Growth Performance of Indian Major Carps at Pond System Using Shrimp Industry Waste in their Diet

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Abstract
A study was carried out to observe the growth performance of Indian major carp utilizing the shrimp industry waste in their supplementary diets in pond system during 1st January to 30th June, 2015. Two types of diet namely Diet-1 (Formulated feed with shrimp waste), Diet-2 (Formulated feed with plants source ingredients) were prepared while Diet-3 (Commercial feed) were purchased from the market and assigned to three treatments viz. T1, T2 and T3. Protein percentage of diets were 28.42%, 28.13% and 27.32%, respectively. The average protein efficiency ratio (PER) for Diet-1 (2.19) differed much to that of Diet-2 (2.03) where Diet-3 (2.38) showed highest PER value. The highest survival rate (%) with Labeo rohita (93.93%), Gibelion catla (94.44%) were found for Diet-3. Therefore, it could be recommended that shrimp industry waste can be replaced with fish meal in the diets of Indian major carps along with other available feed ingredients.

Key words: Growth performance, Indian major carps, Pond condition, Shrimp industry waste

Introduction
Bangladesh is an agriculture based developing country. Fisheries are one of the vital-sector of agriculture and important component of corresponding farming system research in Bangladesh. In recent years aquaculture has been intensified with the view to feed increasing population.

Shrimp waste is basically the dried waste of shrimp industry, consisting of the heads, appendages and exoskeleton. Shrimp waste meal has been identified as an animal protein source of considerable potential (Higgs, 1995). Shrimp meal is an important product of shrimp waste (Ariyani, 1989) and is one of the feed ingredients alternative for protein sources that have good potential (Gernat, 2001; Mahata et al., 2008). Expansion of shrimp processing industry has resulted in increased discharge of waste (Chandrkrachang et al., 1991). Moreover utilization of shrimp processing wastes offers an excellent source of cheap and abundant substitute of fish meal.

The nutritive balance of feed influences feed utilization and growth of fish. It is very essential to know the nutritional requirements particularly for protein, carbohydrate and lipid for optimum growth of a fish species as well as in formulating a balance diet. The success of intensive and semi-intensive fish culture depends on a large extent to the application of suitable feeds. Feed development should take into account knowledge regarding nutrient requirement and digestibility, improved techniques to more water stable feeds and greater utilization of alternative sources of protein. The present study intends to investigate into the diet formulation and preparation of diet with the industrial shrimp waste and its effectiveness in polyculture system with Indian major carps (Labeorohita, Gibelioncatla and Cirrhinuscirrhosus) in pond.

Materials and Methods

Duration of the study and experimental site description
The present study was conducted for the period of six months from 1st January to 30th June, 2015. Feed formulation and preparation takes three months. Growth performance of Indian major carps were evaluated in three experimental ponds located behind the Faculty of Fisheries Bangladesh Agriculture University (BAU), Mymensingh. The ponds were equal in size and similar in shape, depth, basin, configuration and pattern. The water depth was maintained to a maximum of 1.2 m. There was well inflow and outflow system to maintain the water level.

Selection and collection of feed ingredients
Shrimp waste (head and shell) were collected from the processing plants of Chittagong. Different types of feed ingredients such as rice bran, maize, soybean, wheat bran, molasses, minerals and vitamins premix were purchased from local market of Mymensingh. Three types of diets were used for this experiment. Two different diets were formulated (Diet-1: Formulated feed with shrimp waste, Diet-2: formulated feed without shrimp waste/formulated feed with plant sources) while another feed (Diet-3: Commercial feed) was purchased from the local market.
**Feed formulation**
The experimental Diet-1 was formulated using shrimp waste and other ingredients (rice bran, wheat bran, maize, soybean, salt and molasses) which presented in Table 1. The experimental Diet-2 was prepared in the laboratory without using shrimp wastes. Different ingredients such as rice bran, wheat bran, maize, soybean, salt and molasses were used in increased amount to make the total unit volume 100 g (Table 1). On the other hand, Diet-3, the commercial one was purchased from the local distributor of Spectra Hexa Feeds Limited which is commonly known as Mega feed.

