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Bangladesh J. Sci. Ind. Res. **52(3)**, 187-194, 2017

BCSIR

BANGLADESH JOURNAL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

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Culture technique of endangered *Notopterus chitala* (Hamilton, 1822) with *Oreochromis niloticus* for domestication in pond habitat

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Abstract

An experiment was carried out for a period of 180 days (1st April to 30 th September) in 2015 to find out the suitable culture technique of *Notopterus chitala* (Hamilton-Buchanan, 1882) in pond habitats located at the Hatchery Complex, Department of Fisheries, University of Rajshahi. The experiment was conducted under 3 treatments (T_1: only feed used, T_2: feed and Tilapia,T_3:only Tilapia used) each with 3 replications. Mean stocking weight of *Notopterus chitala* was 21.4±0.27 g for all treatments. Basal fertilization was same for all the treatments (cowdung: 1235 kg/ha, urea: 50 kg/ha, TSP: 50 kg/ha). Feed (8-10% of body weight) and fertilized (weekly with cowdung 1000 kg/ha,) based farming was followed in all treatments. Mean value of water temperature varied from 32.53±0.04°C (T_2) to 32.57±0.03°C (T_1) to transparency 32.34±0.68 (T_2) cm to 33.87±0.37 cm (T_3), Dissolved Oxygen 4.76±0.04 mg/l (T_3) to 4.91±0.04 mg/1 (T_1), pH 7.62±0.03 (T_1) to 7.70±0.05 (T_2) , alkalinity 127.04±1.4 mg/l (T_2) to 131.46±0.92 mg/l (T_3),respectively. The mean value of different growth parameters varied with the followings-final weight 380±.88 g (T_1) to 645 ± .57 g (T_2), weight gain 358.6 ± .14 g (T_1) to 623.60± .02 g (T_2), SGR (% bwd^{-1}) 3.84±.02 (T_1) to 4.54± .01 (T_2).The survival rate between 93.33±6.67 % (T_1) to 100 ± 0.00 %(T_2), and the total production of *Notopterus chitala* was found 1593.2±2.46 (T_2) Kg/ha/180 days which was significantly higher than that of others treatments 938.6 ±31.29 (T_1), 1133.7±62.98 (T_3) respectively. The growth parameters are significantly different among the treatments. The total production of Tilapia was observed 1790.18±0.7 (T_2) kg/ha/180 days which was higher than 1584.9±0.39 (T_3).The combined production (Chital + Tilapia) of fish was obtained 3383.2±2.86 (T_2) which was higher than those of 938.6 ±31.29 (T_1) and 2718.6±50.1 (T_3) respectively. The total income raised from 394200±6.36 BDT/ha (T_1) to 736548±24.04 BDT/ha (T_2), net profit 209180±12.49 BDT/ha (T_1) to 468258±17.63 BDT/ha (T_2) and CBR 1.13±.01 (T_1) to 1.75±.02 (T_2) respectively and all growth parameters were significantly ($P<0.05$) different among the treatments. Treatment T_2 (feed and Tilapia used) was proved best in terms of production and economics of *N. chitala* culture in pond habitats based on experimental results.

Keywords : Culture technique; Domestication; Riverine; Endangered; *Notopterus chitala*

Introduction

The carnivorous and predatory *Notopterus chitala* is known as Chital in Bangladesh. Feather-Backs, comprising the genus *Notopterus*, are represented in India by two species, viz., *N. notopterus* and *N chitala*, of which *N. notopterus* has a widespread distribution. It abounds in fresh and brackish waters from India to Malay Archipelago (Day, 1878).Besides being consumed both in fresh and dry state, the species has many potential uses (Anon, 1962). *Notopterus chitala* (Hamilton, 1822) belongs to family Notopteridae found in India, Bangladesh, Pakistan and other regions of Asia. It inhabits standing and sluggish waters of lakes, floodplains, canals and ponds. In captivity, it is however cultured in tanks throughout the greater parts of India. During breeding season it moves from fresh water to brackish waters for reproduction (Riehl and Baensch, 1989). It feeds on insects, small fishes, crustaceans and sometimes on young roots of aquatic plants. It breeds annually and migrates to spawning grounds during rainy days and then back to permanent habitat in dry season (Rainboth, 1996).

