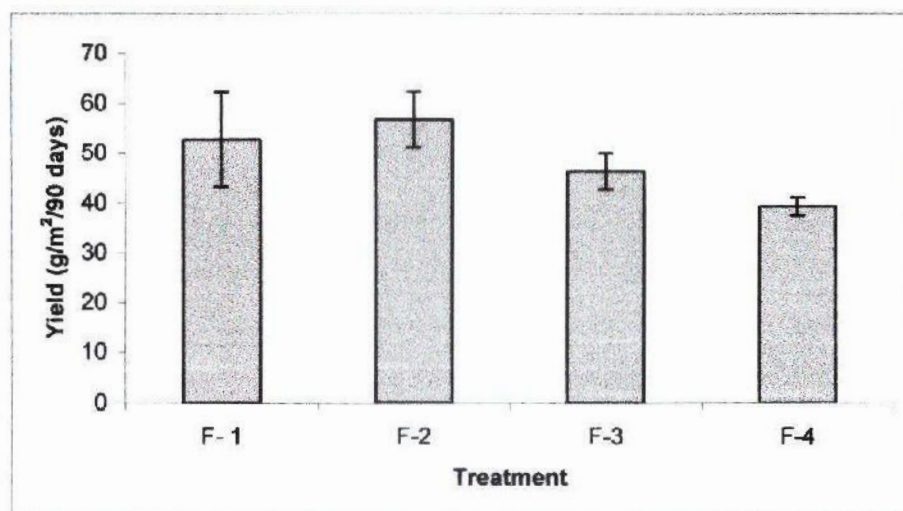


Fig. 7. Comparison of production ($\text{g/m}^2/93$ days) in different treatments after harvesting

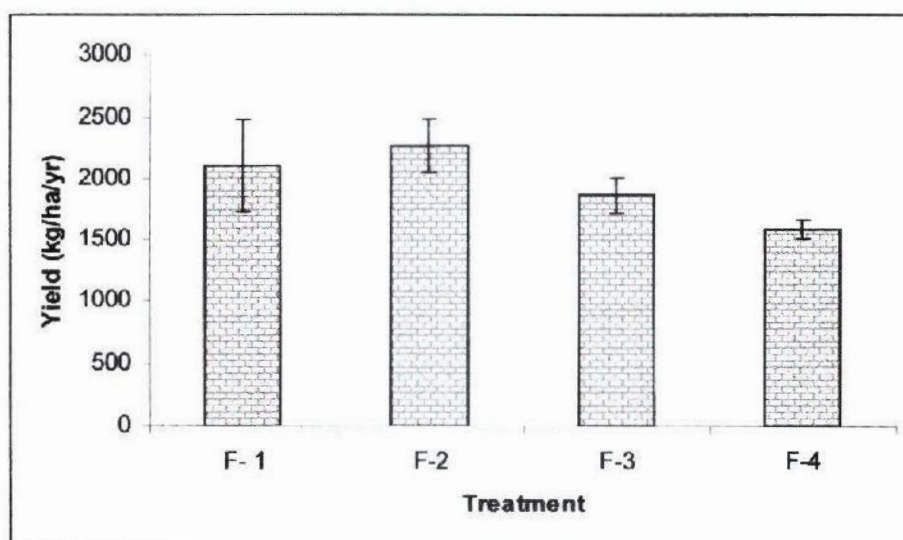


Fig. 8. Comparison of production (kg/ha/Yr) in different treatments after harvesting

4. 2 Water quality parameters

The average results are given in the following Table (Table-7).

Table-6. Water quality parameters in different treatment ponds

Parameter	Different feed treated ponds			
	Feed-1	Feed-2	Feed-3	Feed-4
Temperature ($^{\circ}\text{C}$) morning	30.59 ^a $\pm$ 1.08 (33.10-29)	30.68 ^a $\pm$ 0.87 (32.60-29.20)	30.53 ^a $\pm$ 0.96 (32.30-29.00)	30.70 ^a $\pm$ 1.08 (32.90-28.90)
Temperature ($^{\circ}\text{C}$) evening	31.42 ^a $\pm$ 1.08 (33.10-29.50)	31.43 ^a $\pm$ 1.17 (33.30-28.90)	31.32 ^a $\pm$ 1.03 (33.0-29.0)	31.45 ^a $\pm$ 1.07 (33.50-29.20)
pH morning	7.85 ^c $\pm$ 0.24 (8.20-7.30)	7.88 ^c $\pm$ 0.17 (8.30-7.60)	7.52 ^a $\pm$ 0.23 (7.90-7.10)	7.72 ^b $\pm$ 0.21 (8.0-7.20)
pH evening	8.10 ^c $\pm$ 0.26 (8.50-7.50)	8.13 ^c $\pm$ 0.18 (8.50-7.80)	7.71 ^a $\pm$ 0.23 (8.20-7.20)	7.88 ^b $\pm$ 0.24 (8.20-7.30)
DO (mg/l)	6.71 ^a $\pm$ 1.29 (8.60-3.80)	7.15 ^a $\pm$ 1.38 (9.80-4.20)	6.61 ^a $\pm$ 1.09 (8.60-4.60)	6.89 ^a $\pm$ 1.28 (8.70-4.40)
Hardness (mg CaCO_3/l)	523.63 ^b $\pm$ 55.17 (605-485)	456.25 ^a $\pm$ 56.48 (510-405)	486.75 ^{ab} $\pm$ 16.79 (502.50-467.50)	480.62 ^{ab} $\pm$ 6.52 (487-475)
Alkalinity (mg CaCO_3/l)	285.88 ^c $\pm$ 33.73 (367.50-217.50)	308.85 ^d $\pm$ 32.80 (395-237.50)	203.08 ^a $\pm$ 38.18 (280.00-145.0)	262.85 ^b $\pm$ 24.81 (335.60-220)

Data are mean values ($\pm$ SD) of two replicates (ponds) with maximum and minimum values. Values within the same row having the same superscripts show no significant difference ($P>0.05$).

The temperature in morning in the experimented pond is shown in the Table-7 and Fig. 9. In morning, the mean temperatures of 30.59 $^{\circ}\text{C}$ $\pm$ 1.08, 30.68 $^{\circ}\text{C}$ $\pm$ 0.87, 30.53 $^{\circ}\text{C}$ $\pm$ 0.96 and 30.70 $^{\circ}\text{C}$ $\pm$ 1.08 were found for Feed-1, Feed-2, Feed-3 and Feed-4 treated ponds, respectively. The maximum (33.10 $^{\circ}\text{C}$) and minimum (28.90 $^{\circ}\text{C}$) values were found in Feed-1 and Feed-4 treated ponds, respectively. There was no significant difference ($P>0.05$) in Feed-1, Feed -2, Feed-3 and Feed-4.