**Table 1.** Formulation of Diet-1 (formulated feed with shrimp waste) and Diet-2

| Feed ingredient | Feed for Indian Major carps |
|-----------------|-----------------------------|
|                 | Diet-1 (%) of ingredients | Diet-2 (%) of ingredients |
| Shrimp waste    | 40.00                      | -                         |
| Soya bean meal  | 24.00                      | 48.00                     |
| Wheat bran      | 10.00                      | 12.00                     |
| Maize           | 13.00                      | 25.00                     |
| Rice bran       | 10.00                      | 12.00                     |
| Molasses        | 2.00                       | 2.00                      |
| Vitamin & mineral mix | 0.50            | 0.50                     |
| Salt            | 0.50                       | 0.50                      |
| **Total**       | **100.00**                 | **100.00**                |

**Feed preparation**
All the collected ingredients were ground finely, sieved through small mesh. The ingredients were mixed properly and made into dough and finally made into pellets using a pellet machine. The pellets were dried in solar tent drier. The pellets were allowed to cool in the air, packed in air-tight polythene bags. The following flow diagram (Figure 1) shows the preparation protocol of Diets.

**Preparation of selected pond**
The ponds water were drained out completely and the ponds were exposed to sunlight for about 2 weeks to eradicate all undesirable fish species, insects and other aquatic organisms. Aquatic weeds and grasses on the dykes were removed manually. Repairing of ponds dykes and bottom was done where necessary. The excessive bottom mud was removed from the pond. Lime was applied by spreading homogeneously at the rate of 1 kg/decimal in the pond. After 7 days of lime application, ponds were filled up with water up to 4 feet from a deep tube-well supply. To enhance the growth of phytoplankton, organic and inorganic fertilizer were applied in the pond at the rate of 150 g Urea/decimal, 100 g T.S.P/decimal and 5 kg cattle manure/decimal.

**Experimental design**
The experiment was conducted in three treatments each with three replication. Three different diets were assigned to three different treatments viz. T1, T2 and T3 for pond. In this experiment Diet-1, Diet-2 and Diet-3 were used as the treatment 1, 2 and 3, respectively. The species combination given in different treatments were Rui (*Labeo rohita*), Catla (*Gibelion catla*) and Mrigal (*Cirrhinus cirrhonus*). The fish was stoked at the rate of 100/decimal in different treatments. The most common and suitable three species poly-culture ratio 40: 30: 30 (Catla: Rui: Mrigal) were followed in case of fingerling stocking. Before releasing the fingerling in the pond the initial weight was measured. Fish were fed at a rate of 10% of their body weight for the first one week which was gradually reduced to 8% for the
next seven weeks and 6% for the last four weeks. The feed was supplied using feed spreading method manually. Fish was fed twice daily, half of the ration in the morning between 8.30 to 9.30 am and another half in the afternoon between 4:30 to 5:30 pm.

**Sampling of fish**
Sampling of fish was done to observe the growth of fish and to adjust the feeding rate by using a cast net. Growth of fish in the sampling was measured by using a digital electronic balance.

**Water quality parameters**
Some important water quality parameters such as water temperature (°C), dissolved oxygen (mg/l), and pH were measured during every sampling day. The sample collection were done between 8.30 to 9.30 am.

**Analysis of proximate composition**
Proximate composition of all individual feed ingredients and prepared feeds from those ingredients were analyzed in the Fish Processing Laboratory, Department of Fisheries Technology, Bangladesh Agricultural University, Mymensingh, Bangladesh according to the methods described in the Association of Official Analytical Chemists (1990) with slight modification.

**Analysis of experimental data on growth**
Experimental data collected during the growth trial were used to determine the growth performance by following growth parameters-

\[
\text{Weight gain} = \frac{\text{Mean final fish weight} - \text{Mean initial fish weight}}{} \times 100
\]

\[
\% \text{ weight gain} = \frac{\text{Mean final weight} - \text{Mean initial weight}}{\text{Mean initial weight}} \times 100
\]

\[
\text{SGR (%/day)} = \frac{1nW_t - 1nW_i}{T_2 - T_1} \times 100
\]

Where, \(W_t\) = Final body weight (g) at time \(T_2\)
\(W_i\) = Initial body weight (g) at time \(T_1\)

\[
\text{FCR} = \frac{\text{Amount of feed (kg)}}{\text{Live weight gain (kg)}}
\]

\[
\text{PER} = \frac{\text{Live weight gain (kg)}}{\text{Amount of protein fed (kg)}}
\]

**Data analysis**
Data obtained from the present experiment were analyzed statistically to measure growth performance of different fish species in different treatments. Data were entered into the MS Excel to done simple statistics and XLSTAT for analysis of variances (ANOVA). The mean value was compared by Duncan Multiple Range Test at 5% level of significance.