N. notopterus is commonly found in ponds, especially in wild tanks. The accessory respiratory function of the swim bladder of the fish has been reported by Dehadraj (1962). Biology of this species has not been thoroughly worked related to its food and feeding habits and breeding are not available. (Mookherjee and Majumdar, 1946; Menon *et al*., 1959). This fish is rich in nutritive value and gets high market price despite of the presence of a large number of intramuscular bones. In addition to the above qualities, Chital plays a significant role in regulating the population imbalance that

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may be caused by wild breeding of common carp, abundance of other minnows and insects in ponds under composite carp culture where strict control on the population size of the stocked fish is essential to obtain optimum production (Chaudhuri *et al*., 1975).

Carnivorous fish species like bronze feather back or chital (*Notopterus notopterus*)obtains high prices in the domestic market. The present research work was conducted on the feasibility of growing chital in small sized ponds along with a fast breeding fish species like tilapia (*Oreochromis mossambicus*), which was introduced to India in 1954 (Mazid and Alam, 1995) and can thrive well in shallow water bodies. They have a high breeding rate and can therefore provide a continuous source of diet for chital. Our hypothesis was that, if chital can be successfully grown in small ponds along with tilapia, that would benefit the small growers not only through the sale of chital at high prices, but also through reducing fish feed costs for the culture. Additionally, the farmers can generate income through the sale of harvested tilapia.

Although *Chital* is a tasty, commercially important endangered fish of Indian subcontinent, published reports on its induced breeding, developmental biology and larvae rearing are quite scanty. Very limited research has been conducted on *N. chitala*. Earlier attempts have been made to study its reproductive biology (Kohinoor *et al*., 2012), captive breeding (Hossain *et al*., 2006; Sarker *et al*., 2006), and effects of climate change on the occurrence of *C. chitala* (Banik and Roy, 2014) of this fish have been investigated. Salient researches have been done on the carp and cat fish culture in Bangladesh exception a predatory fish culture in ponds. Development of a simulation model of Chital production may help researchers as well as fish farmers to make decision regarding different inputs use and adoption of management practices for Chital production in aquaculture ponds. So, the present study is conducted to estimate the growth performance of *Notopterus chitala* in ponds with integrated efforts on feed and Tilapia with cost and benefit matters.

Materials and methods

Place and duration of experiments

This experiment was carried out in three experimental ponds situated on the north side of the Fisheries Department in Agricultural Faculty Building, University of Rajshahi, started from 1 April till 30 September, 2015. The experimental ponds for the rearing of fingerlings were 0.50 decimal in area with average water depth of 1 meters T_1, T_2 and T_3 respectively. Water quality was analysed in the Laboratory of Department of Fisheries, University of Rajshahi. The water depth was maintained around 1m using pump machine at regular intervals.

Experimental design

The present experiment was conducted with three treatments namely T_1, T_2 and T_3 each with three replications. The experimental layout has been given in the Table-I below:

Table I. Design of the experiments conducted

Treatment	Feed	Stocking density
T_1	Feed	10 Chital/decimal
T_2	Feed +Tilapia (50)	10 Chital /decimal
T_3	Tilapia (50)	10 Chital /decimal

Pond preparation

Aquatic weed were removed manually and pond water pumped out, then the ponds were exposed to sunlight for about 2 weeks. Pond walls and bottom were repaired where necessary. Liming was done at the rate of 0.5kg/decimal. After 7 days of liming experimental ponds were filled up with water up to 1 meter with shallow water pump machine that was run by electricity. Here after, the research ponds were fenced by nylon net with bamboo sticks. Cowdung (2000 kg/ha), Urea (50 kg/ha) and TSP (50 kg/ha) were applied uniformly into the ponds after 7 days of liming by throwing.

Collection of fishes

The fingerlings of Chital (Notopterous chitala) was collected from Padma River and Tilapia from private nursery operator in Rajshahi district. Fingerlings were transported to the experimental sites through plastic bags with proper aeration.

Stocking of fish

Since Chital is carnivorous and Tilapia omnivorous, it was assumed from the beginning that at least a percentage of Tilapia fish added would end-up as a source of food for Chital. Tilapia (Both male and female) was released 60 days prior to the release of Chital fish, such that enough Tilapia fry were present to serve as food of Chital fish. Stocking was done in the morning when the pond water temperature remained low and care was taken to gradually acclimate the fish to the pond conditions. Initial average length (12.80 ± 0.25cm) and weight (21.4 ±0.27g) of fry were taken before stocking in the ponds.

Feed preparation and feeding

All experimental diets contained 22% protein (in dry matter), with mixture of raw materials such as fish meal, mustard oil cake, rice bran, wheat bran, wheat flour and maize bran. Oil was also provided in the mixture to maintain energy balance. The composition of feed ingredient was presented in Table II.

