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

M. I. Hossain, F. H. Shikha* and A. B. M. A. Hoque
Department of Fisheries Technology,
Bangladesh Agricultural University, Mymensingh-2202
*Corresponding email: shikhafh@bau.edu.bd

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. T_1, T_2 and T_3. Protein percentage of diets were 28.42%, 28.13% and 27.32%, respectively. The water quality parameters of the experimental ponds were monitored at 10 days interval. Diet-1 resulted better growth with *Labeo rohita* (153.68g), *Gibelion catla* (170.14g) and *Cirrhinus cirrhosus* (84.83g) compared to Diet-2 (138.99g, 152.94g, 68.39g respectively). The highest SGR (%/day) value was obtained with *Labeo rohita* (2.66%/day), *Gibelion catla* (2.59%/day) and *Cirrhinus cirrhosus* (2.62%/day) for Diet-3. 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 *Labeorohita* (93.93%), *Gibelioncatla* (92.86%) *Cirrhinuscirrhosus* (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 Table1. 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.

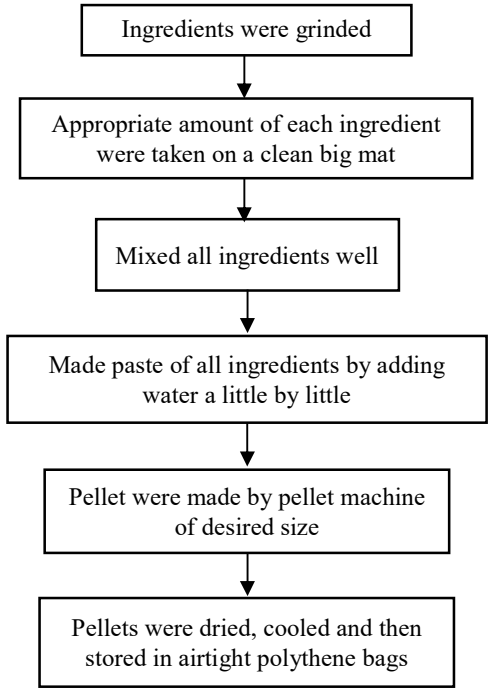

Fig. 1. Protocol for preparation of diets

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 homogenously 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. T_1, T_2 and T_3 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 (ºC), 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-

Weight gain = Mean final fish weight —Mean initial fish weight

$$\% \text{ weight gain} = \frac{\text{Mean final weight} - \text{Mea initial weight}}{\text{Mean initial weight}} \times 100$$

$$\text{SGR (\%/day)} = \frac{1nW_2 - 1nW_1}{T_2 - T_1} \times 100$$

Where, W_2 = Final body weight (g) at time T_2

W_1 = 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	Proximate composition of feed ingredients used for diet preparation			
	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

Proximate composition of diets

The proximate composition of different experimental diets including the control is presented in Table 3. There was a slight variation in protein, lipid, ash and moisture content of different diets.

Table 3. Percentage (%) of proximate composition of the experimental diets

Contents (%) in Diets	Diets used in the study		
	Diet 1	**Diet 2**	**Diet 3**
Moisture	10.74	10.42	11.13
Crude Protein	28.42	28.13	27.32
Lipid	6.53	5.84	5.45
Ash	12.35	11.63	9.87

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 (Patnaik and Das, 1979). In terms of growth, food conversion ratio, protein efficiency ratio, survival rate, diet containing 30% protein level revealed a significantly

($p<0.01$) better performance for *Labeo rohita* in comparison with other diets containing lower or higher protein levels (Singh *et al*., 2006). Tareque *et al*. (2009) also reported that, 30% incorporated protein in diet resulted better results with respect of growth and SGR for *Labeo rohita*, *Cyprinus carpio* Var. *Nudus* and *Puntiusgonionotus*. The results of the present study are more or less nearer to the previous findings.

Water quality parameters

The water quality parameters (temperature, dissolved oxygen and pH) of the experimental ponds were monitored at every 10 days interval during the experimental period. The mean value of water temperature, dissolved oxygen and pH ranged from 26.5ºC to 29.2ºC, 3.49 mg/l to 5.34 mg/l, and 7.34 to 8.20, respectively in different treatments. The minimum temperature (26.5ºC) and the maximum temperature (29.2ºC) was observed in April and June, respectively in Treatment-1(Pond 1). The highest DO concentration (5.34 mg/l) and the lowest DO concentration (3.49 mg/l) was observed in Treatment-2 (Pond 2) on June and April, respectively. The highest pH value 8.20 was recorded in Treatment-1 (Pond 1) on June and the lowest value 7.34 was observed in Treatment-3 (Pond3) on April. Monthly variation 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	Treatments		
		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 31.97ºC 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- 34ºC in polyculture of Indian and Chinese carps. Ali *et al*. (1982) observed that, water temperature ranged from 20.5 to 30.5ºC in pond during study. Hossain (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.

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

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 Treament1 and Treatment 2 showed no significance difference with *Labeo rohita* and *Cirrhonus 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, rohu, 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 *el 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.

Miah *et al*. (1997) found survival rate of carps ranged from 89.23% to 99.23% in their study which is nearer to the findings of present study but Hossain *et al*. (1999) observed the range of survival rate (%) from 71.43% to 81.40% which is quite lower than the present one.

Weight increment (g)

The weight increment every 10 days interval during experiment period of *Labeorohita*, *Gibelioncatla* and *Cirrhinuscirrhosus* are presented in Table 6. The highest weight increment was found in Treatment 3 and the lowest increment was found in Treatment 2 irrespective of fish species.

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

Weight Increment (g) of *Labeorohita*									
Time (Days)	**10 days**	**20 days**	**30 days**	**40 days**	**50 days**	**60 days**	**70 days**	**80 days**	**90 days**
Treatments									
T1	11.47	12.88	14.76	16.65	17.54	18.92	19.77	20.56	21.13
T2	10.32	11.98	13.24	15.57	16.19	16.97	17.78	18.28	18.66
T3	12.67	13.79	15.66	17.61	18.47	19.55	21.46	22.43	22.97
Weight Increment (g) of *Gibelioncatla*									
Time (Days)	**10 days**	**20 days**	**30 days**	**40 days**	**50 days**	**60 days**	**70 days**	**80 days**	**90 days**
Treatments									
T1	15.12	15.44	16.67	17.59	19.39	20.19	20.54	21.31	22.88
T2	12.89	14.34	16.23	17.19	17.65	17.87	18.55	18.88	19.34
T3	17.16	18.35	19.76	20.33	21.17	21.73	23.17	23.63	25.17
Weight Increment (g) of *Cirrhiniscirrhosus*									
Time (Days)	**10 days**	**20 days**	**30 days**	**40 days**	**50 days**	**60 days**	**70 days**	**80 days**	**90 days**
Treatments									
T1	7.15	7.85	8.23	8.67	9.15	9.84	10.85	11.43	11.66
T2	4.78	5.41	6.54	7.77	8.46	8.69	8.88	8.91	8.96
T3	9.24	10.19	10.43	10.56	11.23	11.52	11.88	12.31	12.62

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

	Species wise gross production (kg/ha)			Species wise net production (kg/ha)			Total net production (kg/ha)
Treatments	*Labeorohita*	*Gibelioncatla*	*Cirrhinuscirrhosus*	*Labeorohita*	*Gibelioncatla*	*Cirrhinuscirrhosus*	
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-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.

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