**Results and Discussion**
Proximate composition of different feed ingredients
Proximate composition of different feed ingredients used in diets preparation such as rice bran, wheat bran, maize, soybean and shrimp waste were presented in Table 2.

**Table 2.** Percentage (%) of proximate composition of the feed ingredients

| Name of Ingredients | Crude Protein | Crude Lipid | Total Ash | Total Moisture |
|---------------------|---------------|-------------|-----------|---------------|
| Rice bran           | 13.59 ± 0.38  | 12.73 ± 0.92| 12.19 ± 1.13 | 14.67 ± 1.78 |
| Wheat bran          | 14.13 ± 0.56  | 5.72 ± 0.43 | 4.69 ± 0.28  | 10.17 ± 1.08 |
| Maize               | 14.57 ± 0.71  | 10.46 ± 0.89| 3.53 ± 0.47  | 12.78 ± 1.24 |
| Soybean             | 49.16 ± 0.82  | 4.18 ± 0.26 | 9.54 ± 1.11  | 12.78 ± 0.73 |
| Shrimp waste        | 36.19 ± 0.28  | 13.42 ± 0.67| 23.59 ± 0.21 | 12.19 ± 0.57 |

In the recent years on the basis of nutrition in freshwater aquaculture have led to the development of new feed formulations for Indian carp (Mohanty et al., 1990; Paul et al., 1998). The proximate composition of factory made feeds is reported to be 20-30 percent protein, 2-4 percent lipid, 10-15 percent fibre, 30-40 percent carbohydrate and 8-10 percent ash and often are claimed to have been enriched with lysine, methionine, vitamins and minerals (Nandesha, 1993). Feeds from plant origin also have been accepted for Indian major carps as the growth in fishes has been reported to be as good as the traditional feed (Patnaiik and Das, 1979). In terms of growth, food conversion ratio, protein efficiency ratio, survival rate, diet containing 30% protein level revealed a significantly
Temperature plays significant role in fish production. Boyd (1982) reported that the range of water temperature from 26.06 to 31.97°C is suitable for fish culture. Mollah and Hoque (1978), Rahman et al. (1982), Dewan et al. (1991), Wahab et al. (1995) also reported the surface water temperature ranged from 30.2-34°C in polyculture of Indian and Chinese carps. Ali et al. (1982) observed that, water temperature ranged from 20.5 to 30.5°C in pond during study. Hussain (2000) reported water temperature of ponds range from 26.0 to 32.4°C. All these reports are more or less in agreement with results of the present study. Temperature in the ranges and mean values of water quality parameters in different treatments were presented in Table 4.

Table 4. Monthly variation in the ranges and mean values of water quality parameters in different treatments