The temperatures in evening in the experimental ponds are presented in Table-7 and Fig. 9. In evening, the mean temperature value varied between 31.32 $\pm$ 1.03 to 31.45 $\pm$ 1.07 in Feed-3 and Feed-4 treated ponds, respectively. In evening, the highest temperature (33.50 $^{\circ}\text{C}$) was observed in Feed-4 and lowest temperature (28.90 $^{\circ}\text{C}$) was found in Feed-2. There was no significant difference ($P>0.05$) in Feed-1, Feed-2, Feed-3 and Feed-4.

The pH values in morning in the experimental ponds are shown in Table-7 and Fig. 10. During the period of investigation the mean pH values of 7.85 $\pm$ 0.24, 7.88 $\pm$ 0.17, 7.52 $\pm$ 0.23 and 7.72 $\pm$ 0.21 were found in Feed-1, Feed-2, Feed-3 and Feed-4 treated ponds, respectively. The maximum and minimum values varied 7.10 to 8.30 (Table-7). There

was no significant difference ($P>0.05$) between Feed-1 and Feed-2. Feed-3 and Feed-4 were significantly different from Feed-1 and Feed-2.

In evening, the mean pH values of 8.10 ± 0.26 , 8.13 ± 0.18 , 7.71 ± 0.23 , 7.88 ± 0.24 were found in Feed-1, Feed-2, Feed-3 and Feed-4 treated ponds respectively (Table-7, Fig. 10). The highest value (8.50) was found in Feed-1 and Feed-2 treated ponds. The lowest value (7.20) was found in Feed-3 treated pond. There was no significant difference ($P>0.05$) between Feed-1 and Feed-2. Feed-3 and Feed-4 were significantly different from Feed-1 and Feed-2.

The concentrations of dissolve oxygen (DO) in the experimental ponds are presented in Table-7 and Fig. 11. The mean dissolve oxygen content was observed to be 6.71 ± 1.29 mg/l, 7.15 ± 1.38 mg/l, 6.61 ± 1.09 mg/l and 6.89 ± 1.28 mg/l in Feed-1, Feed-2, Feed-3 and Feed-4 treated ponds, respectively. The highest value (9.80 mg/l) was observed in Feed-2 and lowest value (3.80 mg/l) was observed in Feed-1. There was no significant difference ($P>0.05$) in Feed-1, Feed-2, Feed-3 and Feed-4.

Total hardness was taken monthly during experimental period. Average, maximum, minimum hardness values are shown in (Table-2, Fig. 12). Mean hardness values varied between $456.25 \text{ mg CaCO}_3/\text{l} \pm 56.48$ to $523.63 \text{ mg CaCO}_3/\text{l} \pm 55.17$. There was no significant difference ($P>0.05$) among the hardness values of Feed-2, Feed-3, Feed-4 and Feed-1, Feed-3, Feed-4, respectively.

The total alkalinity was measured weekly during experimental period. The mean alkalinity values of $285.88 \text{ mg CaCO}_3/\text{l} \pm 33.73$, $308.85 \text{ mg CaCO}_3/\text{l} \pm 32.80$, $203.08 \text{ mg CaCO}_3/\text{l} \pm 38.18$ and $262.85 \text{ mg CaCO}_3/\text{l} \pm 24.81$ were observed in Feed-1, Feed-2, Feed-3 and Feed-4 treated ponds, respectively (Table-2, Fig. 13). The maximum value (395 mg CaCO_3/l) was observed in Feed-2 and lowest value (145.0 mg CaCO_3/l) was observed in Feed-1.

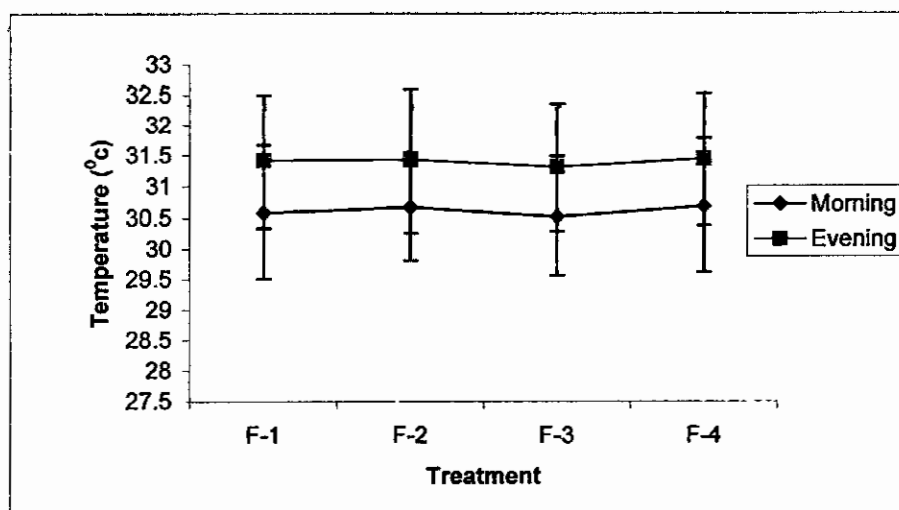


Fig. 9. Difference in temperature of different treatment ponds in the morning and in the evening

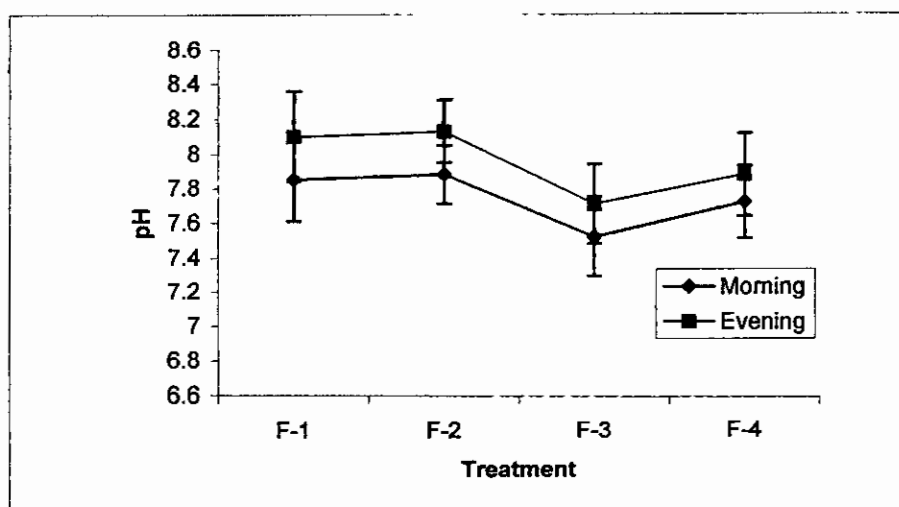


Fig. 10. Difference in pH of different treatment ponds in the morning and in the evening

