International Journal of Applied Research

Journal HP: www.intjar.com, ISSN: 2411-6610

Suitable diet for walking cat fish (*Clarias batrachus* Linn. 1758) in earthen ponds

Angkur Mohammad Imteazzaman[1]*, Shipon Das[2], M Mojibar Rahman[1], Alok Kumar Paul[2], Md. Abdul Khaleque[2], A.M. Farhaduzzaman[3]

[1]*The WorldFish, Bangladesh and South Asia Office, Banani, Dhaka-1213, Bangladesh*
[2]*Department of Fisheries, University of Rajshahi, Rajshahi-6205, Bangladesh*
[3]*Assistant Manager (Program), Palli Karma-Sahayak Foundation (PKSF), Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh*

ARTICLE INFO

Article history

Accepted 25 May 2017
Online release 15 June 2017

Keyword

Clarias batrachus
Magur
Pond
Aquaculture

***Corresponding Author**

A M Imteazzaman
E-mail: zeroankur@gmail.com

ABSTRACT

A 90 days' study have been carried out from 1st August to 30th October to determine the suitable diet for walking cat fish (*Clarias batrachus* Linn) culture in nine earthen ponds situated at the hatchery complex, Department of Fisheries, University of Rajshahi. The experiment was conducted in a completely randomized design having three treatments namely T1, T2, T3, with three replications. Three different low cost diet viz. T_1-diet 1 (30% protein level), T_2-diet 2 (27% protein level) and T_3-diet 3 (24% protein level). Feeds were formulated using poultry viscera and rice polish for diet 1, only commercial pellet feed for diet 2 and mustard oil cake and rice polish for diet 3. The stocking density was 49400 individuals/ha. The feeding rate was 5% for total culture period. The SGR and FCR value were 0.92±0.21 and 2.02 in $T_{1,}$ 0.83±0.10 and 3.62 in T_2 and 0.70±0.025 and 4.14, respectively in T_3. The values showed significantly (P>0.05) different among the treatments. The production *C. batrachus* ranged obtained 3389.4±240.23, 3132.9±387.48 and 2595.2±456.45 kg/ha/90days in T_1 T_3 and $T_{3,}$ and diet 1 resulted significantly (P<0.05) highest production. A simple economic analysis showed that treatment T_1 generated the maximum net profit of Tk. 713542 /ha/90 days. Water quality parameters such as temperature (^{0}C), transparency (cm), pH, dissolved oxygen (mg l^{-1}) and NH_3-N (mg l^{-1}) were monitored fortnightly. Mean values of the water quality parameters showed no significant differences (P>0.05) among the treatments in two trials except NH_3-N in trial one. Present findings indicated that the production and net profit was significantly higher with treatment T_1 (diet 1; 30 % protein level).

Introduction

Clarias batrachus is a high valued, demandable marketing species having good nutrient values in Bangladesh C. *batrachus* is commonly known as "Magur" and is available in all types of freshwater habitats such as rivers, canals, beels swamps and ponds. It breeds in shallow marginal waters of ponds, ditches and natural depressions (Islam and Hossain, 1983; Hafizuddin, 1985; Rahman, 1989; Hafizuddin et al., 1989; Bhuiyan et al., 1992) and inundated paddy-fields during summer monsoon and rainy season, usually between May and August (Ahmed et al., 1985; Bhuiyan, 1964). *C. batrachus* inhibits in the fresh water of Bangladesh, India, Myanmar, Srilanka and Malayasia (Mookerjee and Mazumder, 1950). Commercially the culture of this fish is very much popular in South Asian countries viz. Thailand, Vietnam and India. However, in Bangladesh, very little attempt has been made for its commercial aquaculture, although, the hatchery techniques of this species has already developed. So it is appropriate time to explore the suitable culture technique of *C. batrachus*.

The diet of *C. batrachus* is wide. The early post larval stage is exclusively planktophagus while in the late larval stages it starts including larger organisms in their diets. The juvenile stage is predominantly insectivorous. The adult have a wide range of food preferences with the insect material decaying organic matter as the main item (Yadav, 2003). Mukhopadhay, 1977 reported that *C. batrachus* can be cultured by giving the supplemental diets from plant origin because of the presence of cellulose and high amylase activity in its structure. Food conversion ratio and feed efficiency of the fish has been reported to be 2.2 and 0.45 respectively and 7906 kg/ha fish has produced over a period of 150 days in Thailand (Chuapoehuk and Pothisoong, 1978). For a single crop, the net income to gross returns averaged 37.7 percent; the net income to the total cost ratio averaged 71.4 percent and on annual basis, the return of the capital averaged 108.1 percent (Kloke and Potoros, 1975). Thus *C. batrachus* can be considered as excellent candidate for aquaculture.