| Parameters          | Months | Treatment 1 (Mean±SD) | Treatment 2 (Mean±SD) | Treatment 3 (Mean±SD) |
|---------------------|--------|-----------------------|-----------------------|-----------------------|
|                     |        | Temperature (ºC)      |                       |                       |
| April               | 26.7-28.7 (27.4±0.92) | 26.5 -29.1 (27.4±0.18) | 26.6 -28.8 (27.4±0.99) |
| May                 | 27.2-28.9 (28.2±0.88) | 26.9 -29.1 (28.1±1.15) | 27.3 -28.8 (28±0.75)   |
| June                | 27.4-28.7 (28.1±0.65) | 27.2 -29.2 (28.1±1.01) | 27.3 -28.8 (27.9±0.79) |
|                     |        | Dissolved Oxygen (DO, mg/l) |                       |                       |
| April               | 3.69-5.18 (3.87±0.30) | 3.95 -5.34 (4.79±0.61) | 3.58 -5.21 (4.59±0.71) |
| May                 | 3.69-4.23 (3.87±0.30) | 3.58 -4.89 (4.09±0.69) | 3.65 -4.92 (4.23±0.64) |
| June                | 3.69-4.56 (4.04±0.46 ) | 3.49 -4.71 (4.13±0.61 ) | 3.58 -4.68 (4.19±0.56 ) |
|                     |        | pH                    |                       |                       |
| April               | 7.68 -8.12 (7.87±0.21) | 7.56 -7.91 (7.77±0.15) | 7.34 -8.12 (7.67±0.32) |
| May                 | 7.67 -7.85 (7.77±0.09) | 7.68 -7.90 (7.78±0.11) | 7.78 -7.92 (7.83±0.07) |
| June                | 7.89 -8.20 (8.02±0.15) | 7.78 -7.90 (7.83±0.06) | 7.79 -8.11 (7.92±0.16) |

Temperature plays significant role in fish production. Boyd (1982) reported that the range of water temperature from 26.06 to 31.97°C is suitable for fish culture. Mollah and Hoque (1978), Rahman et al. (1982), Dewan et al. (1991), Wahab et al. (1995) also reported the surface water temperature ranged from 30.2-34°C in polyculture of Indian and Chinese carps. Ali et al. (1982) observed that, water temperature ranged from 20.5 to 30.5°C in pond during study. Hussain (2000) reported water temperature of ponds range from 26.0 to 32.4°C. All these reports are more or less in agreement with results of the present study. Temperature in the ranges and mean values of water quality parameters in different treatments were presented in Table 4.

The Dissolved Oxygen content fluctuated due to photosynthesis process in pond and respiration of the fish. Wahab et al. (1995) recorded dissolved oxygen ranges from 2.2-7.1 mg/l in nine ponds of BAU campus, Mymensingh in their study. Roy (2001) considered 5.0 to 7.0 mg/l of dissolved oxygen content of water is fair or good in respect of productivity. The results of the present study are closer more or less to the previous findings. The present study revealed that the pH value of different treatments ranged from 7.2 to 8.4. Hussain (2000) found a good relationship between pH of pond water and fish culture and obtained satisfactory results at pH 6.5 to 9.0. DoF (1998) reported that pH 5 to 8 is good for fish culture. Swingle (1961) suggested that neutral to slightly alkaline pH has been found to be most favorable for fish ponds. Mean pH values of present study in different month in different treatments were in the suitable range as reported by other researcher.

Growth performance of Indian major carps (Labeo rohita, Gibelion catla and Cirrhinus cirrhosus) Growth performance of Labeo rohita, Gibelion catla and Cirrhinus cirrhosus in different treatments in terms of mean weight gain, percent weight gain, specific growth rate, FCR, PER and survival rate are presented in Table 5. The mean weight gain of Labeo rohita,
Gibelion catla and Cirrhinus cirrhosus in different treatments was significantly different. The highest weight gain of Labeo rohita (164.60 g), Gibelion catla (190.46 g) and Cirrhinus cirrhosus (99.98 g) was found in Treatment 3. The lowest weight gain among these three treatments was found in Treatment 2. The weight gain in Treatment 1 is average while compared with Treatment 3 and 1.

Table 5. Growth performance of Labeo rohita, Gibelion catla and Cirrhinus cirrhosus in different treatments