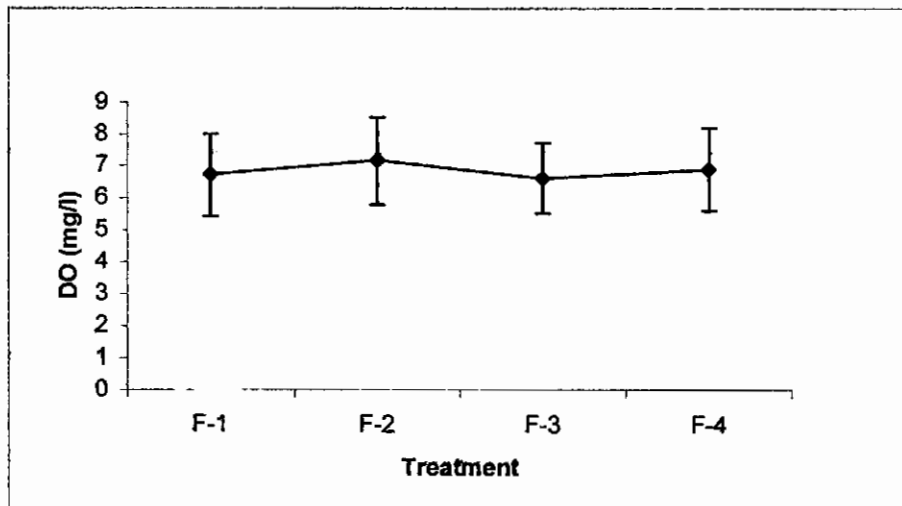


Fig. 11. Comparison of dissolve oxygen content in different treatments

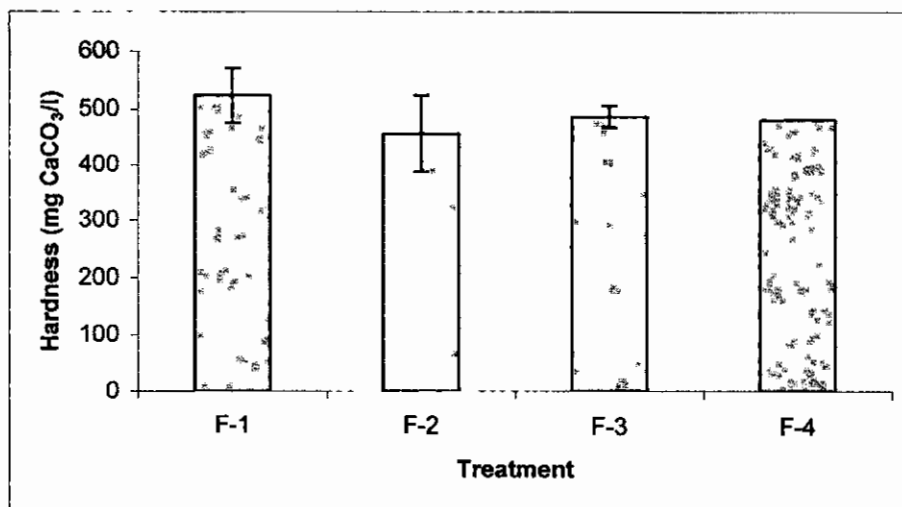


Fig. 12. Comparison of water hardness in different treatments

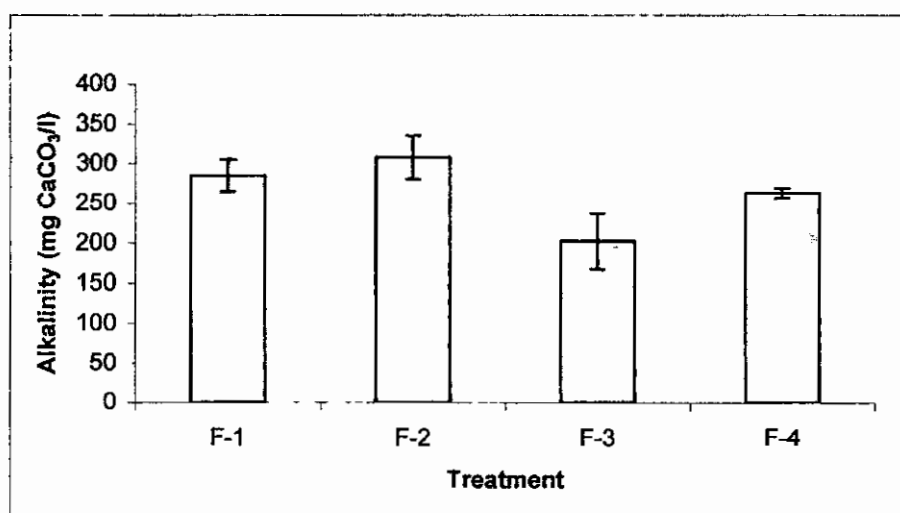


Fig. 13. Comparison of water alkalinity in different treatments

4. 3 Proximate composition of prawn from different experimental treatments

Proximate composition of prawn body flesh and head flesh from different experimental treatments are shown in (Table-8, Table-9).

The protein content in body flesh among different feed ranged from $17.10 \pm 0.28\%$ to $18.77 \pm 1.39\%$ (Table-8, Fig. 14). The maximum protein content was found in Feed-3 ($18.77 \pm 1.39\%$) and the minimum was found in Feed-4 ($17.10 \pm 0.28\%$). Protein content in head flesh also varied in different feed. Highest value was observed in Feed-1 ($15.88 \pm 0.17\%$) and lowest value was observed in Feed-2 ($13.21 \pm 1.01\%$; Table-9, Fig. 14).

Lipid content in body flesh also varied in different feed. Highest value was observed in Feed- 4 ($1.69 \pm 0.59\%$) and lowest value was observed in Feed-3 ($1.30 \pm 0.4\%$; Table-8, Fig.15). The lipid content in head flesh among different feeds ranged from $5.54 \pm 0.49\%$ to $6.5 \pm 0.64\%$. The maximum lipid content was found in Feed-3 and the minimum value was calculated in Feed-2 (Table-9, Fig. 15).

The ash content in body flesh among different feed was $1.38 \pm 0.09\%$, $1.4 \pm 0.1\%$, and $1.23 \pm 0.11\%$, $1.62 \pm 0.07\%$ in Feed-1, Feed-2, and Feed-3 and Feed-4, respectively

(Table-8). Ash content in head flesh also varied in different feed. Highest value was observed in Feed-4 ($5.22 \pm 0.25\%$) and lowest value was observed in Feed-1 ($4.19 \pm 0.23\%$; Table-9, Fig. 16).

Table-7. Proximate composition of prawn in body flesh received from different feeds

	Feed-1	Feed-2	Feed-3	Feed-4
Protein (%)	18.27 ± 0.73	18.09 ± 0.29	18.77 ± 1.39	17.10 ± 0.28
Lipid (%)	1.45 ± 0.25	1.30 ± 0.06	1.30 ± 0.4	1.69 ± 0.59
Ash (%)	1.38 ± 0.09	1.4 ± 0.1	1.23 ± 0.11	1.62 ± 0.07
Moisture (%)	78.79 ± 0.66	78.47 ± 0.38	78.52 ± 1.04	78.48 ± 0.53

Data are mean values ($\pm$ SD) of two replicates.