There are 0.30 million ha. of ponds and ditch in Bangladesh, where seasonal and derelict ponds constitute a significant portion. The seasonal ponds are not considered for growing major carp. These seasonal water-bodies hold tremendous potential for adopting culture system of *C. batrachus* having shorter life cycle and easily adapt with poor water quality.

In commercial aquaculture, market price of *C. batrachus* bears the major importance. The fish has a high market value and great consumer preference. In spite of the advantages that this fish has, very little attempt has been made in Bangladesh for commercial aquaculture. The farmers of our country are traditionally familiars with the culture of carp fishes. Due to high market price, fish farmers often show considerable interest in *C. batrachus* culture, but the biggest constraint is non availability of suitable culture technique.

Several researches have been done on carps and few cat fish's culture in Bangladesh. However, no work is carried out on diet for indigenous cat fish culture (*C. batrachus*). Development of a simulation model of diet for Magur production may help researchers as well as fish farmers to make decision regarding different inputs use and adoption of management policies in aquaculture ponds.

Culture of short cycle walking catfish has considerable impact on the livelihood of the poor landless farmer. The research output could help to culture *C. batrachus* with locally available low cost feed. Marginal farmers can be ensured maximum benefit from their waterbodies including the derelict ponds and finally it might fulfill the nutritional requirement of rural people. Therefore, the present study was undertaken to develop a sustainable model for indigenous cat fish in aquaculture system.

Materials and Methods

Experimental ponds

The experiment was performed in nine earthen ponds of 45-48m^2 in the hatchery complex, Department of Fisheries, University of Rajshahi. The ponds were similar in shape, depth, basin configuration including water supply facilities. The water depth was maintained around 1.2-1.5 m. To maintain the water level and to keep the good water quality, water added to the ponds at regular intervals using pump machine.

Experimental design

The experiment was conducted in a completely randomized design having three treatments namely T_1, T_2, T_3, with three replications. The stocking density were same in all treatments; 49,400 individuals/ ha^-. The differences in treatments were in providing feed quality as shown in table-1.

Table 1. Layout of the experiment:

Treatments
T_1- Diet 1; 30% Protein level (Poultry viscera 60% + Rice polish 40%)
T_2- Diet 2; 27% Protein level (commercial pellet feed; grower grade)
T_3- Diet 3; 24%Protein level (Mustard oil cake 78%+ Rice polish 22%)

Pond preparation

For controlling undesirable species and aquatic weeds, all undesirable fish were completely eradicated by applying rotenone at a rate of 2.5 g m-3. Aquatic weeds were removed manually. The grasses of the pond dikes were also cut into small size by using scythe. Lime (Calcium carbonate) was applied at the rate of 300 kg ha-1 after one week of rotenone application. Lime was liquefied into an aluminum bucket and then applied by spreading homogenously in the ponds. Ponds were fertilized with urea and triple super phosphate (TSP) each at a rate of 25 kg ha-1 and cowdung at a rate of 1000 kg ha-1 after three days of liming. TSP was applied after dissolving in plastic buckets for 10 to 12 hours before application. Fertilizers were applied by spreading methods.

Collection of fishes

The fingerlings *C. batrachus* were collected from a private hatchery of the Madhupur Upazila of Tangail district. The average weights of the fingerlings were 30.6±3.55g fingerlings were brought to the experimental site through plastic barrels with proper aeration.

Post stocking management

Feeding of fishes

The fishes were fed with different protein content feeds (Table 1 and 2). The feeds were also applied daily at a rate of 5% body weight for total culture period. Feed requirement were calculated and adjusted after sampling of fishes once in a month. The proximate composition of feed ingredients and experimental diets was analyzed according to the methods given in Association of Official Analytical Chemists (AOAC, 1980).

Table 2. Proximate composition of the diet used in this study.

Proximate composition (%)	Diets Commercial pellet feed	Mustard oil cake	Poultry viscera	Rice polish
Moisture	10.00	11.67	82.23	15.58
Protein	27.00	27.60	45.40	10.25
Lipid	12.42	11.40	23.54	16.80
Fiber	9.08	12.48	1.89	15.12
Ash	17.10	14.25	13.89	18.28
NFE	34.40	34.27	15.28	39.55

Fertilization

Urea and triple super phosphate (TSP) each were applied to the ponds at the rate of 6.25 kg ha^{-1} and cowdung 125 kg ha^{-1} at 7 days intervals throughout the cultured period besides this, sack of poultry manure containing 50 kg were floating in each pond.

Growth sampling of fish

Fishes were sampled fortnightly using seine net to assess their growth and health condition. At least 10 fish from each pond were taken to make assessment of growth trends and to readjust feeding rate. Length and weight of sampled fish were measured immediately after collection.