| Growth parameters | Species          | Treatments (Mean ± SD)                      |
|-------------------|------------------|---------------------------------------------|
| Mean weight gain  | Treatment 1       | Treatment 2       | Treatment 3       |
|                   | (Mean ± SD)       | (Mean ± SD)       | (Mean ± SD)       |
| Labeo rohita      | 153.68 ± 1.45b    | 138.99 ± 1.62c   | 164.60 ± 1.56a    |
| Gibelion catla    | 170.14 ± 1.28b    | 152.94 ± 1.65c   | 190.46 ± 1.80a    |
| Cirrhinus cirrhosus| 84.83 ± 1.51b   | 68.39 ± 1.22c    | 99.98 ± 1.24a     |
| Percent weight gain| Labeo rohita     | 881.61 ± 29.32b  | 857.71 ± 32.27b   | 1024.12 ± 11.52a  |
|                   | Gibelion catla    | 853.47 ± 15.20b  | 761.88 ± 13.11c   | 956.73 ± 22.82a   |
|                   | Cirrhinus cirrhosus| 831.01 ± 48.88b | 804.69 ± 21.93b   | 986.56 ± 26.55a   |
| Specific growth rate (SGR%/day) | Labeo rohita | 2.51 ± 0.03b | 2.48 ± 0.04b | 2.66 ± 0.01a |
|                   | Gibelion catla    | 2.47 ± 0.01b    | 2.36 ± 0.02c     | 2.59 ± 0.02a     |
|                   | Cirrhinus cirrhosus| 2.45 ± 0.03b | 2.42 ± 0.03b | 2.62 ± 0.03a |
| FCR               | Combined         | 1.59 ± 0.11b    | 1.73 ± 0.12a     | 1.52 ± 0.09a     |
| PER               | Combined         | 2.19 ± 0.23b    | 2.03 ± 0.15c     | 2.38 ± 0.25a     |
| Survival rate (%) | Labeo rohita     | 88.89 ± 4.81a   | 87.88 ± 5.25c    | 93.93 ± 5.25b    |
|                   | Gibelion catla    | 89.58 ± 3.61a   | 92.86 ± 7.14a    | 92.85 ± 7.14a    |
|                   | Cirrhinus cirrhosus| 94.44 ± 4.81a  | 93.33 ± 11.54a   | 93.33 ± 11.54a   |

S.N: The values in the same rows having similar letter(s) do not differ significantly otherwise differ significantly (p<0.05) as per Duncan Multiple Range Test (DMRT).

Significantly highest percent weight gain was obtained for Labeo rohita (1024.03%), then for Cirrhinus cirrhosus (986.55%) and lowest for Gibelion catla (956.72%) and in Treatment 3. The nearly higher percent weight gain was found in Treatment 1 (where Diet 1 was used formulated with shrimp industry waste). The significant highest SGR (specific growth rate) value was also obtained for Labeo rohita (2.66%/day), then for Cirrhinus cirrhosus (2.62%/day) and lowest for Gibelion catla (2.59%/day) in Treatment 3. SGR (%/day) of Labeo rohita and Cirrhinus cirrhosus in Treatment1 and Treatment 2 showed no significance difference with Labeo rohita and Cirrhinus cirrhosus but Gibelion catla showed significance variation among the treatments. The best FCR (food conversion ratio) value was observed in Treatment 3 (1.52 ± 0.09) where Treatment 1 (1.59 ± 0.11) showed comparatively better result than Treatment 2 (1.73 ± 0.12). The best PER (protein efficiency ratio) value was obtained with Treatment3 (2.38) while Treatment 1 (2.19) showed comparatively better result than Treatment 2 (2.03) among the treatments. The highest survival rate (%) for Labeo rohita (93.93%), Gibelion catla (92.86%) Cirrhinus cirrhosus (94.44%) were found for Treatment 3. There was no significant variation in survival rate among the treatments expect for Labeo rohita in Treatment 3.

Ahmed and Varghese (1992) reported that, the weight of catla, rohu, silver carp and grass carp varied between 187.22 and 267.55 g in a polyculture system during 5 months' rearing period which is slightly higher than the present study. Saha et al. (1997) found that the daily weight gain of catla, rui and mrigal were 0.53g to 0.70g, 0.38g to 0.57g and 0.39g 0.93g. Rahman (1996) reported the daily weight gain of catla, rui and mrigal were 2.57g to 3.44g, 2.08g to 2.75g and 2.53g to 3.21g respectively in BAU campus which is more or less similar to the present study.