Table-8. Proximate composition of prawn in head flesh received from different feeds

	Feed-1	Feed-2	Feed-3	Feed-4
Protein (%)	15.88 ± 0.17	13.21 ± 1.01	15 ± 0.83	14.56 ± 1.53
Lipid (%)	6.32 ± 0.64	5.54 ± 0.49	6.5 ± 0.64	6.47 ± 0.45
Ash (%)	4.19 ± 0.23	4.72 ± 0.22	4.7 ± 0.25	5.22 ± 0.25
Moisture (%)	73.19 ± 0.93	76.2 ± 0.49	73.69 ± 0.86	73.52 ± 0.62

Data are mean values ($\pm$ SD) of two replicates.

Wide range of moisture content in body flesh among different feed was observed ranging from $78.47 \pm 0.38\%$ to $78.79 \pm 0.66\%$ (Table-8, Fig.17). The highest value was observed in Feed-1 ($78.79 \pm 0.44\%$) and lowest value was observed in Feed-2 ($78.47 \pm 1.32\%$) fig-4. Moisture content in head flesh also varied in different feed. Maximum value was found in Feed-2 ($76.20 \pm 0.49\%$) and minimum value was found in Feed-1 ($73.19 \pm 0.93\%$; Table-9, Fig.17).

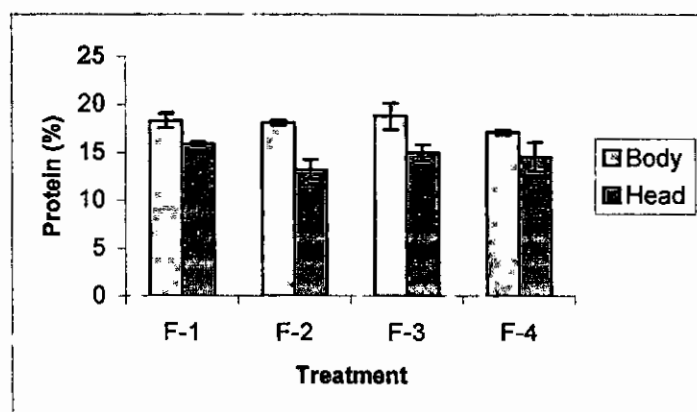


Fig. 14. Comparison of protein contents in body flesh and head flesh of prawn in different treatments.

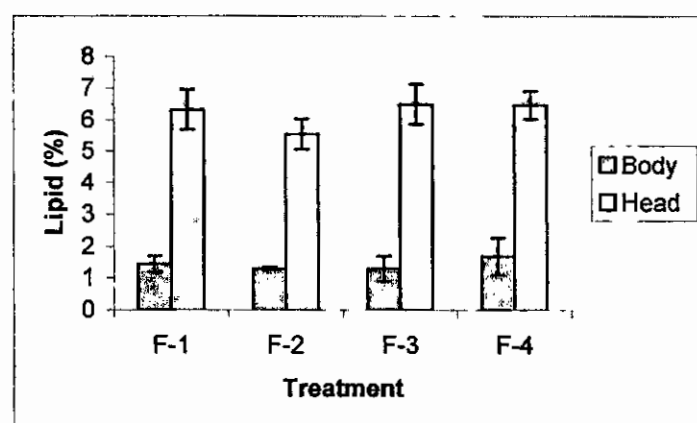


Fig. 15. Comparison of lipid contents in body flesh and head flesh of prawn in different treatments.

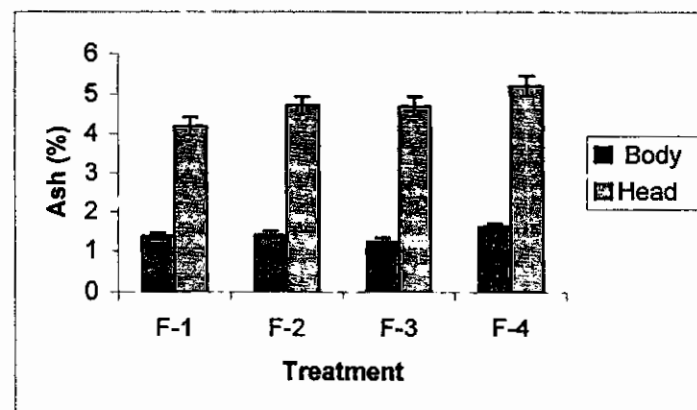


Fig. 16. Comparison of ash contents in body flesh and head flesh of prawn in different treatments.

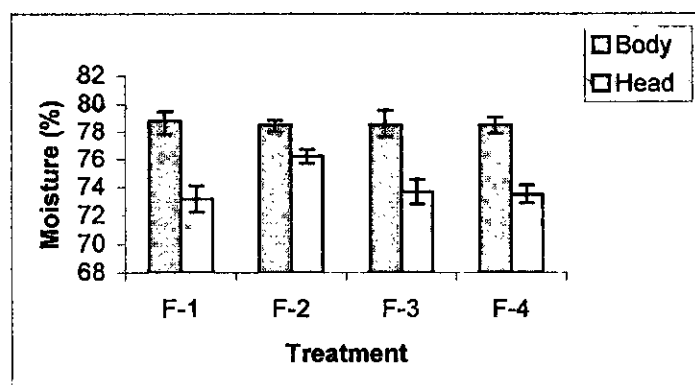


Fig. 17. Comparison of moisture contents in body flesh and head flesh of prawn in different treatments.

4.5 Economic analysis

A simple economic analysis was made to estimate the net profit derived from monoculture of *M. rosenbergii* in ponds with formulated diets (Table-10). The cost of experimental feeds was based on the price of ingredients in the Khulna local market. The cost of the experimental diets appeared to be 18.44, 17.57, 16.69 and 14.95 Tk./Kg for Feed-1 (control), Feed-2, Feed-3 and Feed-4, respectively (Table-5). The price of PL was 5 Tk. /piece. Taking the market price of prawn 260/Kg, production from Feed-2 (25% shrimp meal) produced the highest economic return (Table-10).

Table-9. Economic analysis of prawn production at the end of the monoculture operation

Investments	Treatment			
	Feed-1	Feed-2	Feed-3	Feed-4
Pond preparation: Lime, fertilizer (organic & inorganic)	25	25	25	25
Cost of prawn (Juveniles)	700	700	700	700
Operational cost	150	150	150	150
Feed cost	272.93	250.31	255.33	217.48
Total cost	1147.93	1125.31	1130.33	1092.48
Gross income from prawn sale	1369.68	1474.2	1204.58	1021.8
Net profit (Tk./Treatment/ 93 days)	221.75	348.89	74.25	-70.68
Net profit (Tk./ha/ 93 days)	44350	69778	14850	-14136

Figures are in Tk



CHAPTER FIVE

DISCUSSION

5.0 Discussion

5.1 Growth performance of prawn

Keeping in view the importance of various components and locally availability of cheaper feed materials, the present investigation has been mainly concerned with the formulation and preparation of quality prawn feed and their application to prawn juvenile *Macrobrachium rosenbergii*.