Fish harvesting

Harvesting was done in the month of October after completed the study by drying of pond.

Physical and chemical analysis of water

A number of water quality parameter such as temperature (^{0}C), transparency (cm), pH, dissolve oxygen (mg l^{-1}) alkalinity, ammonia-nitrogen (mg l^{-1}), were measured fortnightly at 9:00-10:00 am at the pond site to assess the physico-chemical condition of the pond. pH of pond water was measured by a direct reading pH meter (HACH) at the pond site. The dissolved oxygen, total alkalinity and ammonia-nitrogen of water were measured by using a HACH Kit (DR/2010 model, HACH, Loveland, CO, USA, a direct reading spectrophotometer) at the pond site.

Plankton enumeration

Plankton samples were collected monthly from each pond. A bucket contained two liters of water was used to collect 10 liters of water from five different places and depth of the pond and passed through fine mesh (55 µm) plankton net. The concentrated samples were transferred to a measuring cylinder and carefully made up to a standard volume of 50 ml with distilled water. Then the collected plankton samples were preserved in 10% buffered formalin in small plastic bottles each for subsequent studies. From each 50 ml preserved sample, 1 ml sub-sample was examined using an S-R cell (Sedge-Wick-Rafter cell S50, Microlitre) and a binocular microscope (Olympus, M-4000D, Japan) with phase contrast facilities. Identification of plankton to the genus level was carried out using the Keys from Prescott (1962) and Belinger (1992). For each pond, mean number of plankton was recorded and expressed numerically per liter of water. The quantitative estimation of plankton was done using the following method of Stirling (1985).

Statistical analysis

For the statistical analysis of data collected, one-way analysis of variance (ANOVA) was performed using the SPSS (Statistical Package for Social Science, evaluation version-15.0). Significance was assigned at the 0.05% level.

Economics analysis

A simple economic analysis was done to estimate the economic return in each treatment. The total cost of inputs was calculated and the economic return was determined by the differences between the total return (from the current market prices) and the total input cost. The cost in taka per unit yield (CPY) was calculated and was expressed as the cost in Tk/kg of fishes produced.

Results and discussion

Water quality parameters

Transparency

Water transparency varied in different ponds under different treatments. The mean values of water transparency in treatments T_1, T_2 and T_3 were 34.75±1.09, 36.17±1.67 and 35.68±1.97cm, respectively. Water transparency ranged from 33.5±4.94 to 36±1.41, 33.5±0.70 to 38±2.82 and 34±2.82 to 39±2.82cm in the treatments T_1, T_2 and T_3, with the lowest value (29cm) observed on 30th September in treatment T_1 and the highest value (41 cm) was observed on 30th October also in treatment T_3. There was no significant difference (P>0.05) was observed among the treatments (Table 3).

Temperature

The mean values of temperature (^{o}C) were 32.33± 2.8, 32.29 ± 2.83 and 32.34 ± 2.83^{o}C in treatment T_1, T_2 and T_3, respectively. There was no significant difference (P>0.05) in the mean among the treatments. The range of water temperature varies from 29.05±0.07 to 36.05±0.07^{o}C in treatment T_1, 28.95±0.07 to 36±0.0^{o}C in treatment T_2 and from 29±0.0 to 36.12±0.03^{o}C in treatment T_3. The maximum temperature (36.15^{o}C) was found in treatment T_3 on 30th August and minimum was (28.9^{o}C) found in T_2 on 30th October (Table 3)..

Dissolved oxygen

The ranges of oxygen concentration in different ponds were varied from 4.85±0.22 to 6.62±0.24 in T_1, 4.79±1.33to 7.02±0.24 in T_2 and 4.45±0.77 to 6.75±0.36 in T_3. The mean values of DO concentration in T_1 T_2 and T_3 were 5.67±0.32, 5.67±0.21 and 5.49±0.44mgl^{-1}, respectively. The highest value of DO (7.2mgl^{-1}) was recorded on 30th October in T_2 and the lowest value (3.85mgl^{-1}) was also recorded in T_2 on 30th September. There was no significant difference (P>0.05) among the treatments (Table 3).

pH

The mean values of pH in treatments T_1, T_2 and T_3 were 7.91±0.49, 7.74±0.0.43 and 7.87±0.40, respectively. pH value ranges from 7.1±0.14 to

8.4±0.0, 7.05±0.21to 8.25±0.21and 7.3±0.42 to 8.3±0.28 in T_1, T_2 and T_3. The lowest value (6.9) observed on 30th October in T_2 and the highest value (8.5) was observed on 15th August in T_3 (Table 3).