The diets were processed as pellets in the laboratory. The supplemental feed was given to fingerling at the rate of 10% and 8% at first three months and last three months respectively. The quantities of feed were adjusted every 30 days interval on the basis of increase in the average body weight of the stocked biomass. Half of the ration was supplied at 9.00 am and remaining half was supplied at 4.00 pm. The proximate composition of each feed were carried out following A.O.A.C Method (1990) in table III.

Table II. Composition of feed ingredient used in the experiments

Ingredients	Percentage (%)
Fish meal	25
Rice bran	15
Wheat bran	15
Mustard oil cake	20
Maize bran	15
Wheat flour	10

Table III. Proximate composition of feed used in the experiments

Components	Diets
Moisture	9.7 %
Crude protein	22.5%
Crude lipid	12.6%
Crude fiber	15.5%
Ash	10.85%
NFE	28.85%

* Nitrogen free extract (NFE) calculated as

100-% (Moisture + Crude protein+ Crude lipid+ Crude Fiber+ Ash)

Growth sampling of fishes

Fishes were sampled on every month interval in the morning (09:00 to 10:00 hrs). The length and weight were recorded by random sampling of 10 % Chital fishes from each pond. Length was taken by using a centimeter scale and weight by using a balance from each experimental pond by using a small net. Fishes were handled carefully to avoid stress during sampling.

Fish harvesting

Harvesting was done in the month of September 2015 by dewatering after completion of the trial and other necessary procedures.

Water quality monitoring

A number of physico-chemical parameters of pond water were monitored monthly from 9.00-10.00 am and analyzed by using HACH water quality analytical kit (FF-2, USA). Transparency was measured by a secchi disc of 20 cm diameter. The water temperature was recorded by a centigrade thermometer (0°C to 120°C) from different place of the pond. The dissolved oxygen concentration, pH, total alkalinity and ammonia-nitrogen of water were measured by the aid of a water quality test kit (HACH kit model FF-2, USA) at the pond site.

Analysis of experimental data on the growth parameters

Fish were weighed to gram using an electronic balance. All fish growth parameters were calculated on different aspects such as length and weight gain, survival rate, specific growth rate (SGR) and production of fishes. The procedure of calculation is as follows:

Length gain (cm) = Average final length – Average initial length

Weight gain (g) = Mean final weight (g)- Mean initial weight (g).

$$\text{SGR } (\%\ \text{bwd}^{-1}) = \frac{\text{ln final weight-In initial weight}}{\text{Culture period in days}} \times 100 \text{ (Brown, 1957)}$$

$$\text{Survival rate } (\%) = \frac{\text{Number of fish harvested}}{\text{Number of fish stocked}} \times 100 \text{ (De Silva, 1989)}$$

Production= No. of fish harvested x final weight of fish

Statistical analysis

Average final fish weights, food conversion value (FCR), specific growth rate (SGR) were calculated for each dietary treatments at the end of the experiments. Water quality, growth, survival rates (%) and fish production were subjected to using one-way analysis of variance (ANOVA) and tested Duncan's New Multiple Range Test (DMRT) to identify significant differences among the mean values .This statistical analysis was performed with the support of the computer software SPSS (Statistical package for social sciences, 16) program (Zar, 1984).

Results and discussion

The results and discussion of the present experiment regarding compositions of growth, survival rate, water quality parameters and production of fishes are presented below

Hydrological parameters

The mean values of water quality parameters such as water temperature, transparency, pH, dissolve oxygen and alkalinity with standard deviation (SD) under different treatments are shown in Table IV. Water parameters were not significantly ($P<0.05$) different among the treatments observed.

Table IV. Mean values (±SD) of water quality parameters

Treatment parameters	T_1	T_2	T_3
Temperature (^{0}C)	32.57±0.06^a	32.53±0.04^a	32.55±0.03^a
Transparency (cm)	33.16±0.49^a	32.34±0.68^a	33.87±0.37^a
pH	7.62±0.09^a	7.70±0.05^a	7.69±0.03^a
DO (mg l^{-1})	4.91±0.04^a	4.85±0.08^a	4.76±0.04^b
Alkalinity (mg l^{-1})	130.08±0.42^a	127.04±1.4^b	131.46±0.92^a

Parameters were not significantly different (p<0.05) among the treatments.