The stocking densities of prawn in the present study were 3/m². Thangdurai (1991) reported that a stocking density of 3/m² was optimum in India feeding on a combination of groundnut cake, rice bran and fish flesh. By investigating the potential of *M. rosenbergii* culture in Malaysia a produced of 977 kg/ha/158 days was cycle with 32.4% survival, when prawns were stocked at 10/m² and feed 30% protein ration at 20, 10 and 5% body weight daily for the first, second and subsequent months, respectively (Ang, 1990). Hossain *et al.* (2000) reported that the stocking of prawns was 2.5/m². Sedgwick (1979) explained that growth was affected by the increase of total biomass due to higher stocking density, which ultimately decreases the efficiency of feed conversion with higher FCR value. Chakraborty *et al* (1997) showed that stocking density affected the individual weight gain of shrimp but mortality may not be correlated with the stocking densities therefore, similar experiment should be conducted with lower stocking density to compare the growth efficiency and mortality. Law *et al.* (1990) suggested that copra cake, soybean meal and wheat flower (which are low cost ingredient in Malaysia) were good sources of nutrients of prawn after examining their digestibility in 30 or 40% protein feeds with juveniles and adults. Generally adult prawns could digest these ingredients, shrimp meals and fishmeals better than juveniles.

Present study focused only on the utilization of shrimp meal as an alternative of costly item fishmeal in prawn feed. The highest weight increment was observed in Feed-2. The highest weight gain was observed in Feed-2 (22.85 ±0.19; Table-6, Fig. 2). The lowest weight gain was observed in Feed-3 (18.33 ±0.11). Weight gain varied in treatment might be due to percentage of inclusion of shrimp meal for growth of prawn. Shrimp meal contains chitin; which is essential for growth of prawn. Present study showed that inclusion of 25% shrimp meal produced better result in comparison to other feed

including control treatment. Some recent studies indicate that the use of supplemented feed with required amount of chitin could give faster growth rate of Bagda shrimp. Studies on protein digestibility of bagda shrimp by using chitin as supplement in the diet confirm that the use of chitin at 5% to the diet could enhance protein digestibility and mineral uptake, hence growth, significantly than using normal commercial shrimp feeds (Shiau and Yu, 1998; Kamal, 1999; Shiau and Liu, 1994). Das *et al.* (1990) stated that shrimp head meal and squid meal combination is attractants for growth of shrimp. Hossain *et al.* (2000) achieved individual weight of 33.6g of galda that was better result from present study. Tidwell *et al.* (1993) reported individual weight of 42g in the monoculture of *M. rosenbergii* using formulated diet containing 32% protein. Brody *et al.* (1980) stated that the size of prawn above 30g in weight is regarded as marketable size in many parts of the world. Durairaj *et al.* (1992) noted an improved growth rate when prawns in manure ponds were fed a pelleted feed containing shrimp head meal (20%) and fish meal (10%) rather than a conventional feed ratio 1:2:1 for groundnut oil cake, rice bran and trash fish but the trial was unreplicated. Wyvan *et al.* (1987) showed negative correlation between stocking density and growth.

Low FCR is an indicator of better food utilization efficiency of formulated feed. High energy diets produce the lowest conversion ratio (FCR) and lowest nutrient retention (Hillstead, 2001). The mean feed conversion ratio (FCR) varied between 2.26 ± 0.20 and 3.33 ± 0.03 (Table-6, Fig. 2). The highest value was found in Feed-4 and lowest value was found in Feed-2. From the test of the efficiency of feed items, it has been noticed that there was a gradual increase in FCR with the increase of shrimp meal in the feeds due to the use of multi-ingredients having both plant and animal source at different combination. From the proximate composition of feed, higher ash content was found in Feed-4 containing 100% shrimp meal. According to proximate analysis ash content is comparatively greater from Feed-1 to Feed-4. This may be the cause of variation in FCR. Siddiqui *et al.* (1997) reported higher FCR of 3.7 (5 prawns/m²) to 5.6 (20 prawns/m²) for *M. rosenbergii* in concrete tank fed diet containing 34% protein. Hossain (2004) reported that FCR varied between 2.18 to 2.43, which are comparatively lower than that of present study. On the other hand, Hossain *et al.* (2000) reported the FCR ranging from 3.06 to 4.85, which is greater than that of present study. Azimuddin *et al.* (1999) observed that the FCR varied from 1.73 to 2.04 for the growth of Thai pangus in net case feed on

formulated diet, which is comparatively lower than that of present study. Das, *et al.* (1990) stated that FCR of prepared pellets varied from 2.94 to 6.3. This result is higher from present study.

High protein efficiency ratio indicates maximum utilization of protein content. Among different factors protein quality has a significant effect on PER (Stiffens 1989). The present study, Protein efficiency ratio varied between 1.16 ± 0.09 (Feed- 4) to 1.65 ± 0.37 (Feed 2). Asadujjaman *et al.* (1998) observed PER ranging from 1.28 to 1.60, which is almost similar to the findings of the present study.

The specific growth rate (SGR %/day) of prawns ranged between 2.51 ± 0.04 to 2.87 ± 0.09 in Feed-4 and Feed-2, respectively (Table-6, Fig. 4). Feed containing 25% shrimp meal showed the highest SGR value and feed containing 100% shrimp meal showed the lowest SGR value. Feed-1 (Control treatment) containing 100% fishmeal showed low SGR than Feed-2. Shrimp head meals contain chitin (Shiau and Liu, 1994). Present study reveals that excess chitin is not suitable for prawn growth; however, minimum chitin is essential for better growth of prawn. Hossain (2004) observed SGR of prawn ranged between 2.74 to 3.12 and reported that SGR (%/day) *M. rosenbergii* were higher when fed Saudi- Bangla shrimp diet (starter and grower) and diet containing 32% protein. Du- Li (2002) observed (SGR %/day) was higher when prawn fed diet containing 40% protein compared with 20% and 30% protein group. Chisty and Rahman (1999) observed highest SGR in control (1.85%). Asadujjaman *et al.* (1998) highest SGR were found 2.04 feed containing 30% protein for growth of (*Catla catla* Ham.) by artificial feed.

The survivality (%) of prawn was observed between $67.33 \pm 2.83\%$ to $85.33 \pm 5.66\%$ in Feed-4 and Feed-3, respectively (Table-6, Fig-5). The lowest and highest survivality was observed in Feed-4 and Feed-3, respectively. Chisty and Rahman (1999) obtained survivality rate of 80% to 93%. Wills and Berrigan (1977) suggested a survival rate of 50% is acceptable in farming practice. Daniels *et al.* (1995) reported highest survival rate of 73.7 to 81.9% with *M. rosenbergii* fed a specially formulated diet in earthen ponds. Hossain *et al.* (2000) reported the survival rate of 65.3%. Tidwell *et al.* (1993) reported that survival rate of 78% in the monoculture of *M. rosenbergii* using formulated diet containing 32% protein. Takata (1974) observed 18% survival rates over a culture period

of 300 days with the stocking density of 18 individual of *M. rosenbergii* per square meter. Azim *et al.* (2001) observed survival rate for galda and bagda ranging from 23.0 to 36.8% and 8.2 to 24%, respectively. The highest survival of galda was observed in the gher where the medium stocking density and equal ratio of galda and bagda along with finfish at the rate of 3000/ha was maintained. Azim *et al.* (2001) also reported that the lowest survival rate was obtained in the gher where the highest stocking density (70000/ha) and four times higher number of galda in comparison to bagda along with fin fish at the rate of 10000/ha was cultured. Present study observed higher survival rate than survival rate reported by Hoq *et al.* (1996), 32-75.7% in a polyculture with the finfish. Scott *et al.* (1988) found an average 63% survival of galda in a polyculture system gold shiner. Das *et al.* (1990) reported that survival rate was 100% in different feed treatment and stated that this could be possible due to proper aeration and frequent water exchange.