Total alkalinity

Total alkalinity fluctuated from 100.85±20.29 to 153.05±15.48mg l^{-1} in treatment T_1, 133.5±28.99 to 170±25.45mg l^{-1} in T_2 and 144±8.48 to 166.5±0.70 mg l^{-1} in T_3.The highest value of total alkalinity was 188mg l^{-1} in T_2 on 30th October and the lowest value was 86.5 mg l^{-1} in T_1 on 15th August. Mean values of total alkalinity were 134.19±20.72, 151.33±12.45 and 153.49± 7.61 mg l^{-1} in treatment T_1, T_2 and T_3, respectively. The mean values were not significantly different (P>0.05) among the treatments (Table 3).

Ammonia nitrogen

The mean values of ammonia-nitrogen were 0.012± 0.008, 0.015±0.010 and 0.016±0.003mg l^{-1} in T_1, T_2 and T_3, respectively. The mean values were not significantly different (P>0.05) among the treatments, It ranges from 0.005±0.007to 0.026±0.019 mg l^{-1} in treatment T_1, 0.006±0.006 to 0.031±0.031mg l^{-1} in treatment T_2 and 0.012±0.003 to 0.018±0.008 mg l^{-1} in treatment T_3. The highest value of ammonia-nitrogen (0.054mg l^{-1}) was found in treatment T_2 on 30th October and the lowest value was found nil in T_1 on 15th August (Table 3).

Table 3. Water quality parameters of the ponds under three treatments.

Parameters	Treatments (Mean values ±SE)		
	T_1	T_2	T_3
Transparency (cm)	34.75±1.09^a (29-42)	36.17±1.67^a (33-40)	35.68±1.97^a (32-41)
Temperature (^{0}C)	32.33±2.8^a (29.0-36.1)	32.29±2.83^a (28.9-36)	32.34±2.83^a (29.0-36.15)
pH	7.91±0.49^a (7.0-8.4)	7.74±0.43^a (6.9-8.4)	7.87±0.40^a (7.1-8.5)
DO (mg l^{-1})	5.67±0.32^a (4.69-6.8)	5.67±0.21^a (3.85-7.2)	5.49±0.44^a (3.9-7.01)
Total alkalinity (mg l^{-1})	134.19±20.72^a (86.5-134)	151.33±12.45^a (113-188)	153.49±7.61^a (138-167)
NH_3-N (mg l^{-1})	0.012± 0.008^a (0.0-0.040)	0.015±0.010^a (0.001-0.054)	0.016±0.003^a (0.004-0.032)

Figures in the same row having same superscripts are not significantly different

The range of temperature, transparency, pH and dissolved oxygen, total alkalinity and ammonia nitrogen were cm, 29.0 to 36.15^{o}C, 29 to 41, 6.9 to 8.5, 3.85 to 7.1 mg l^{-1} 86.5 to 138 mg l^{-1} and 0.0 to 0.054 mg l^{-1}. Mean values of water qulltiy parameters shows no significant (P>0.05) difference among the treatments The above water quality parameters were in suitable range of tropical fish culture conditions except water temperature which was slightly higher from the suitable range; this might be due to low rainfall and large scale climate change in Rajshahi region. However this result was more or less similar with the findings of Viveen et al. (1985), Sarkar (2005) and Haque et al. (2005) recorded temperature and pH range of the water of the catfish rearing ponds between 20-30^{o}C & 6.5 to 8.0, 28-31^{o}C & 6.85-7.03 and 24-33.9^{o}C & 6.62-7.85, respectively in catfish rearing ponds, Hossain et al. (2007) recorded 17.5 to 27.25^{o}C & 6.5-8.0 in earthen ponds, which is comparatively lower than the present study, but the pH values are closely related with the present study. Clay (1979) reported that a temperature preference for African catfish juvenile was found to be 32.71±1.5^{o}C. The recorded temperature in the present experimental ponds are little higher than the findings of Clay (1979). Britz and Hecht (1987) stated that higher growth rates were obtained between 25 to 33^{o}C and the best was at 30^{o}C. The values of dissolved oxygen obtained from the present study are coincide with the findings of Haque et al. (2005) who recorded the DO ranges from 3.87-5.85 mg/l^{-1} and 2.15-6.74 mg/l^{-1}. Sudden fluctuations of DO concentration were observed in the present study, which might be due to decomposition of uneaten supplementary feeds, metabolic wastes and plankton population. Similar observation also made by Sarkar et al. (2005) and Jena et al. (1998).

Table 4. Generic status of different groups of identified plankton in the experimental ponds.