The major hydrological parameters that were recorded during the study period were similar to data reported in other such studies. Boyed (1998) reported that suitable water temperature of 25-32°C for warm water aquaculture of species. In the present study the mean values of water temperature was found to be ranged from 32.53±0.04 to 32.57±0.06°C. In the present experiments higher temperature (32.57±0.06°C) with the treatment T_1 and the lowest temperature (32.53±0.04 ºC) with the treatment T_2 were observed. This statement complies with Ali *et al*. (1982) who found the temperature to be ranged from 20.5-36.5°C. This statement is also more or less similar to Chakraborty *et al*. (2005) and Alim (2005). Water transparency is a gross measure of pond productivity. Comparatively higher mean value (33.87 ± 0.37 cm) of water transparency was observed with the treatment T_3 and lower mean value (32.34±0.68 cm) was recorded in the treatment T_2.This finding strongly agreed with Boyed (1998) who found transparency between 30-45cm as good for fish culture. Tasneem (1998), Israfil (2000), Khatun (2004), Chowdhury (2005), recorded almost similar transparency values of pond water in related experiments. According to Swingle (1967), pH values ranging from 6.5 to 9.0 were observed suitable for pond fish culture which is similar in the present study. The mean value of dissolve oxygen was found to be ranged from 4.76±0.04 (T_3) to 4.91±0.04 (T_1) mg/L. This statement is in conformity with Haque (1996), Tasneem (1998), Israfil (2000), Khatun (2004), and Sarker (2007). Ellis *et al*. (1946) reported that the dissolved oxygen content at levels of 3 ppm or less should be regarded as hazardous to lethal and 5 ppm or more dissolved oxygen is suitable for fish production. In the present experiment the mean dissolved oxygen values were closely near to suitable range. Total alkalinity values in the present study are strongly advocated with the findings of Hossain *et al*. (2006) and Haque *et al*. (2005), who recorded the values ranging from 81.25 to 147,87.33-114.0 mg/l^{-1}, 41.0-208.0 mg/l^{-1} and 71.0- 175.0 mg/l^{-1} respectively.

Growth and production performance of N. chitala

Growth parameters such as final weight, gain in weight, average daily gain, and SGR% (Table-V) showed statistically significant (p<0.05) differences between three treatment groups whereas the initial weight has no significant (P<0.05) variation.

In the present study the mean final weight 380±.88 g to 645 ± .57 g and mean final length varied from 20.80±.01cm to 29.30±.01cm which is more or less similar to Biswas *et al*. (2011). The growth was almost similarto the three treatments a period for 180 days. Biswas *et al*. (2011) worked on Seabass culture with prey feeding system for 120 days and reported that the mean final weight ranged from 366.43±116.89g to 486.33±130.56g and mean final length ranged from 305.53±25.27 mm to 325.33±32.52mm. Mackinnon (1989) reported 400-450 g growth in a commercial grow-out trial of seabass with 35% survival over a period of 10 months.

N. chitala was found to be fast-growing fish and reached 2 kg in 243 days (Rahmatullah *et al*., 2009). The highest final weight (645±.57g) was found with the treatment T_2 (with feed and Tilapia) and fairly similar final weight (510±.88 g) was found with the treatment T_3 (with Tilapia) whereas lowest final weight (380±.88 g) was found with the treatment T_1 (with only feed). The highest weight gain 623.60±.01g in T_2 might be due to the fact that the fish had received the tilapia fry as feed at a time and effectively utilized the applied feed effectively converted into muscle. Fish length and weight gain of Chital in the present study were highest (16.5±.05cm and 623.60±.01 g respectively) in the fish fed with Tilapia fry+feed in T_2 and the lowest gain (8.03±.05cm and 358.60±.14g) was observed in fishes using only feed (once) monthly in T_1. Haque *et al*. (1993) observed the daily average weight gain of carp fry 0.391 g/day with a mixture of rice bran and mustard oil cake (1:1) as supplemental feed fed at the rate 5% of total fish body weight daily. The present study is more or less similar with Rahmatullah *et al*. (2009) who worked on Chital withTilapia and recorded the average weight gain of Chital 4.42g per day.