Hossain *et al.* (2000) reported that total production of ranged for 304.5 to 563.3 kg/ha/105 days where as Azim *et al.* (2001) reported the same as ranging from 428.5 to 868.9 kg/ha. Total production comprised of both galda and bagda in ghers was 514.6-740.3 kg/ha. The authors stated that the overall productions of all the experimental ghers were satisfactory in comparison to shrimp production of about 70-100 kg/ha owing to the practice of traditional extensive culture technologies in the experimental region (Wahab, 1998). Hoq *et al.* (1996) reported that the highest prawn production of 428.4 kg/ ha in polyculture system with galda and other finfishes in the same region. Brick and Stickney (1979) stocked juvenile prawns at 11000/ha with tilapia fry at 2000/ha, obtained mean prawn survival of 95%. He stated high protein feed is used in his observations and individual weight gained was 24.5g. The authors yield was 2.1 kg/day /ha. These yields were slightly lower than present study. Cohen and Ra'anan (1983) obtained an average daily yield of 3.9 kg/ha at a prawn stocking density of 15000/ha with 85% of survival. Alam *et al.* (1996) showed that survival range varied from 66-70% and suggested that the daily rate of prawn yield could have been more than that have been achieved, if the prawns are stocked at onset of summer and harvested at the onset winter months.

A Simple economic analysis of the culture operation showed that Feed-2 has generated the maximum net profit of Tk. 348.89/93 days of culture period where as, control treatment was Tk. 221.75/93 days. Feed-4 showed negative result.

5.2 Water quality parameters

Proper fisheries management and scientific fish culture basically depends on the various information about the limnological aspects of water body. The knowledge of physico-chemical conditions of water bodies provides an important tool for successful fish production. Different physico-chemical factors of a water body, which determine the character and quality of biological production, are very important for scientific fish culture and fisheries management. According to Hickling (1963) fish farming is a practical application of food production, limnology, and fresh water biology.

The physico-chemical parameters observed in the present study were found within the suitable range for prawn culture.

Temperature is one of the most important factors, which influence the physico-chemical and biological events of a water body. In morning, the maximum (33.10°C) and minimum (28.90°C) values were found in Feed-1 and Feed-4 treated ponds, respectively. In evening, the highest temperature (33.50°C) was found in Feed-4 and lowest temperature (28.90°C) in Feed-2 treated ponds. The obtained value from the experimental ponds agreed well with the findings of Mollah and Haque (1978) and Wahab *et al.* (1995) from ponds of Bangladesh Agricultural University Campus. Maclean *et al.* (1994) stated that water temperature ranged from 28.9 to 29.1°C for the culture of freshwater prawn in earthen ponds. Rahman *et al.* (1982) stated that the favorable temperature is 26.06°C to 31.97°C . The low growth might be explicable by the observed lower temperature. Ling (1967) suggested that optimum temperature for growth of post juvenile prawn was in the range of $28-31^{\circ}\text{C}$. Ling (1969) recommended the range of temperature from 22°C to 32°C for optimum growth of fresh water species that was the case in the present study. Fujimura (1974) reported that the optimum temperature for growth is between 28 and 31°C and that temperature below 23°C is lethal to young juveniles. Sandifer and Smith (1979) maintained water temperature at 27°C to 29°C and obtained the best growth of juveniles in nursery ponds. Hossain *et al.* (2000) measured the water temperature in 12 experimental ponds in the Bangladesh Agricultural University Campus,

Mymensingh which varied between 28.7°C to 31.5°C for the culture of fresh water prawn (*M. rosenbergii*). The results of the above studies are almost similar to that of the present study.

The pH is also called productivity index of water body. The highest value (8.50) was found in Feed-1 and Feed-2 treated ponds while the lowest value (7.20) was found in Feed-3 treated pond. The variations in the values of pH were marginal and were almost similar throughout the study period. Alam *et al.* (1996) reported that pH values ranged from 6.65 to 7.80. He stated that the higher value of pH was found in early august which might be due to the increased rate of photosynthetic activities of phytoplankton with concomitant decrease of carbon dioxide. The increased values of pH might be due to decrease of carbon dioxide and precipitation CaCO_3 . The pH value ranged from 7.5 to 8.5 was suitable for *M. rosenbergii* in earthen ponds (Jia-Mo *et al.*, 1988). Hoq *et al.* (1996) reported that pH ranged from 7.5-8.0 in five prawn farmers ponds. Hossain *et al.* (2000) reported that pH ranged from 6.8 to 8.4 was suitable for *M. rosenbergii*. The observed pH values from the present study agreed well with the findings of Hossain *et al.* (1997) who found the pH range 6.7 to 8.3 and Kohinoor *et al.* (1998) who obtained the pH range of 7.18 to 7.24 in the research ponds of Bangladesh Agricultural University Campus.

Only exception was sudden drop of dissolved oxygen at early morning in the initial part of the experiment causing little prawn mortality. Similar type of prawn mortalities were also reported by Mazid and Mahmood (1994) and Humayun *et al.* (1986) in *M. rosenbergii* in monoculture ponds with supplemental feed. Bhuyan (1970) reported that dissolved oxygen content from 5.0 mg/l to 7 mg/l is required for high production. Rahman (1997) stated that oxygen concentration is higher in winter season and lower in summer season due to inverse relation of dissolved oxygen with temperature due to cold temperature of water as the cold water has the greater oxygen holding capacity. Pahwa and Mehrota (1966), Dewan (1973) and Islam *et al.* (1974) found almost similar results. Jia-Mo *et al.* (1988) reported that the dissolved oxygen was 4.5 mg/l where

M. rosenbergii were cultured in earthen ponds. Jaruvat and Somunak (1987) reported that shrimp would normally die if dissolved oxygen is less than 0.7 mg/l. Dissolved oxygen level in water of the experimental ponds as recorded in the present study agreed well with findings of Wahab *et al.* (1995), who recorded lower dissolved oxygen ranging from 2.0-7.2 mg/l during their experiment in the BAU Campus. Hoq *et al.* (1996) recorded DO ranging from 4.0 to 5.9 mg/l in five prawn farmers from 5 to 8 mg/l, which were suitable for fish culture. The results of the above studies were almost in agreement of with the findings of present study.