Groups		Genus
Bacillariophyceae	:	*Cyclotella, Navicula, Nitzschia, Asterionella.*
Chlorophyceae	:	*Actinastrum, Chlorella, Tetraedron, Ulothrix, Volvox Zygnema, Palmella, Ceratium, Tetradesmus*
Cyanophyceae	:	*Spirulina, Microcystis, Oscillatoria, Aphanizomenon Anabaena.*
Euglenophyceae	:	*Euglena, Phacus*
Rotifera	:	*Asplanchna, Brachionus, Keratella,*
Crustacea	:	*Cyclops, Diaptomus, Diphanosoma, Moina, Daphnia* Nauplius

Table 5. Plankton (x10^3 cells/L) recorded from the ponds under the three treatments.

Groups	Treatments (±SE)		
	T_1	T_2	T_3
Bacillariophyceae	9.29±0.49^a	9.63±1.71^a	9.69±1.58^a
Chlorophyceae	35.43±5.22^a	32.76±2.48^a	36.23±4.35^a
Cyanophyceae	19.03±1.51^a	19.48±2.56^a	14.17±1.62^b
Euglenophyceae	4.37±1.25^a	2.78±1.02^b	3.76±0.47^a
Total Plankton	68.13±7.05^a	64.67±4.80^a	63.86±3.30^a
Rotifera	1.68±0.45^b	2.63±0.73^a	1.05±0.54^c
Crustacea	2.7±0.76^a	2.97±0.19^a	2.58±0.48^a
Total zooplankton	4.38±1.89^a	5.6±0.92^a	3.63±1.52^b
Total plankton	72.52±7.67^a	70.28±5.73^a	67.5±4.31^a

Figures in the same row having same superscripts are not significantly different

Plankton population

Plankton populations were identified up to genus level (Table 4). It consisted of 29 genera belonging to 6 planktonic groups. Twenty genera of phytoplankton belonging to Bacillariophyceae (4), Chlorophyceae (9), Cyanophyceae (5) and Euglenophyceae (2) and 9 genera of zooplankton belonging to Rotifera (3) and Crustacean (6) were identified (Table 4).

The species diversity increased with the culture period, which might be due to the availability of sufficient nutrients released through decomposition of unused feed and fish metabolic wastes. As nutrient excretion by fish generally increased with fish biomass, it is suggested that nutrient excretion by fish might stimulate growth of algae (Opuszynski 1979, Starling 1993). Boyd (1973) reported that fish excreta and uneaten portion of feed in catfish ponds supply large quantities of nutrients. Studies in catfish ponds in Alabama, USA demonstrated close relationships among feedings rates, microalgal abundance and the frequency and severity of low dissolved oxygen concentrations (Tucker et al. 1979)

Six planktonic groups were identified out of which 4 were from phytoplankton and 2 were from zooplankton. Similarly, Khan et al. (2005) recorded 4 group of phytoplankton and 2 groups of zooplankton. A total 29 genera of planktons, among these 20 of phytoplankton belonging to Bacillariophyceae (4), Chlorophyceae (9), Cyanophyceae (5) and Euglenophyceae (2) and 9 of zooplankton belonging to Rotifera (3) and Crustacean (6) were identified. More or less similar results are also made by Khan et al. (2005) and Dewan et al. (1991). Thus the recorded planktonic communities of the present experiment reflect the typical feature of plankton in tropical fish pond.

The mean abundance of total phytoplankton was ranged from $58.13x10^3$/L to 74.31x103/L in different treatments. Chlorophyceae was dominant among the phytoplankton group and Euglenophyceae was the least dominant group. The total zooplankton concentration was found to range from 2.5 $x10^3$/L to 6.59x103/L among the different treatments. Total phytoplankton and zooplankton comprises 93.94% & 6.06%, in T_1, 92.01% & 7.99%, in T_2 and 94.60% & 5.39%, respectively in T_3. The mean value of total plankton was ranged from 61.7 $x10^3$/L to 78.69 $x10^3$/L among the different treatments which is more or less similar to the findings of Mumtazuddin and Khalique (1987). Total plankton was not significantly (P>0.05) different among the treatments, might be due to the same stocking density and combination of the cultured species. The abundant planktonic population throughout the study period might be due to regular application of feed daily and fertilizer at five days' interval.