Sugama and Eda (1986) showed that the average daily growth of 4.62 to 6.05 g in net cage culture with trash fish. Growth and production are dependent on the amount of supplied feed (Bardach *et al*., 1972). Genodepa (1986) harvested 351.5 g of seabass with a stocking size of 221.5 g having a culture period of 94 days (daily growth rate of 1.3 g) using trash fish in a monoculture pond. Abbas *et al*. (2013) studied that the *Notopterus notopterus* and *Rita rita* having average body weight of 75.0 ± 7.1 gm and 59 ± 15.1 gm and corresponding length of 21.7 ± 0.8 cm & 17.1 ± 1.5 were

Table V. Variation in the mean values of growth parameters under different treatments during the study period

Treatments Parameters	T_1	T_2	T_3
Initial weight (g)	21.4 ±0.27 ^{a}	21.4± 0.27^a	21.4± 0.27 ^{a}
Final weight (g)	380±0.88 ^{c}	645 ± 0.57 ^{a}	510± 0.88 ^{b}
Weight gain (g)	358.6 ± 0.14 ^{c}	623.60± 0.02 ^{a}	488.60 ±0.02 ^{b}
Initial length(cm)	12.80 ± 0.25 ^{a}	12.80 ±0.25 ^{a}	12.80 ±0.25 ^{a}
Final length(cm)	20.80± 0.01 ^{c}	29.30 ± 0.02 ^{a}	25.80±0.01 ^{b}
Length gain(cm)	8.03± 0.05 ^{c}	16.5±0.05^a	13.20±0.08 ^{b}
SGR (% bwd^{-1})	3.84±0.02 ^{c}	4.54±0.01 ^{a}	4.23 ±0.01 ^{b}
ADG	4.78±0.02^c	8.31±0.02 ^{a}	6.51±0.01 ^{b}
Survival rate (%)	93.33±6.67 ^{a}	100 ± 0.00 ^{a}	93.33± 6.67 ^{a}
Initial weight (g) of Tilapia	Absence of Tilapia	30.17±0.23	30.17±0.23
Final weight (g) of Tilapia	Absence of Tilapia	145.10 ±0.1	138.10±0.11
Yield of Chital (kg/ha/6months)	938.6 ±31.29 ^{c}	1593.2±2.46 ^{a}	1133.7±62.98 ^{b}
Yield of Tilapia(kg/ha/6months)	Absence of Tilapia	1790.18±0.7	1584.9±0.39
Total yield (kg/ha/6months)	938.6 ±31.29 ^{c}	3383.2±2.86 ^{a}	2718.6±50.1 ^{b}

Figures in a row bearing common letter(s) do not differ significantly (p<0.05)

determined respectively .The result of present study is more or less similar to the aforementioned citations.

The average daily gain was also found higher in the treatment T_2 (8.31±00) whereas, the lowest value was found in T_1 (4.78±.01). All values were significantly (P<0.05) different among the treatments. ADG were 0.119±0.005g, 0.128±0.016g, 0.134±0.024g at the end of 15, 35, 60 days respectively and in treatment B (28% protein) where it was 0.098±0.006g, 0.099±0.003g, 0.104±0.002g.

In the present study, the specific growth rates of Chital (SGR% bw/day), 3.84±.01, 4.54±.01 and 4.23±.01 % per day was found in T_1, T_2 and T_3 which is more or less similar to the finding of Hossain and Islam (2006), who reported the SGR (bwd^{-1}) prawn, catla, rohu and silver carp ranged from 3.99 to 4.26%, 3.71% to 3.83%, 2.49 to 2.55% and 2.44% to 2.59% respectively. From the above discussion it can be concluded that the higher specific growth rates in T_2 where fish maximum used feed and Tilapia fry.

In the present study, the survival rates were different in different experimental ponds. The survival rate of Chital was found to be 93.33±6.67, 100±00 and 93.33±6.67 in treatments T_1, T_2 and T_3 respectively (Table-V). Significant difference (P<0.05) was noticed among the treatments for the mean values of survival rate. The survivability rate of *N. chitala* fry was significantly affected by different feed used (Hossain *et al*., 2006).During the present study, the mean survival rate varied from 93.33±6.67 to 100±00 %. This survival rate is more or less similar to the survival rate of 92.00 to 98.50 %, recorded by Hossain *et al*. (2006) who reported that, the highest survival rates of *N. chitala* fry (98.50%) was observed when *Barbados gonionotus* spawn and *Tubifex* sp. was used as feed for *N.chitala* fry, followed by (96.0%) *Barbados gonionotus* spawn and *Hypophthalmichthys molitrix* spawn, while it was the lowest (92.0%) when *Barbados gonionotus* spawn and *Moina* sp. was used as feed for *N. chitala*. Ferdous *et al*. (2014) recorded survival rate from 79 to 92 % in Tilapia culture pond under different stocking densities

Production and economic generation

The cost of different inputs and economic return from the sale of fishes are summarized in Table VI. The total cost of inputs and economic return per hectare were significantly (p<0.05) different among the treatments.