The present study revealed that, the SGR (%/day) value of different treatments of Labeo rohita, Gibelion catla, Cirrhinus cirrhosus ranges from 2.51-2.66, 2.47-2.59, and 2.45-2.62 respectively. Jasmine et al. (2011) stated that, the mean SGR (%/day) of catla, silver carp and Golda in different treatments were 1.19 to 1.21, 1.26 to 1.40 and 1.99 to 2.07, respectively. Rahman et al. (2007) recorded the mean SGR of catla, rui, mrigal and mahseer in different treatments under polyculture system as 1.09 to 1.12, 1.13 to 1.14, 1.10 to 1.12 and 1.15 to 1.16. Islam (1996) found that SGR (%/day) of catla, rui and mrigal varied from 1.34 to 1.62, 1.66 to 1.89 and 2.51 to 2.68, respectively. The calculated SGR (%/ day) value of the present study is comparatively higher than the above findings of different authors which may due to the differences in experiment diets, time and location. The mean FCR value ranging from 1.52 to 1.73 in different treatments in the present study which are...
comparable with the FCR values of 1.47-1.69 reported by Jena et al. (2002) for carps in various stocking densities. Das et al. (1975) recorded a low FCR value of 1.9, Sinha and Saha (1980) observed higher FCR value of 3.9 even with commercial fish feeds for the polyculture of carp species. Stickney (2005) considered FCR values of 1.5 to 2.0 as good for most aquatic organisms.

The PER value of different treatments ranged from 2.03 to 2.38 in this study which is more or less in agreement with the findings of Jahan et al. (2013). They reported PER value ranged from 2.17-2.37 for Labeo rohita in the performance of soybean meal as a dietary protein source.

Table 6. Weight increment (g) of Labeo rohita, Gibelion catla and Cirrhinus cirrhosus in different treatments during the experimental period

| Time (Days) | Treatment 1 | Treatment 2 | Treatment 3 |
|-------------|-------------|-------------|-------------|
| 10 days     | 11.47       | 10.32       | 12.67       |
| 20 days     | 12.88       | 11.98       | 13.79       |
| 30 days     | 14.76       | 13.24       | 15.66       |
| 40 days     | 16.65       | 15.57       | 17.61       |
| 50 days     | 17.54       | 16.19       | 18.47       |
| 60 days     | 18.92       | 16.97       | 19.55       |
| 70 days     | 19.77       | 17.78       | 21.46       |
| 80 days     | 20.56       | 18.28       | 22.43       |
| 90 days     | 21.13       | 18.66       | 22.97       |

Estimation of fish production
Species wise fish production was obtained from different treatments in the experimental ponds for a period of 90 days. The highest net production of Labeo rohita, Gibelion catla and Cirrhinus cirrhosus were estimated 3785.51 kg/ha in Treatment 3 followed by Treatment 1 (3111.85 kg/ha) and Treatment 2 (2942.02 kg/ha), respectively (Table 7).

Table 7. Production of fish in terms of kg/ha during the experimental period

| Treatments | Species gross production (kg/ha) | Species net production (kg/ha) | Total net production (kg/ha) |
|------------|---------------------------------|-------------------------------|-----------------------------|
| Diet-1     | 1127.25 1682.09 665.16          | Diet-1 1127.25 1682.09 665.16 | Diet-1 1127.25 1682.09 665.16 |
| Diet-2     | 1111.42 1667.12 531.81          | Diet-2 1111.42 1667.12 531.81 | Diet-2 1111.42 1667.12 531.81 |
| Diet-3     | 1383.94 2025.76 760.93          | Diet-3 1383.94 2025.76 760.93 | Diet-3 1383.94 2025.76 760.93 |

Cost analysis of formulated diets
Addition of shrimp industry waste along with other ingredients in the diets of Indian major carp bears a great significance to make a diet cost effective. The calculated price (including all cost) of per kilogram Diet-1, Diet-2 and Diet-3 were 30.19, 37.79 and 40.80 Tk., respectively (Table 8).
Table 8. Cost estimation of experimental Diets (Diet-1 and Diet-2)