Growth and production performances of *C. batrachus*

In the present experiment the average final weights and length were 70.2±2.34g & 21.1±0.74cm, 64.6±3.35g & 20.3±1.23cm and 57.7±1.49g & 20.5±0.96cm in T_1, T_2 and T_3, respectively (Table 6). The net gain of individual fish in T_1 was higher (39.6g) than those of treatments T_2 (34.0g) and T_3 (27.1g). Weight increments were statistically significant (P>0.05) among the treatments. The highest growth in weight and were observed in $T_{1,}$ due to supply of high quality protein supplement feed. The stocked fishes were feed 30%, 27% and 24% protein contained feed. The best results were obtained from where the fishes were supplied 30% protein supplement diet and followed by 27%, 24% protein diets, this finding are supported by Chuapoehuk (1987) who carried out experiment with 30, 35 and 40% protein diets and observed that the diet containing 30% protein produced optimum growth, but Mollah and Hossain (1990) tested different diets containing 30% 34.7%, 39.5%, 44.1% and 48.9% protein in dry weight basis and reported that 39.5% protein is optimum in diet for commercial rearing of *Clarias batrachus* . Rahman et al. (1987) reported that 45% crude protein gave the best results. However, the mentioned results contradict with the findings of Chuapoehuk (1987) and Mollah and Hossain (1990) they report that 30% and 39.5% respectively, crude protein in the diet gave the optimum growth in *C. batrachus*.

The FCR values in the present study ranged between 2.05 to 4.14, which were significantly (P>0.05) different among the treatments (Table 7). The lowest value was recorded in T_1 (2.05) with diet-1 where the fish's feeds on poultry viscera (60%) and rice polish (40%), followed by T_2 (3.62) and T_3 (4.14) Haque et. al. (2005) recorded comparatively lower FCR value by using BFRI formulated feed containing 30.44% crude protein. The FCR value in T_3 was much higher than the findings of Haque et al. (2005) might be due to low protein level (24%) and less feed utilization. The specific growth rates of *C. batrachus* were significantly influenced by the dietary protein levels. The SGR value in T_3 was very low (0.70). Significantly higher (P<0.05) SGR (0.92) were found in T_1. The survival rates during the experiment period were not significantly different (P>0.05) among the treatments. The net production were ranged from 2595.2 to 3389.4 kg/ha among the different treatments, which were much higher than the findings of Haque et al. (2005) who recorded the total production ranged between 1398.08 and 2145.34 kg/ha, might be due to stocking of large size fishes. The highest net productions were observed in T_1 with poultry viscera and rice polish supplement diet and lowest in T_3. The net productions are significantly different (P>0.05) among the treatments.

Table 6. Growth in weight and length of *C. batrachus* after 90 days rearing under different treatments.

Parameters		Treatments		
		T_1	T_2	T_3
Growth (g)	Initial	30.6±3.55	30.6±3.55	30.6±3.55
	Final	70.2±2.34 [a]	64.6±3.35 [a]	57.7±1.49 [b]
	Net gain	39.6±0.55 [a]	34.0±0.78[a]	27.1±0.68[b]
Length (cm)	Initial	15.7±0.79	15.7±0.74	15.7±0.52
	Final	21.1±0.74 [a]	20.3±1.23 [a]	20.5±0.96 [a]
	Net gain	5.4±0.66 [a]	4.6±0.37[a]	4.8±0.22 [a]

Figures in the same row having same superscripts are not significantly different

Table 7. Growth, survival and production performance of *C. batrachus* among the treatments.

Parameters	Treatments		
	T_1	T_2	T_3
FCR	2.02 [c]	3.62[b]	4.14 [a]
SGR %(g. day^{-1})	0.92±0.21 [a]	0.83±0.10 [a]	0.70±0.025 [b]
DWG (g. day^{-1})	0.44±0.65 [a]	0.37±0.87 [a]	0.30±1.01 [b]
Survival rate (%)	94.5±1.56[a]	93.25±1.89 [a]	91.25±2.57 [a]
Net production (Kg/ha)	3389.4±240.23 [a]	3132.9±387.48 [a]	2595.2±456.45[b]

Figures in the same row having same superscripts are not significantly different

Table 8. Input cost and economic return n in *C. batrachus* for 90 days in ponds of three different treatments.

Components	Treatments		
	T_1	T_2	T_3
Fingerlings (Tk/ha)	4,33,640	4,33,940	4,33,940
Feed cost (Tk/ha)	88,920	1,68,242	1,46,305
Miscellaneous (Tk/ha)	51,870	51,870	51,870
Total cost (Tk/ha)	574,430 [b]	6,54,052 [a]	6,32,115 [a]
Total return (Tk/ha)	12,87,972 [a]	11,90,502 [a]	9,86,176 [b]
Net profit (Tk/ha)	7,13,542 [a]	5,36,450[b]	3,54,061 [c]
Cost per unit of yield (Tk/kg)	169.4 [b]	208.76 [a]	243.57 [a]
Net profit per unit of yield (Tk/kg)	210.52 [a]	171.23 [b]	136.42 [c]
Cost and benefit ratio	1:1.24 [a]	1:0.82 [b]	1: 0.56 [c]