The higher values of total hardness from the experimental ponds were probably due to the application of lime and the values were in the suitable range for shrimp farming as reported by Clarke (1954). He stated that more carbonate was found when free CO₂ was drawn up from water by photosynthesis. Azim *et al.* (2001) observed that the total hardness varied from 40 to 80 mg CaCO₃/l. New (1995) recommended the total hardness level for prawn culture is 40-60 mg CaCO₃/l. Alam *et al.* (2001) observed that the total hardness ranged from 33.0 mg CaCO₃/l to 91.0 mg CaCO₃/l in different treatment. He stated that in all the treatments, total hardness gradually increased from first fortnight to eight fortnights. The highest value of total hardness in eight fortnights might be due to lowest value of free CO₂ and thereby increased CaCO₃.

The total alkalinity was measured weekly during experimental period. The mean alkalinity values of 285.88 mg CaCO₃/l $\pm$ 33.73, 308.85 mg CaCO₃/l $\pm$ 32.80, 203.08 mg CaCO₃/l $\pm$ 38.18 and 262.85 mg CaCO₃/l $\pm$ 24.81 were observed in Feed-1, Feed-2, Feed-3 and Feed-4 treated ponds, respectively. The maximum value (395 mg CaCO₃/l) was observed in Feed-2 and lowest value (145.0 mg CaCO₃/l) was observed in Feed-1. Alikunhi (1957) stated that the highly productive water bodies should have more than 100mg/l alkalinity. Chisty and Rahman (1999) stated that total alkalinity of 100 mg CaCO₃/l to 175 mg CaCO₃/l indicates good water quality. From the above discussion we might conclude that all the experimental ponds were suitable for prawn culture.

CHAPTER SIX

CONCLUSION

6.0 Conclusion

Macrobrachium rosenbergii is omnivorous and corpophagous. However, when prawn cultured semi-intensively and intensively, supplementary feed is required. In fish culture, feed cost accounts about 60-70% of the total cost, which is very expensive, especially for farmers of Bangladesh (Hossain, 2004). The investigation focused on the utilization of shrimp meal with locally available feed ingredients with minimum cost. The water quality parameters of the experimental ponds were studied. There was no adverse condition of the limnological factors found during the study period. Result from the biological evaluation performed under this investigation indicated that Feed-2 was superior to other feeds with regards to the FCR, SGR, PER, survival rate, and price of feed. Feed-2 containing 75% fishmeal and 25% shrimp meal may be recommended as a suitable supplementary feed for monoculture of *M. rosenbergii* in ponds.

CHAPTER SEVEN

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7.0 References

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APPENDICES

1. Analysis (growth performance of prawn)

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
FCR	1.00	2	2.4383	.5481	.3875	-2.4858	7.3625	2.05	2.83
	2.00	2	2.2588	.2030	.1436	.4347	4.0828	2.12	2.40
	3.00	2	2.9693	9.088E-02	6.426E-02	2.1527	3.7858	2.91	3.03
	4.00	2	3.3329	2.652E-02	1.875E-02	3.0946	3.5711	3.31	3.35
	Total	8	2.7498	.5075	.1794	2.3255	3.1741	2.05	3.35
PER	1.00	2	1.6513	.3712	.2624	-1.6834	4.9860	1.39	1.91
	2.00	2	1.7136	.1540	.1089	.3298	3.0975	1.60	1.82
	3.00	2	1.3313	4.075E-02	2.881E-02	.9652	1.6973	1.30	1.36
	4.00	2	1.1585	9.217E-03	6.518E-03	1.0757	1.2413	1.15	1.17
	Total	8	1.4637	.2878	.1018	1.2230	1.7043	1.15	1.91
SGR	1.00	2	2.7944	.1805	.1276	1.1727	4.4162	2.67	2.92
	2.00	2	2.8731	9.952E-02	7.037E-02	1.9790	3.7673	2.80	2.94
	3.00	2	2.6733	7.741E-02	5.474E-02	1.9778	3.3688	2.62	2.73
	4.00	2	2.5132	4.476E-02	3.165E-02	2.1110	2.9153	2.48	2.54
	Total	8	2.7135	.1682	5.947E-02	2.5729	2.8541	2.48	2.94
Total Weight Gain	1.00	2	2634.000	475.1758336	0.000	-1635.28486903	284.228	2298.00	2970.00
	2.00	2	2835.000	281.4285199	0.000	306.46535363	534.7	2636.00	3034.00
	3.00	2	2316.500	181.7264128	5.000	683.75273949	247.3	2188.00	2445.00
	4.00	2	1965.000	90.5097	64.000	1151.80292778	197.1	1901.00	2029.00
	Total	8	2437.625	416.6605147	3.117	2089.28812785	961.9	1901.00	3034.00
Survivality	1.00	2	88.3333	16.4992	11.6667	-59.9057236	5724.76	76.67	100.00
	2.00	2	83.6667	7.0711	5.0000	20.1356147	1977.78	78.67	88.67
	3.00	2	85.3333	5.6569	4.0000	34.5085136	1582.81	81.33	89.33
	4.00	2	67.3333	2.8284	2.0000	41.9209	92.7457	65.33	69.33

			3						
	Total	8	81.166	11.3067	3.9975	71.7140	90.6193	65.33	100.00
			7						
Individual Weight Gain	1.00	2	20.104	.43041	.30435	16.2372	423.97145	19.800	20.409
			35						
	2.00	2	22.854	.19257	.13617	21.1246	524.58497	22.719	22.991
			81						
	3.00	2	18.334	.11151	7.8848E-02	17.3327	319.33644	18.256	18.413
		59							
	4.00	2	20.834	.99841	.70599	11.8644	429.80522	20.129	21.541
			83						
	Total	8	20.532	1.78201	.63004	19.0423	522.02194	18.256	22.991
			14						

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
Total Weight Gain	971417419922 00400.000	3	4	.000
Survivality	169166835714 7345.000	3	4	.000

a Test of homogeneity of variances cannot be performed for FCR because the sum of caseweights is less than the number of groups.

b Test of homogeneity of variances cannot be performed for PER because the sum of caseweights is less than the number of groups.

c Test of homogeneity of variances cannot be performed for SGR because the sum of caseweights is less than the number of groups.

d Test of homogeneity of variances cannot be performed for IWT.GAIN because the sum of caseweights is less than the number of groups.

Post Hoc Tests

Homogeneous Subsets

FCR

Duncan

	N	Subset for alpha = .05	
FEED		1	2
2.00	2	2.2588	
1.00	2	2.4383	
3.00	2	2.9693	2.9693
4.00	2		3.3329
Sig.		.078	.287

Means for groups in homogeneous subsets are displayed.

a Uses Harmonic Mean Sample Size = 2.000.

PER
Duncan

		N Subset for alpha = .05	
FEED		1	
4.00	2	1.1585	
3.00	2	1.3313	
1.00	2	1.6513	
2.00	2	1.7136	
Sig.		.055	

Means for groups in homogeneous subsets are displayed.
a Uses Harmonic Mean Sample Size = 2.000.