| Feed ingredients     | Unit price (Tk/Kg) | Diet-1 | Diet-2 |
|----------------------|-------------------|--------|--------|
|                      | Amount used (g)   | Cost (Tk) | Amount used (g) | Cost (Tk) |
| Shrimp shell         | 16.66             | 400     | 6.32   | 0       | 0       |
| Soybean              | 42                | 240     | 10.08  | 480     | 20.16   |
| Wheat bran           | 30                | 100     | 3.00   | 120     | 3.60    |
| Maize                | 23                | 130     | 2.99   | 250     | 5.75    |
| Rice bran            | 24                | 100     | 2.04   | 120     | 2.88    |
| Molasses             | 60                | 20      | 0.80   | 20      | 0.80    |
| Vitamin premix       | 250               | 5       | 2.50   | 5       | 2.50    |
| Salt                 | 20                | 5       | 0.10   | 5       | 0.10    |
| Other charge         |                   |         | 2.00   |         | 2.00    |
| Total Cost           |                   | 1000 g  | 30.19  | 1000 g  | 37.79   |

Conclusion

Therefore, the present study could be concluded as, in terms of weight gain of fishes irrespective of species and also the calculated values for cost per kg diet preparation, use of shrimp industry waste in the supplementary diet of Indian major carp fish culture not only provides better protein percentage but also minimize the diet preparation cost in a significant margin.

References

Ahmed I and Varghese TJ. 1992. Compatibility of Macrobrachium rosenbergii (de Man) for polyculture with major carps. In: Proceedings of National Syn Jposium on Freshwater Prawns Macrobrachium species, Cochin University Science and Technology, Kochi, 197-199.

Ali S, Rahman AK, Patwary AR, Islam KHR. 1982. Studies on the diurnal variations in physico-chemical factors and zooplankton in a freshwater pond. Bangladesh J. Fish., 2-5: 15-23

AOAC. 1990. Official Methods of Analysis, 15th ed. Association of Official Analytical Chemists, Washington, DC, USA.

Ariyani F. 1989. The production of prawn head silage, MS Thesis, The University of South Wales, England.

Chandrkrachang S, Chinadit U, Chandayot P, Supasiri T. 1991. Profitable spin-off from shrimp-seaweed poly culture. INFOFISH International, 6: 26-28.

Das P, Kumar D, Guha Roy MK. 1975. National demonstration on composite fish culture in West Bengal. J. Inland Fish. Soc. India, 7: 112-115.

Dewan S, Wahab MA, Beveridge MCM, Rahman MH, Sarker BK. 1991. Food selection, selectivity and dietary overlap among Plantivorous Chinese and Indian major carps fry and fingerlings grown in extensively managed, rain-fed ponds in Bangladesh, Aquaculture and Fisheries Management, 22: 227-294.

DoF (Department of Fisheries). 1998. Matshya Saptah Shankalan, Directorate of Fisheries, Bangladesh.

Gernat AG. 2001. The effect of using different level of shrimp meal in laying diets. Journal of Poultry Science, pp.633-636.

Higgs DA, Dosanjh AF, Prendergast RM, Beams RW, Hardy W. 1995. Nutrition and Utilization Technology in Aquaculture. Champaign II. Chapman and Hall. Company, New York, USA, pp. 130-156.

Hossain MA, Amin MR, Islam MS, Hoque MM. 1999. Comparative growth performance of reverine and hatchery produced Indian major carps (Cataca caiba Ham., Labeo rohita Ham. And Cirrhinus mrigala Ham.). Bangladesh J. Zool., 27: 65-73.

Hossain MY. 2000. Effects of iso-phosphorus organic and inorganic fertilizer on water quality parameters and biological production, MS Thesis, Department of Fisheries Management, Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh.

Islam MR. 1996. Comparative growth rate of fishes in polyculture and integrated culture system, MS thesis, Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh, 38-41.

Jahan DA, Hussain L, Islam MA, Naima A. 2013. Evaluation of Soybean Meal as a Dietary Protein Source on the Performance of Labeorohita (Ham.) Spawn Reared under Pond Condition. The Agriculturists, 11(2): 14-20.

Jasmine S, Molina M, Hossain MY, Jewel MAS, Ahamed F, Fulanda B. 2011. Potential and Economic Viability of Freshwater Prawn Macrobrachium rosenbergii (de Man, 1879) Polyculture with Indian Major Carps in Northwestern Bangladesh. Our Nature, 9: 61-72.
Jena JK, Ayyappan S, Aravindakshan PK, Das B, Singh SK, Muduli HK. 2002. Evaluation of production performance in carp polyculture with different stocking densities and species combinations. *Journal of Applied Ichthyology*, 18: 165-171.