The maximum production of *N. chitala* (1593.2±2.46 kg/ha/6 months) was obtained in T_2 when Tilapia and feed was used. The lowest fish production (938.6±31.29kg/ha/6 months) was observed in T_1 which might be due to only feed used. The extrapolated annual yields of Chital (*N. chitala*) were 0.92 t ha-1 year-1 (Rahmatullah *et al.,* 2009).The present result is much higher than the finding of Rahmatullah *et al*. (2009) which might be due to use of feed and Tilapia at a time.

The total production of fish (*N. chitala and O. niloticus*) ranged from 938.6±31.29 kg/ha (T_1) to 2319.38±2.86 kg/ha (T_2),which were more or less similar with the findings of Haque *et al*. (2005) who recorded the total production ranged between 1398.08 and 2145.34 kg/ha.

The cost of input was lowest in T_1 and followed by T_2 and T_3. The net economic return was highest (7,36,548 Tk/ha) in T_2 and lowest (3,94,212 Tk/ha) in T_1.The net economic return was much higher than the findings of Haque *et al*. (2005) who obtained the net profit ranged from 1,15,047 Tk/ha to 2,71,178 Tk/ha might be due to the more production and high market price of fish. The total cost (BDT/ha/6 months) varied from 185020±2.98 (T_1) to 268290±15.27 (T_2). Significant difference was found among the treatments for the total cost.

The cost benefit ratio (CBR) of *N. chitala* in different treatments of the present study varied from 1:1.3 (T_1) to 1:1.75 (T_2) showing significant difference among the treatments. This statement is more or less similar to Jannat *et al*. (2012). Samad *et al*. (2014) also calculated the CBR ranged between 1:0.56 to 1:1.24 of *C. batrachus* culture in earthen ponds.

Considering the growth performance, overall production, net profit and the best results were obtained from T_2 with Tilapia as feed, may be recommended as a suitable feed which for culture of *N. chitala*.

Conclusion

The total production of *N. chitala* was increased with the application of feed and Tilapia in T_2. So, we can expect for obtaining enhanced Chital production from ponds, which will increase the national economy of our country could be a great source of income and employment for the unemployed ones. This information is important to fish farmers as a management tool to achieve optimum fish growth, production and profitability. *N. chitala* is an endangered riverine fish in the prevailing conditions of Bangladesh. So we have to adopt proper management as soon as possible for its conservation. With a view to making the conservation measure more effective appropriate culture system should be taken to improve their conservation status. Pond rearing of this species can lead to domestication as well as conservation of endangered species *N. chitala*.

Table VI. Economics of different treatments of the experiment during the study period (6 months/ha)

Treatments / Economics	T_1	T_2	T_3
Pond preparation (BDT/ha)	26400±00 a	26400±00 a	26400±00 a
Cost of fry (Chital)	69160±00 a	69160±00 a	69160±00 a
Cost of fry (Tilapia)	Absence of Tilapia	49400±00	49400±00
Feed cost	42460±28.87 b	76330±23.33 a	Absence of feed
Operational cost	47000±00 a	47000±00 a	47000±00 a
Total cost (Tk/ha/6 months)	185020±2.98 c	268290±15.27 a	191940±18.56b
Return from Chital(Tk/ha/6 months)	394200±6.36 c	663930±14.89 a	414950±24.03 b
Return from Tilapia (Tk/ha/6 months)	---	179000±17.93 a	158400±9.40 b
Total return (Tk/ha/6months)	394200±6.36 c	842930±24.04 a	573350±14.89 b
Net benefit (Tk/ha/6 months)	209180±12.49 c	574640±17.63 a	381410±20.81 b
CBR	1.13±.01c	2.14±.02a	1.98±.01b

Figures in a row bearing common letter(s) do not differ significantly ($p<0.05$)

Input prices and fish prices were calculated according to Rajshahi fish market (Purchase price of Chital 28 BDT/fingerling, Purchase price of Tilapia 4 BDT/piece, selling price 420 BDT/kg Chital, selling price 100 BDT/kg Tilapia, 250 BDT/labourer etc.)

Acknowledgement

The authors are indebted to Department of Fisheries, University of Rajshahi, Bangladesh for providing necessary facilities to complete this research work.

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Received: 27 November 2016; Revised: 28 December 2016; Accepted: 29 May 2017.