SGR
Duncan

		N Subset for alpha = .05	
FEED		1	2
4.00	2	2.5132	
3.00	2	2.6733	2.6733
1.00	2	2.7944	2.7944
2.00	2		2.8731
Sig.		.070	.155

Means for groups in homogeneous subsets are displayed.
a Uses Harmonic Mean Sample Size = 2.000.

Total Weight Gain
Duncan

		N Subset for alpha = .05	
FEED		1	2
4.00	2	1965.000	
		0	
3.00	2	2316.500	2316.500
		0	0
1.00	2	2634.000	2634.000
		0	0
2.00	2	2835.000	
		0	
Sig.		.090	.158

Means for groups in homogeneous subsets are displayed.
a Uses Harmonic Mean Sample Size = 2.000.

Survivality
Duncan

			NSubset for alpha = .05
FEED			1
4.00	2	67.3333	
2.00	2	83.6667	
3.00	2	85.3333	
1.00	2	88.3333	
Sig.		.097	

Means for groups in homogeneous subsets are displayed.
a Uses Harmonic Mean Sample Size = 2.000.

Individual Weight Gain
Duncan

			NSubset for alpha = .05		
FEED			1	2	3
3.00	2	18.33459			
1.00	2		20.10435		
4.00	2		20.83483		
2.00	2			22.85481	
Sig.		1.000	.258	1.000	

Means for groups in homogeneous subsets are displayed.
a Uses Harmonic Mean Sample Size = 2.000.



2. Analysis (water quality parameters)

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound	Minim um	Maximu m
Temperature (morning)	1.00	28	30.5893	1.0826	.2046	30.1695	31.0091	29.00	33.10
	2.00	28	30.6821	.8692	.1643	30.3451	31.0192	29.20	32.60
	3.00	28	30.5321	.9630	.1820	30.1587	30.9056	29.00	32.30
	4.00	28	30.7000	1.0781	.2037	30.2820	31.1180	28.90	32.90
	Total	112	30.6259	.9909	9.363E-02	30.4404	30.8114	28.90	33.10

Temperature (evening)	1.00	28 31.417 9	1.0795	.2040	30.9993	31.8364	29.50	33.10
	2.00	28 31.428 6	1.1680	.2207	30.9756	31.8815	28.90	33.30
	3.00	28 31.317 9	1.0289	.1944	30.9189	31.7168	29.00	33.00
	4.00	28 31.446 4	1.0748	.2031	31.0297	31.8632	29.20	33.50
	Total	112 31.402 7	1.0753	.1016	31.2013	31.6040	28.90	33.50
pH (morning)	1.00	28 7.8536	.2365	4.469E- 02	7.7619	7.9453	7.30	8.20
	2.00	28 7.8750	.1669	3.155E- 02	7.8103	7.9397	7.60	8.30
	3.00	28 7.5214	.2267	4.284E- 02	7.4335	7.6093	7.10	7.90
	4.00	28 7.7214	.2079	3.929E- 02	7.6408	7.8020	7.20	8.00
	Total	112 7.7429	.2517	2.379E- 02	7.6957	7.7900	7.10	8.30
pH (evening)	1.00	28 8.1036	.2603	4.920E- 02	8.0026	8.2045	7.50	8.50
	2.00	28 8.1286	.1823	3.445E- 02	8.0579	8.1993	7.80	8.50
	3.00	28 7.7071	.2308	4.362E- 02	7.6176	7.7966	7.20	8.20
	4.00	28 7.8786	.2440	4.611E- 02	7.7840	7.9732	7.30	8.20
	Total	112 7.9545	.2866	2.708E- 02	7.9008	8.0081	7.20	8.50
DO	1.00	20 6.7075	1.2939	.2893	6.1019	7.3131	3.80	8.60
	2.00	21 7.1486	1.3825	.3017	6.5192	7.7779	4.20	9.80
	3.00	20 6.6130	1.0898	.2437	6.1029	7.1231	4.60	8.60
	4.00	20 6.8885	1.2797	.2861	6.2896	7.4874	4.40	8.70
	Total	81 6.8432	1.2607	.1401	6.5644	7.1220	3.80	9.80
Hardness	1.00	4 523.62 50	55.1745	27.5873	435.830061	11.4200	485.00	605.00
	2.00	4 456.25 00	56.4764	28.2382	366.3835546	11.165	405.00	510.00
	3.00	4 486.75 00	16.7854	8.3927	460.0407513	4.593	467.50	502.50
	4.00	4 480.62 50	6.5240	3.2620	470.2439491	1.0061	475.00	487.00
	Total	16 486.81 25	43.9579	10.9895	463.3890510	2.360	405.00	605.00
Alkalinity	1.00	26 285.88 46	33.7367	6.6163	272.2581299	5.112	217.50	367.50
	2.00	26 308.84 62	32.8200	6.4365	295.5899322	1.025	237.50	395.00
	3.00	26 203.07	38.1813	7.4880	187.6552218	4.987	145.00	280.00

		69					
	4.00	26	262.85	24.8084	4.8653	252.8312272	8719 220.00 335.60
		15					
Total	104	265.16	51.0428	5.0052	255.2383275	0914 145.00	395.00
		48					

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
Temperature (morning)	.625	3	108	.601
Temperature (evening)	.315	3	108	.815
pH (morning)	.855	3	108	.467
pH (evening)	.798	3	108	.498
DO	.322	3	77	.810
Hardness	7.807	3	12	.004
Alkalinity	2.891	3	100	.039

Post Hoc Tests

Homogeneous Subsets

Temperature (morning)

Duncan

N Subset for alpha = .05

FEED		1
3.00	28	30.5321
1.00	28	30.5893
2.00	28	30.6821
4.00	28	30.7000
Sig.		.575

Means for groups in homogeneous subsets are displayed.

a Uses Harmonic Mean Sample Size = 28.000.

Temperature (evening)

Duncan

N Subset for
alpha =
.05

FEED		1
3.00	28	31.3179
1.00	28	31.4179
2.00	28	31.4286
4.00	28	31.4464
Sig.		.693

Means for groups in homogeneous subsets are displayed.

a Uses Harmonic Mean Sample Size = 28.000.

pH (morning)
Duncan

		NSubset for alpha = .05		
FEED		1	2	3
3.00	28	7.5214		
4.00	28		7.7214	
1.00	28			7.8536
2.00	28			7.8750
Sig.		1.000	1.000	.705

Means for groups in homogeneous subsets are displayed.

a Uses Harmonic Mean Sample Size = 28.000.

pH (evening)
Duncan

		NSubset for alpha = .05		
FEED		1	2	3
3.00	28	7.7071		
4.00	28		7.8786	
1.00	28			8.1036
2.00	28			8.1286
Sig.		1.000	1.000	.687

Means for groups in homogeneous subsets are displayed.

a Uses Harmonic Mean Sample Size = 28.000.

DO
Duncan

		NSubset for alpha = .05	
FEED		1	
3.00	20	6.6130	
1.00	20	6.7075	
4.00	20	6.8885	
2.00	21	7.1486	
Sig.		.227	

Means for groups in homogeneous subsets are displayed.

a Uses Harmonic Mean Sample Size = 20.241.

b The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.