Figures in the same row having same superscripts are not significantly different

Economic analysis and profitability

The cost of different inputs and economic return from the sale of fishes in different treatments are summarized in table 16. The total cost of inputs and economic return per hectare were significantly different (P>0.05) among the treatments. The cost of input was lowest in T_1 and followed by T_2 and T_3. The net economic return was highest in T_1 and lowest in T_3. The cost per unit of yield ranged from 169.4-243.57Tk/kg, which was significantly (P>0.05) different among the treatments. The highest was in T_3 (243.57 Tk/kg) followed by T_2 (208.76 Tk/kg) and T_1 (169.4 Tk/kg). Similarly, the net profit per unit of yield was highest in T_1 (210.52 Tk/kg) and lowest in T_3 (136.42 Tk/kg), which was significantly different among the treatments. Cost and benefit ratio were calculated 1:1.24, 1: 0.82 and 1: 0.56 among T_1, T_2 and T_3, respectively (Table 8).

Along with the increase in production, the purpose of aquaculture practices is to earn a profit. Wyban et al. (1988) indicated that stocking density, growth rate, survival and market price are the most sensitive factors to increase profit. After the fry price of feed constituted the highest operational cost and make a positive relation with the net profit among the treatments. The total cost of inputs and economic return per hectare were significantly different (P>0.05) among the treatments. The cost of input was lowest in T_1 and followed by T_2 and T_3. The net economic return was highest (7, 13,542Tk/ha) in T_1 and lowest (3, 54,061Tk/ha) in T_3. The net economic return was so much higher than the findings of Haque et al. (2005) who obtained net profit ranged from (1,15,047K/ha to 2,71,178TK/ha) might be due to more production and high market prices of fishes. The cost per unit of yield ranged from 169.4-243.57Tk/kg, which was significantly (P>0.05) different among the treatments. The highest was in T_3 (243.57 Tk/kg) followed by T_2 (208.76 Tk/kg) and T_1 (169.4 Tk/kg). Similarly, the net profit per unit of yield was highest in T_1 (210.52 Tk/kg) and lowest in T_3 (136.42 Tk/kg), which was significantly different (P>0.05) among the treatments. Cost and benefit ratio were 1:1.24, 1: 0.82 and 1: 0.56 among T_1, T_2 and T_3, respectively.

The application of low-cost on farm fish feed have much potential for reducing feed cost without affecting growth rate and yield. Considering, the growth performance, FCR value, overall production and net profit, the best result was obtained from T_1 with Diet-1. Thus diet 1 containing poultry viscera 60% and rice polish 40% may be recommended as a suitable diet for culture of *C. batrachus.*

References

Ahmed, K., Mustafa, G., Ali, S. and Shahjahan, M. (1985). Induced Spawning of Magur Fish, *Clarias batrachus* (L.) by StrippingMethod in Plastic Bowl Hatchery. *Bangladesh Journal of Zoology*, 13(1): 19-24.

Association of Official Analytical Chemists (AOAC) (1980). Official methods of Analysis of the Association of Analytical Chemists. (ed. W. Horwitz), 13th edition, Washigton, D. C. 1018pp.

Belinger, E.G. (1992). A Key to Common Algae. The Institute of Water and Environmental Management, London, UK.

Bhuiyan, A. L. (1964). Fishes of Dacca. *Asiatic Society of Pakistan,*Dacca. 148pp.

Bhuiyan, S. A., Islam, M. N. and Hossen, T. (1992). A check list of the fishes of Rajshahi. *The Rajshahi University Studies*, pp**:** 287-306.

Boyd, C. E. (1973). Summer algal communities and primary productivity in fish ponds. *Hydrobiologia.* 40: 357-390p.

Britz, P. J and T. Hechet. (1987). Temperature preferences and optimum temperature for growth of African catfish (*Clarias gariepinus*) larvae and post larvae *Aquaculture.* 63(1-4): 205-214p.

Clay, D. (1979). Population biology, growth and feeding of African catfish (*Clarias gariepinus*) with special references to juvenile and their importance in fish culture. *Arch. Hydrobiol*. 87(4**)**: 453-482p.

Chuapoehuk, W. and T. Pothisoong. (1978). A preliminary study of pond production of *Clarias batrachus* (Linn.) fed a hard pellet. Thai Fish. Gaz. 31(4**)**: 313-318.

Dewan, S., M. A. Wahab, M. C. M. Beveridge, M. H. Rahman and B. K. Sarker. (1991). Food selection selectivity and dietary overlap among planktivorous Chinese and Indian major carps fry and fingerlings grown in extensively managed, rain-fed ponds in Bangladesh. *Aquacult and Fish Management*. 22: 277-294p.

Hafizuddin, A. K. M. (1985). Freshwater fishes of Chittagong and Chittagong Hill Tracts. *Chittagong University Studies, Part II*, 9(2): 65-70.