Mahata ME, Dharma A, Ryanto I, Rizal Y. 2008. Effect of substituting shrimp waste hydrolysate of *Penaeus merguiensis* for fish meal in Broiler. *Pakistan Journal of Nutrition*, 7(6): 806-810.

Miah MS, Uddin MS, Shah MS. 1997. Effect of stocking rations on the growth and production of fishes in mixed polyculture system. *Bangladesh J. Fish.*, 20(1-2): 135-138.

Mohanty SN, Swamy DN, Tripathi SD. 1990. Growth, nutritional indices and carcass composition of Indian major carp by *Catla catla*, *Labeo rohita*, fed four dietary protein levels. *Aquaculture Hungarica* (Szarris), 6: 211-217.

Mollah MFA, Haque AKMA. 1978. Studies on monthly variations of Plankton in relation to the physio-chemical conditions of water and bottom soil of two ponds. II. Zooplankton. *Bangladesh J. Fish.*, 1: 99-103.

Nandeesh MC. 1993. Aquafeeds and feeding strategies in India, pp. 213-254. In M.B. New, A.G.J. Tacon and Csavas I (eds.) Farm-made Aquafeeds. Proceedings of the FAO/ AADCP Regional Expert Consultation on Farm-Made Aquafeeds, 14-18 December 1992, Bangkok, Thailand. FAO-RAPA/AADCP, Bangkok, Thailand, 434p.

Patnaik KS, Das KM. 1979. Utilization of some aquatic weeds as feed for rearing carp spawn and fry. In *Proceedings of the Symposium on Inland Aquaculture*. Central Inland Fisheries Research Institute, Barrackpore, India, 12.

Paul BN, Nandi S, Sarkar S, Mukhopadhyay PK. 1998. Dietary essentiality of phospholipids in Indian major carp larvae. *Asian Fishery Science*, 11: 253-259.

Rahman MA, Rahman MR, Rahman MS. 2007. Evaluation of growth and production of the mahseer, *Tor putitora* (Ham.) in polyculture with indigenous major carps, pp. 161-175.

Rahman MM. 1996. Effect of stoking size on the growth, survival and production of carps under polyculture system, MS thesis, Department of Aquaculture, Bangladesh Agricultural University, Mymensingh.

Rahman MS, Chowdhury MY, Haque MA, Haq MS. 1982. Limnological studies of four ponds. *Bangladesh J. Fish.*, 2-5: 25-35.

Roy K. 2001. Effect of stocking density on the growth of carps in ponds, M. S. Thesis, Dept. of Aquaculture, Bangladesh Agricultural University, Mymensingh.

Saha C, Mohapara BC, Giri SS. 1997. Central Inst. Of Fresh Water Aquaculture. *J. Aquaculture in the tropics*. Kausalyaganaga, Bhubaneswar 751002, Orissa, India.

Singh PK, Gaur SR, Chari MS. 2006: Effect of Varying Protein Levels on the Growth of Indian Major Carp Rohu, *Labeorohita* (Hamilton). *International Journal of Zoological Research*, 2: 186-191.

Sinha M and Saha PK. 1980. Efficacy of a commercial fish feed for composite fish culture *J. Inland Fish. Soc. India*, 12(2): 51-55.

Stickney RR. 2005. Aquaculture, an introduction test, CABI publication, Cambridge, USA. 265p.

Swingle SH. 1967. Relationship of pond water to their suitability for fish culture. Proc. 9th *Pacific Sci. Congr.*, 10: 72-75.

Tareque AMHB, Alam MM, Rahman MM, Rahman MM, Rahman SM. 2009. Effect of some formulated feeds on the growth and survival of *Tha Sharpunti* (*Puntius gonionotus*) fry. *Bang. J. Mar. Sci. and Fish.*, 1(1): 21-31.

Wahab MA, Ahmed ZF, Islam A, Rahmatullah SM. 1995. Effect of introduction of common carp, *Cyprinus carpio* (L) on the pond ecology and growth of fish in polyculture. *Aquacult. Res.*, 26: 619-628.