Hafizuddin, A. K. M., Mahmood, N. and Azadi, M. A. (1989). An addition to the Ichthyofauna of Kaptai lake. *Bangladesh Journal of Zoology*, 17(1): 29-33.

Haque, F., S. Khan, Z. Ferdoushi, M. M. Haque and M. R. U. Sarkar. (2005). Nutrient loading and microalgal proliferation in pangasid catfish, *Pangasius hypophthalmus* culture ponds. *Bangladesh. J. Fish*. 29(1-2): 55-62p.

Hossain, M. M., S. Khan, M. R. U. Sarkar and M. M. Haque. (2005). Microalgal community structure in experimental carp-pangasid catfish polyculture ponds. *Bangladesh J. Fish. Res*. 9(2**):**121-132p.

Islam, M. S. and Hossain, M. A. (1983). An account of the fishes of the Padma near Rajshahi. *Rajshahi Fisheries Bulletin*, 1(2): 1-31.

Jena J. K. P. K. Aravindakshan, S. Chandra, H. K. Mudili and S. Ayyappan (1998). Comparrative evaluation of growth and survival rate of Indian major carps and exotic carps in raising fingerlings. *J. Aquacul. Trop*. 13(2): 143-150p.

Khan. M. G. Q., M. A. Hasanat, M. M. Hassan and M. Z. Rahman. (2005), Effects of different stocking density of Indian major carps (*Labeo rohita, Catla catla* and *Cirrhinus cirrhosus*) and Thai Pangas (*Pangasius hypophthalmus*) on plankton population in pond culture system. *Bangladesh. J. Fish.* 29(1-2): 11-22p.

Kloke, C. W. and M. Potoros. (1975). The technology and economics of catfish (*Clarias* sp.) farming in Thailand, *IPFC Occasional paper*. 1975/2.

Mookerjee, H. K. and Mazumder, S. R. (1950). Some aspects of the life history of *C. batrachus. Proceedings of the Zoological Society of Bengal*, **3**(1): 71-84.

Mollah, M. F. A. and M. A. Hossain. (1990). Effects of artificial diets containing different protein levels on growth and feed efficacy of catfish (Clarias batrachus). *Indian. J. Fish*. 37(3):251-259p.

Mumtazuddin M. and M. A. Khalique. (1987). Observation on the growth potential of carp hatchings in relation to fertilization and supplemental feeding. *Bangladesh J. Fish*. 2-5**:** 83-90p.

Opuszynski, K. (1979). Silver carp, *Hypophthalmichthys molitrix* (val.) in carp ponds. III. Influence on ecosystem. *Ekol. Pol*. 27: 117-133p.

Prescott, G.W. (1962). Algae of the Western great Lake Area. Wm.C. Brown Co., Dubugue, Iowa.

Rahman, M. A. S. Gheyasuddin, M. A. Mazid, M. Zaher and M. A. Hossain. (1987). Formulation of quality fish feeds from indigenous raw materials for intensive culture of catfish (*C. batrachus*). *Bangladesh. J. Fish*., **(**1): 59-66.s

Rahman, A. K. A. (1989). Freshwater Fishes of Bangladesh. *TheZoological Society of Bangladesh,* Dhaka, pp. 364.

Sarkar, M. R. U., S. Khan and M. M. Haque. (2005). Production and economic return in pangasid catfish (*Pangasius hypophthalmus*) monoculture and polyculture with silver carp (*Hypophthalmichthys molitrix*) in farmers ponds. *Bangladesh J. Fish*. 9(2**)**:111-120p.

Starling. F. L. R. M. (1993). Control of eutrophication by silver carp (*Hypophthalmichthys molitrix*) in the tropical Paranoa reservoir (Brasilia, Brazil): a mesocosm experiment. *Hydrobiologia*, 257: 143-152p.

Stirling, H.P. (1985). Chemical and Biological Methods of water Analysis for Aquaculturists. Institute of Aquaculture, University of Stirling, Scotland, UK.

Tucker, L., C. E. Boyd and E. W. McCoy, (1979). Effects of feeding rates on water quality, production of channel catfish and economic returns. Trans Am. Fish. Soc., 108: 389-396p.

Viveen, W. J. A. R., C. J. J. Richter, P. G. W. J. Van Oordt, J. A. L. Jansen and E. A. Huisman (1985). Manual for the culture of the African catfish (*Clarias gariepinus*) Directorate General for international Corporation. The Hauge, The Netherlands 93 pp.

Wyban, J. A., J. N. Sweeney and R. A. Kanna, (1988). Shrimp yields and economic potential of intensive round pond system. *J. World Aquaculture*. Soc., 19 (4): 201-217.

Yadav, B. N. (1997). Food feeding habits and alimentary canal. Fish and Fisheries. Daya Publishing House, Dellhi. 25p.